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Research on the Impact of Logistics Infrastructure on Manufacturing Agglomeration

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Abstract: Logistics infrastructure is the foundation to guarantee the social activities of manufacturing enterprises. This paper collects and collates the panel data of 11 provinces and municipalities in eastern China from 2010 to 2019, selects the comprehensive road network density of roads and railways as the proxy variable of land transportation logistics infrastructure, uses location entropy to represent the degree of manufacturing agglomeration, applies the frontier econometric analysis method, establishes the threshold panel model, empirically tests the theory, and tests the spatial nonlinear economic impact of logistics infrastructure on manufacturing agglomeration. This paper draws the following conclusions: under the condition that the comprehensive road network density of logistics infrastructure is the threshold variable, the impact of logistics infrastructure on manufacturing agglomeration is non-linear, and the specific performance is the "inverted U" relationship of first strong and then weak. Consumption level, urbanization development level and opening degree promote manufacturing agglomeration. Labor cost, economic development level and government intervention negatively affect manufacturing agglomeration in the eastern region in order to guide the manufacturing enterprises to rationally distribute in space, to further guide the industrial clusters, to optimize the allocation of resources, and to provide a certain reference for the formulation of government policies and systems.

1. Introduction

In 2020, China coordinated the epidemic prevention and control and economic and social development, and became the only country in the world with a positive economic growth. Preliminary calculation showed that the GDP for the year was 1,015,986 billion yuan, up 2.3% over the previous year. The value-added of high-tech manufacturing industry increased by 7.1% over the previous year, accounting for 15.1% of the industrial value-added above designated size, and manufacturing workers accounted for about one-third of the total employment. It can be seen that manufacturing industry is the main force driving the real economic growth and easing the severe employment situation. With the continuous updating of the industrial structure and the continuous expansion of the industrial scale, the logistics infrastructure in many regions cannot meet the development requirements of the industry, resulting in the lack of connectivity of logistics and transportation between regions, which affects the development of less developed regions. The 19th National Congress pointed out that at this stage, the economic growth rate is slowing down and the development quality needs to be improved. If we want to expand and strengthen the manufacturing enterprises, we must learn from the development experience of developed countries and combine with the actual situation in China to establish a comprehensive logistics and transportation system, reasonably strengthen the construction of logistics infrastructure, solve the problem of unreasonable allocation, and create favorable conditions for the rapid and balanced development of industrial manufacturing. It is of great significance to study the impact of logistics infrastructure on manufacturing agglomeration.

2. Literature Review

Wang Xinwei (2020) pointed out that the land transportation logistics infrastructure affects a city's economic development. A perfect land transportation logistics infrastructure can reduce the local logistics transportation cost, make exchanges between regions more frequent, and promote the agglomeration of manufacturing industry [1]. In 1990, the theory of new economic geography was proposed by paul krugman et al. The theory holds that the perfection of logistics infrastructure will have a great impact on the location of enterprises. Chen Ke, Yin Liangfu, Wang Junying, Han Bowen (2020) and others believe that the main reason is that the logistics infrastructure has accessibility, network and promoting factor mobility, which make the manufacturing enterprises in the region have a great spatial dependence, thus affecting the degree of agglomeration [2]. Jiang Lei (2018) used monetary form to express investment in transportation infrastructure and studied its impact on regional economy [3]. Shen Liang et al. (2014), Hou Zhiqiang (2018), Zhang Baili (2019), Ma Yu, Qiu Shu Hua, Wang Xin Yu (2020) and others all use the density of logistics infrastructure as an indicator, i.e. the respective operating mileage of every 100 square kilometers of railways and highways in the region. This method takes into account the area of the region's land and the degree of construction of land transportation logistics infrastructure, and can evaluate the degree of logistics superiority more comprehensively, which is highly representative [4]. Xu Nya and Chen Qian (2019) put forward many different indicators and rich and simple measurement methods when studying the measurement of spatial agglomeration of manufacturing enterprises in China, such as location entropy, spatial Gini coefficient, EG index, etc., which can all be used to estimate the degree of industrial agglomeration [8]. A. Condoo-Melhorado (2013) used spatial Gini coefficient as a measure indicator of manufacturing agglomeration when studying the impact of manufacturing agglomeration on total factor productivity and energy intensity. This indicator may cause large measurement error, mainly because the differences in size and organizational structure of manufacturing enterprises are not considered in the calculation process [9].

Arup Mitra (2014) pointed out that by collecting relevant information and data, it can be seen that the continuous upgrading and innovation of China's manufacturing industry is largely due to the development of logistics infrastructure. It is of practical and theoretical significance to explore the relationship between them [10]. Tang Hongxiang (2017) selected the panel data of the western region from 2000 to 2014, selected a number of variables, and built an econometric model about land transportation logistics infrastructure and manufacturing agglomeration. Eviews6.0 was used to make an empirical analysis of the model. The result showed that the higher the road density, the more obvious the manufacturing agglomeration was, and the knowledge spillover effect and labor cost negatively affected manufacturing agglomeration [11]. Moh'd Anwer Al-Shboul(2017), Piyali Majumder and Aparna Sawhney(2020) think that if a region wants to vigorously develop its manufacturing industry, it must have a sound logistics infrastructure. Road density ensures the integrity of the supply chain of enterprises from purchasing, manufacturing to transportation and promotes regional economic development [12]-[13]. Lu Zheng (2019) selected highway density as the representative of logistics infrastructure, and made an empirical analysis by using the cutting-edge space panel and threshold panel models, and concluded that there is a nonlinear influence relationship between land transportation logistics infrastructure and manufacturing agglomeration [14]. Liu Guangcai, Qin Jiao, and Wang Ying (2020) constructed a panel threshold model based on the relevant data of road transportation and railway transportation from 1999 to 2017, and discussed whether different logistics modes would have an impact on agglomeration economy. The results showed that there was a "U" shaped influence relationship between them, that is, negative inhibition followed by positive promotion. According to the empirical results, policy suggestions were put forward to guide the rational planning of regional industries and high-quality development [15]. Chen Haibo and Chen Chiping (2018) adopted the panel data model, combined with the new economic geography theory, and empirically proved that transportation capacity is positively promoting the development of manufacturing industry [16]. You Zhenlai and Zhao Junpeng (2018) used the threshold model to study the impact of logistics infrastructure agglomeration on manufacturing upgrading, and selected the relevant data of all cities in China from 2005 to 2013. Finally, it was concluded that logistics infrastructure has a significant role in promoting manufacturing upgrading with double thresholds [17]. Wu Didi (2020), Cao Yongqin, Zhou Xiaolun (2020) The density of logistics infrastructure affects the layout of manufacturing industry, and the agglomeration of manufacturing industry affects the economic development [18][19]. Ermakova A (2020) China's economic growth is inseparable from the development of logistics infrastructure, and there is a big gap in the spatial spillover effect in different periods. Logistics infrastructure can change the market behavior of enterprises [20].

3. Research and Design

3.1. Variable Selection and Data Sources

3.1.1. Interpreted Variable

Location entropy. On the basis of considering the differences in the size of prefecture-level cities, in order to accurately reflect the concentration level of manufacturing industry in different provinces, and taking into account the availability of results data, Wang Jian, Tang Hongxiang and other scholars' measurement methods are used for reference in many measurement methods of industrial concentration level.

3.1.2. Threshold Variable and Explanatory Variable

In this paper, the threshold variable is set as the comprehensive network density, which represents the land transportation logistics infrastructure. The location selection of manufacturing enterprises is affected and restricted by many factors. There is only one explanatory variable, which will have a great impact on the final results. Therefore, after referring to the relevant literature, the important influential variables such as economic development level, labor cost, consumption level, openness to the outside world, government expenditure and so on are selected as the other explanatory variables. The details are shown in Table 1.

3.1.3. Data Source

The data required for the variables are all from China Statistical Yearbook, China Science and Technology Statistical Yearbook, China Demographic and Employment Statistical Yearbook, China Industrial Economic Statistical Yearbook, China Logistics Statistical Yearbook and China Economic Database for each year from 2010 to 2019, as well as statistical yearbooks for each region. In order to avoid heteroscedasticity and reduce collinearity, and also to avoid the influence of dimension, the consumption level and the density of the comprehensive road network are paired in the empirical analysis.

Table 2 gives the statistical description results of each relevant variable. As can be seen from the table below, the maximum value of agglomeration degree in eastern China from 2010 to 2019 is greater than 1, which is 1.830, indicating that the manufacturing industry in this province is agglomeration, with a high level of specialization, and the minimum is only 0.370, indicating that the development level of manufacturing industry in China is uneven and the development gap between regions is large. Judging from the inventory of land transportation logistics infrastructure, the maximum value of logistics density reaches 218.8, while the minimum value is only 44.49, indicating that the distribution of China's logistics density network is uneven and the construction of land transportation logistics infrastructure is uneven across China. China's land area is large, and the distribution of natural resources is very uneven. A perfect land transportation logistics infrastructure can overcome the geographical constraints, quickly and conveniently transport resources from supply to demand, and can also save transportation costs. Therefore, better logistics conditions have a strong attraction for manufacturing enterprises. With the great investment and construction in our country, the land transportation and logistics infrastructure in various regions has been very developed. It is difficult to promote the further agglomeration of manufacturing industry solely by relying on the low transportation cost.

Table 1: List of variable measurements

Variable type	Variable name	Variable measurement index
Interpreted variable	Location entropy (S_i)	Manufacturing employment by province Industry-wide employment by province National manufacturing employment Employment in the whole industry nationwide
Threshold variable	Integrated road network density(RRD)	Annual railway freight volume of each province Total annual railway freight transportation nationwide Railway mileage Provincial annual highway freight volume Total annual road freight transportation nationwide Road operating mileage The area of the province
Explanatory variable	Level of economic development(ECO)	Per capita GDP
	Government spending(GOV)	Total Fiscal Expenditure/Nominal GDP
	Degree of opening to the outside world(OPEN)	Total export-import volume/ GDP
	Labor cost(WAGE)	Average wages of employees
	Consumption level(LNEXP)	Total retail sales of social consumer goods

Table 2: Descriptive statistics of each variable

Variable	Sample number	Average value	Minimum value	Maximum value	Variance
Si	110	1.113	0.370	1.830	0.374
RRD	110	125.1	44.49	218.8	44.13
ECO	110	6.940	1.810	16.42	3.072
GOV	110	0.187	0.113	0.322	0.0532
OPEN	110	0.357	0.120	0.468	0.0859
IND	110	0.357	0.120	0.468	0.0859
WAGE	110	4.804	4.487	5.222	0.166
EXP	110	4.072	3.456	4.633	0.282

Note: The above data are obtained from simple analysis of the original data of each year's statistical yearbook.

3.2. Construction of Threshold Panel Model

Based on the theory of logistics development strategy, new economic geography and the theory of industrial agglomeration and diffusion, this paper puts forward a testable hypothesis: the land transportation logistics infrastructure in eastern China has a non-linear relationship with manufacturing agglomeration. The focus of this paper is on the effects of land transport logistics infrastructure improvement on manufacturing agglomeration in different stages. Therefore, the threshold panel model proposed by Hansen (1999) is applied to estimate the critical point at which land transport logistics infrastructure can promote or hinder manufacturing agglomeration. The basic model is:

$$y_{it} = u_i + \beta_1' x_{it} I(q_{it} \le \gamma) + \beta_2' x_{it} I(q_{it} > \gamma) + \varepsilon_{it} \tag{1}$$

In formula (1), yit is the explained variable, xit is the explained variable and qit is the threshold variable, dividing the sample data into several intervals; γ is the threshold value, εit is the residual term, and I(·) is the indicative function. Equation (1) can also be expressed as:

$$\mathrm{y}_{\mathrm{it}} = \begin{cases} \mu_i + \beta_1' \chi_{it} + \varepsilon_{it}, if q_{it} \le \gamma \\ \mu_i + \beta_2' \chi_{it} + \varepsilon_{it}, if q_{it} > \gamma \end{cases} \tag{2}$$

In order to reduce the variation within the group, the equation is adjusted as follows:

$$\begin{aligned} \mathrm{y}_{it}^* &= \mathrm{y}_{it} - \overline{y_1} \\ \chi_{\mathrm{it}}^*(\gamma) &= \chi_{it} - \overline{\chi_1}(\gamma) \\ \varepsilon_{\mathrm{it}}^* &= \varepsilon_{it} - \overline{\varepsilon_1} \end{aligned} \tag{3}$$

Order:

$$\mathrm{y}_{\mathrm{i}}^* = \begin{bmatrix} y_{\mathrm{i}2}^* \\ \vdots \\ y_{iT}^* \end{bmatrix}, \quad \chi_{\mathrm{i}}^*(\gamma) = \begin{bmatrix} \chi_{\mathrm{i}2}^*(\gamma)' \\ \vdots \\ \chi_{\mathrm{iT}}^*(\gamma)' \end{bmatrix}, \quad \varepsilon_{\mathrm{i}}^* = \begin{bmatrix} \varepsilon_{\mathrm{i}2}^* \\ \vdots \\ \varepsilon_{\mathrm{iT}}^* \end{bmatrix} \tag{4}$$

To:

$$Y^* = \beta' X^*(\gamma) + \varepsilon^* \tag{5}$$

Given any value of γ, the estimated value of β can be estimated by the least square method, which is expressed in matrix as follows:

$$\hat{\beta}(\gamma) = (X^*(\gamma)' X^*(\gamma))^{-1} X^*(\gamma)' Y^* \tag{6}$$

The residual error is:

$$\hat{\varepsilon}^*(\gamma) = Y^* - X^*(\gamma) \hat{\beta}(\gamma) \tag{7}$$

The corresponding sum of squares of residuals is:

$$S_{\mathrm{n}}(\gamma) = \hat{\varepsilon}^*(\gamma)' \hat{\varepsilon}^*(\gamma) = Y^*(1 - X^*(\gamma)(X^*(\gamma))^{-1} X^*(\gamma)')Y^* \tag{8}$$

In Equation (8)$\hat{\varepsilon}^*(\gamma)$, the is the estimate of $\hat{\varepsilon}(\gamma)$, and then the threshold estimate for which the sum of squares of the residuals is the smallest is calculated:

$$\hat{\gamma} = \arg\min_{\gamma} S_n(\gamma) \tag{9}$$

Once $\hat{\gamma}$ is obtained, the estimate $\hat{\beta}(\hat{\gamma})$ of $\hat{\beta}$ is determined. From this, the residual value is $\hat{\varepsilon}^* = \hat{\varepsilon}(\hat{\gamma})$ and the residual variance is:

$$\hat{\sigma}^2 = \frac{1}{n(T-1)} \hat{\varepsilon}^{*'} \hat{\varepsilon}^* = \frac{1}{n(T-1)} S_1(\gamma) \tag{10}$$

Next, it is checked whether the threshold effect exists, the zero hypothesis is set as $H_0 : \beta_1 = \beta_2$, and the F statistic is constructed:

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2} \tag{11}$$

When determining whether the sample data has threshold effect, we should look at the magnitude of the P value when the null hypothesis holds. A very small value of P represents a rejection of the null hypothesis. When the model is estimated to have several thresholds, the bootstrap method proposed by Hansen is adopted. First, the fixed-effect panel model is assumed to have a single threshold, if it does exist, the second threshold is assumed to exist again, and so on.

According to the selection of influencing factors of manufacturing agglomeration in Table 1 and the results of quantitative analysis, and in combination with the basic settings of the threshold panel model, this paper establishes a threshold model of land transportation logistics infrastructure to manufacturing agglomeration, taking the comprehensive road network density of the logistics infrastructure railway and highway as the threshold variable, and taking the level of economic development (ECO), government expenditure (GOV), openness to the outside world (OPEN), labor cost (WAGE) and consumption level (LNEXP) as the explanatory variables, to find out the threshold value of the impact of logistics infrastructure on manufacturing agglomeration.

Based on the above, the logistics infrastructure threshold model is established as follows:

$$\begin{aligned} Si_{it} &= \mu_i + \beta_1^{'} RRD_{it} I\left(RRD_{it} \le \gamma_1\right) + \beta_2^{'} RRD_{it} I\left(\gamma_1 \le RRD_{it} \le \gamma_2\right) + \beta_3^{'} RRD_{it} I\left(RRD_{it} \ge \gamma_2\right) \\ &+ \beta_4^{'} ECO_{it} + \beta_5^{'} GOV_{it} + \beta_6^{'} \mathrm{OPEN}_{it} + \beta_7^{'} \mathrm{WAGE}_{it} + \beta_8^{'} \mathrm{LNEXP}_{it} + \varepsilon_{it} \end{aligned}$$

Among them, Si (level of manufacturing agglomeration development) is the explanatory variable, μ1 is the individual effect of each province in the country, β1, β2 and β3 are the coefficients of the explanatory variables in different threshold intervals, and the five explanatory variables establish the threshold panel model of logistics infrastructure respectively. γ1 and γ2 are specific thresholds, and the samples are divided into three groups. εit is random interference term.

4. Empirical Analysis

4.1. Threshold Effect Test

If you want to build a threshold panel model, you first have to test whether there is a threshold effect in both time. If there is a threshold effect, then further identify the number of thresholds in the model and determine whether the model is set with a single threshold, a double threshold or a triple threshold. Table 3 is mainly used to test whether there is a threshold effect on the land transportation logistics infrastructure variables. From the F value and P value obtained from the results, it can be seen that the effect of 1 threshold and 2 thresholds is very significant, while the effect of 3 thresholds is not significant. Therefore, 2 thresholds, i.e. double thresholds, are selected for modeling and analysis below. In the process of this threshold panel model estimation, the bootstrap times are all set to 300.

Table 3: Test results of threshold effect of transportation infrastructure

Model	F	P	BS count	Critical value		
				1%	5%	10%
Single threshold	24.49	0.2900	300	64.4068***	50.1952**	41.0433*
Double threshold	30.78	0.0800	300	50.2938***	35.2035**	26.8428*
Triple threshold	13.45	0.3933	300	51.0840***	34.0965**	23.7438*

4.2. Estimation of Threshold and Authenticity Test

There is a strict estimation method for the threshold estimation of manufacturing agglomeration at the level of land transportation logistics infrastructure, and a 95% confidence interval is determined. When the threshold variable exceeds the estimation value, the independent variable and dependent variable will change. Table 4 shows the estimates and corresponding confidence intervals for the double threshold model.

Table 4: Threshold estimates and confidence intervals

	Threshold estimate	95% confidence interval
Single threshold	5.2289	[5.2113,5.2820]
Double threshold	3.8898	[3.8236,3.9259]

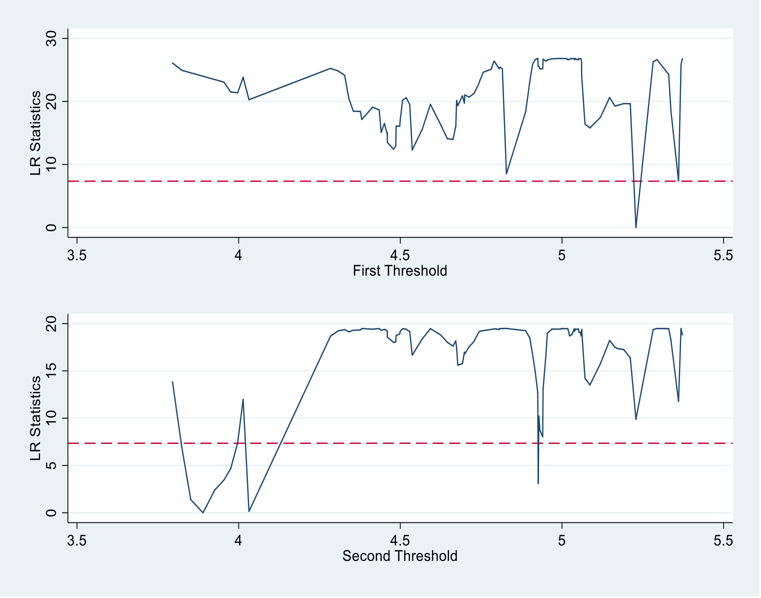

Figure 1: Estimates and confidence intervals for thresholds

BOOTSTRAP, which appeared in 1999, constructs the statistic LR of gradual distribution and likelihood ratio, which can make scholars clearly observe the number of thresholds and the changes of values, so it has been widely used in research. The process of finding the optimal solution can be seen more intuitively by the likelihood ratio function diagram. At 95% confidence level, if the confidence interval corresponding to the threshold estimate is too large, the hypothesis that the variable threshold exists should be rejected. On the contrary, the threshold estimation is accurate and acceptable. In the likelihood ratio function Figure 1, the solid line is the likelihood ratio statistic LR, and the part below the dotted line in the figure is the threshold value of the likelihood ratio under the 95% confidence interval, and the threshold value is the point where LR approaches zero infinitely. Combined with the significance test results, the 95% confidence interval of the two thresholds in the model is the interval formed by the critical value (corresponding to the dotted line in the figure) when the LR value is less than 5% significance level, which is small enough to be within the original hypothesis, indicating that the thresholds are true. Figure 1 Threshold parameter values corresponding to the curve part between the dotted line and the intersection points of the curve. According to the two threshold parameters, the logistics infrastructure level of each region can be divided into three parts: high, medium and low, which respectively correspond to the influence degree of different logistics infrastructure levels on manufacturing agglomeration.

4.3. Threshold Effect Regression

According to the variable estimation results in Table 4, it can be found that the fitting degree of this model exceeds 95%, and the F test passes, indicating that the threshold panel model is applicable to the research objects and corresponding data, and the interpretation degree is reasonable. After determining the threshold estimation value, the correlation coefficient in the threshold panel model is estimated. The estimation result is shown in Table 5. With the integrated road network density lrrd of logistics infrastructure as the threshold variable and eco,gov, open, wage and exp as the explanatory variables, the moderating effect of different development levels of logistics infrastructure on manufacturing agglomeration is explored.

From Table 5, it can be found that when the density of the comprehensive road network is lower than the threshold value of 3.8898, the impact of logistics infrastructure on the agglomeration of manufacturing industry is positive, and for every 1% increase in the level of logistics infrastructure, the agglomeration of manufacturing industry develops by 0.284%, that is to say, with the development of logistics, the manufacturing industry will tend to concentrate somewhere in space, and areas with dense logistics are also areas with high concentration of manufacturing industry. The regression coefficient at this stage is positive, because the logistics infrastructure system has accessibility and network, which can promote the free flow of labor, technology, resources and other factors of production, become a channel connecting different regions, make the exchanges between regions more frequent, promote the agglomeration of enterprises in spatial location, and drive the development of less developed regions. From 2010 to 2014, the economic development level of the eastern region is not very high. When selecting the location for manufacturing, the first consideration is transportation cost. The more perfect the logistics infrastructure, the lower the logistics cost, which will attract manufacturing enterprises to further cluster.

When the density of integrated road network is between 3.8898 and 5.2289, the promotion effect of logistics infrastructure on the spatial agglomeration distribution of manufacturing industry gradually decreases. At this time, the logistics infrastructure continues to develop and the transportation cost generally decreases, which is no longer the main consideration factor for enterprises to conduct interregional trade. The revenue continues to increase, but the impact of logistics infrastructure on the agglomeration of manufacturing industry is not particularly obvious.

When the comprehensive road network density of logistics infrastructure is greater than 5.2289, the logistics infrastructure has a certain inhibitory effect on the agglomeration of manufacturing industry. For every 1% increase in land transportation logistics infrastructure, the agglomeration level of manufacturing industry will be reduced by 0.119%. This is because various industries tend to choose regions with better logistics conditions. When the regional logistics conditions are developed to a certain extent, a large number of industries will cluster in this region. The degree of agglomeration in this region will reach saturation, which will lead to a series of problems, such as traffic congestion, resulting in reduced transportation efficiency, excessive and intense competition among enterprises in the region, crazy price increase, etc. Faced with the crowding effect brought by over-agglomeration, these large manufacturing enterprises have begun to look for other regions with more advantages. At this time, the logistics infrastructure in other regions has been further improved, which can meet the requirements of manufacturing enterprises for logistics and transportation. The advantages of appropriate decentralization outweigh the disadvantages.

Table 5: Variable estimation results

		Coefficient estimate	t	P>|t|	95% confidence interval
Si	1	2.844***	3.33	0.001	[1.148, 4.540]
	2	0.042***	0.07	0.942	[-1.098, 1.182]
	3	-1.188***	1.62	0.099	[-2.647, .272]
eco		-0.009***	-4.58	0.000	[-.013, .005]
gov		-0.687**	-3.47	0.000	[-1.467, .273]
open		0.328***	3.02	0.003	[.112, .544]
wage		-0.240***	-4.52	0.000	[-.535, .346]
exp		0.0598**	1.97	0.042	[-.00044, .12009]
Cons		-1.299***	-5.54	0.000	[-1.764, -.833]

Note:*,**,*** are significant at 10%, 5% and 1% respectively.

In addition, the coefficient estimates of the degree of opening to the outside world and the level of urban consumption are positive, and the impact on manufacturing industry agglomeration is positive after passing the significance level of 10%. It means a high degree of opening to the outside world and an increase in import and export trade. It is also more conducive for manufacturing enterprises to learn advanced foreign high and new technologies, promote industrial upgrading, expand scale and improve production efficiency. The easier it is to attract manufacturing investment to set up factories. The higher the level of urban consumption, the better the public service facilities and the convenient flow of production factors. It has a broad market prospect and can attract manufacturing enterprises to migrate and gather in the region. The estimated coefficients of economic development level, government intervention and labor cost are negative, and pass the significance level of 1%, and the impact on manufacturing industry agglomeration is negative, which indicates that the higher the economic development level, the higher the raw materials and cost, the higher the economic development level in the eastern region, the higher the price, the higher the labor cost naturally than in the central and western regions, the higher the price of land leasing business, the higher the cost of trade payment, which is not conducive to enterprise development and manufacturing agglomeration; The impact of government intervention on the location and distribution of manufacturing sites is to disperse the spatial distribution of manufacturing enterprises. In order to promote the balanced development of the economy, the government, through policy intervention, increased investment in the central and western regions and issued a series of preferential policies, scattered the eastern regions with high concentration of manufacturing industries, guided and encouraged the concentration of manufacturing industries in the central and western regions with low production costs. In recent years, some large manufacturing enterprises, starting to invest and set up factories in the central and western regions with lower transaction costs, such as Hubei and Jiangxi. High and new technology and information exchange will drive the scale of small and medium-sized enterprises to grow, drive the continuous development of the centralized economy in the central and western regions and attract more manufacturing enterprises. Manufacturing firms prefer cities with low labor costs when selecting locations.

4.4. Robustness Test

In order to ensure the robustness of the results, this paper replaces the consumption level with the urbanization level of the current year. In the robustness test section, the bootstrap times of model (1)-model (5) are the same as above.

Table 6 can still be seen that the impact of logistics infrastructure on manufacturing agglomeration is a very significant double-threshold effect. With the continuous development of logistics infrastructure, the non-linear impact on manufacturing agglomeration is first positive and then negative. It is true that the improvement of logistics infrastructure has greatly improved the concentration level of local manufacturing industry, but when the logistics infrastructure continues to develop to a certain extent, it will change the previous trend and have a slight negative impact, restricting the concentration of manufacturing industry in the region, such as developed areas such as Beijing and Shanghai.

Table 6: Stability test

Variable	(1)	(2)	(3)	(4)	(5)
Lrrd<=3.8898	2.672***	2.668***	2.653***	2.378***	2.224***
3.8898<Lrrd<5.2289	0.031***	0.017***	0.011***	0.009***	0.009***
Lrrd>=5.2289	-0.003***	-0.004***	-0.002**	-0.001***	-0.001***
	(-0.92)	(-1.09)	(-0.21)	(-0.20)	(-0.11)
eco	-0.0231***	-0.0230***	-0.020***	-0.018**	-0.034***
	(-2.35)	(-2.37)	(-1.35)	(-0.93)	(-1.29)
gov		-0.519***	-0.416***	-0.453***	-0.310***
		(-1.14)	(-0.73)	(-0.57)	(-0.39)
open			0.464***	0.396***	0.494***
			(0.35)	(0.24)	(0.29)
wage				-0.060***	-0.328***
				(-0.12)	(-0.46)
urb					1.009***
					(0.65)
F	3.085	2.495	2.217	1.781	2.581

Note: *,**,*** are significant at 10%, 5% and 1% respectively.

The positive influence coefficient of the degree of opening to the outside world and the level of urbanization indicates that the degree of opening to the outside world is high and there are many activities of import and export trade, which drives the development of regional economy and attracts manufacturing industry to invest and build factories in the eastern region with superior geographical position; In areas with high urbanization level, the wage level is relatively high and there are many employment opportunities, which will cause a large number of labor force to leave the countryside and villages and towns and come to cities, towns and factories to provide manufacturing enterprises with the labor force elements they need for production, and attract enterprises to locate factories in areas with high urbanization development level. The level of economic development and government intervention have a negative impact on the agglomeration of manufacturing industry. This shows that the level of economic development is high, the level of consumption is high, the demand for products is high, and the requirements on the quality and level of products are high. If manufacturing enterprises want to meet the differentiated demand of the market and form their own characteristics, they must find a new position that is beneficial to them. Therefore, the high level of economic development has a proliferation effect on the manufacturing industry. The regression coefficient of government intervention variables is negative. In recent years, the government has invested heavily in the construction of the logistics system in the central and western regions in order to develop the central and western regions. Now the market in the central and western regions is rich in resources allocation, convenient in economic transactions and low in production and operation costs. Enterprises are considering various factors comprehensively and starting to set up factories in other regions. Therefore, the government intervenes in the spatial distribution of scattered industries.

According to the result analysis, it can be seen that the sign direction and significance level of the explanatory variables and control variables estimation coefficients of the test results in Table 6 are basically the same as those in Table 5, indicating that the empirical test in this paper is robust.

5. Conclusions

This paper selects the relevant data of 11 provinces (municipalities directly under the central government and autonomous regions) in the eastern region of China from 2010 to 2019 for analysis. The logarithm of the density of railway and highway comprehensive road network represents the development level of logistics infrastructure, and establishes a threshold panel model with manufacturing agglomeration as the explanatory variable, the density of comprehensive road network as the threshold variable, and the level of economic development, government expenditure, openness to the outside world, labor cost and consumption level as the explanatory variables. According to the empirical results, it can be seen that the logistics infrastructure is neither a purely positive or negative impact on manufacturing agglomeration, and there is a significant non-linear relationship between the two. The specific conclusions are as follows:

(1) Under the condition that the comprehensive road network density of logistics infrastructure is the threshold variable, the impact of logistics infrastructure on manufacturing agglomeration is a non-linear process with first positive impact, then negative impact, and the double threshold is the most obvious. The regression equation can be divided into three stages. The first stage is when the comprehensive road network density of logistics infrastructure is less than the first threshold, logistics infrastructure plays a positive role in promoting the agglomeration of manufacturing industry. The higher the development level of logistics infrastructure in a region, the higher the degree of agglomeration of manufacturing industry. The second stage is that the variable value of the integrated road network density of the logistics infrastructure is greater than the first threshold value and less than the second threshold value. At this time, it is only a trend to strengthen the positive impact and maintain a relatively stable state. The third stage is when the variable value of the integrated road network density of the logistics infrastructure is greater than the second threshold value, the regional competitive advantage in logistics and transportation gradually weakens, and the dependence of manufacturing agglomeration on the logistics infrastructure decreases.

(2) According to the regression results, we can see the impact of each explanatory variable on manufacturing agglomeration. Among them, the impact of consumption level, urbanization development level and the degree of opening to the outside world on manufacturing agglomeration has maintained a positive correlation at a high significance level. Labor cost, economic development level and government intervention have a certain negative impact on manufacturing agglomeration in the eastern region.

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