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The Influence of Transportation on Market Integration in China

Luo Shen

School of Economic and Management, North China Electric Power University, Beijing, 102206, China

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Abstract: Convenient transportation is usually considered to promote circulation. This paper constructs the framework of "factor flows and market integration" to explore the influence of transportation on market integration. Then this paper reflects market integration influenced by transportation. During the study period, the overall role of road on market integration is more limited to the local, and the spatial spillover effect is not significant. There is spatial aggregation effect in the market segmentation in China, and the local market segmentation is outstanding as a whole. The division of labour, information transmission occur through the actual transportation.

1. Introduction

With the development of modern transportation, the regional spatial form has changed significantly. Convenient transportation is usually considered to promote division of labour, expand market scope and improve production efficiency. Adam Smith discussed the role of water transportation in expanding the scope of the market. Young further expanded Smith's theory. In the new economic geography, the transportation cost is considered as an important factor affecting the regional imperfect competition and labor mobility.

From the research results, the related research mainly analyzes the impact of transportation infrastructure on market integration and market segmentation. Different choice of proxy variables for infrastructure leads to different theoretical explanations. Theoretically, transportation infrastructure reduces transportation cost, expands market scale (Zhang et al., 2018)[1], promotes market power (Li et al., 2019)[2] and improves market accessibility of enterprises (Liu et al., 2020)[3] by shortening travel time. If financial input and mileage are taken as proxy variables, the conclusion is that the spatial spillover of transportation infrastructure on market integration has different effects in different stages and regions (Fan et al., 2017; Chen et al., 2014; Wang&Kong, 2020)[4][5][6], and there is an "inverted U" relationship between inhibition and promotion (Sun&Yin,2021)[7]. Dong&Jiang(2020)[8] found that the weakening of road infrastructure on commodity market segmentation is more significant. They believe that this is because road transportation is a general end consumer goods, which combines transportation infrastructure with transportation.

This paper argues that due to the different choice of model variables, the theoretical explanation is biased, and the research conclusions are also different. Taking the high-speed railway as an example, if the above method is used to study the Beijing-Shanghai high-speed railway and Lanzhou-Xinjiang

high-speed railway, the theoretical assumption is almost the same, but the average annual passenger volume of Beijing-Shanghai high-speed railway is about 100 million, and Lanzhou-Wulumuqi high-speed railway is about 4.55 million. The actual situation is obviously different, which will lead to weak explanatory power.

Transportation play an important role for market integration with the construction of national comprehensive three-dimensional transportation network in China. Then, what is the mechanism and policy meaning of the factor flow brought by transportation affecting the market integration in reality? It has certain theoretical and practical significance to study the impact of China's infrastructure construction on the domestic market integration from a new perspective.

2. Current Situation of Market

From the current research point of view, "market integration" mainly refers to the development, maturity and perfection of the market-oriented mechanism of the market mechanism, eliminating the obstacles existing in the market exchange, so as to make trade and other economic and social activities more convenient and form a unified big market. When the transportation situation improves, enterprises can choose inputs with more optimized price and quality combination from a broader factor market. According to the "law of one price", if the fluctuation of relative price difference in different regions tends to converge with time, it means that the transaction cost between regions is reduced, and the market tends to be integrated. The relative price index method is used to measure the degree of market segmentation of each province to reflect the degree of market integration

$$\Delta Q_{ijt}^{k} = \ln\left(P_{it}^{k}/P_{jt}^{k}\right) - ln\left(P_{it-1}^{k}/P_{jt-1}^{k}\right)$$
$$Var\left(\Delta Q_{ijt}^{k}\right) = Var\left(\left|\Delta Q_{ijt}^{k}\right| - \overline{\left|\Delta Q_{t}^{k}\right|}\right) \quad (1)$$

Where *i* and *j* represent different regions, T represents time, K represents the kth commodity, and P represents the retail price index of commodity. This paper uses the measurement between two provinces (municipalities) in China. Figure 1 shows the trend of market segmentation of the whole country and the three major regions.

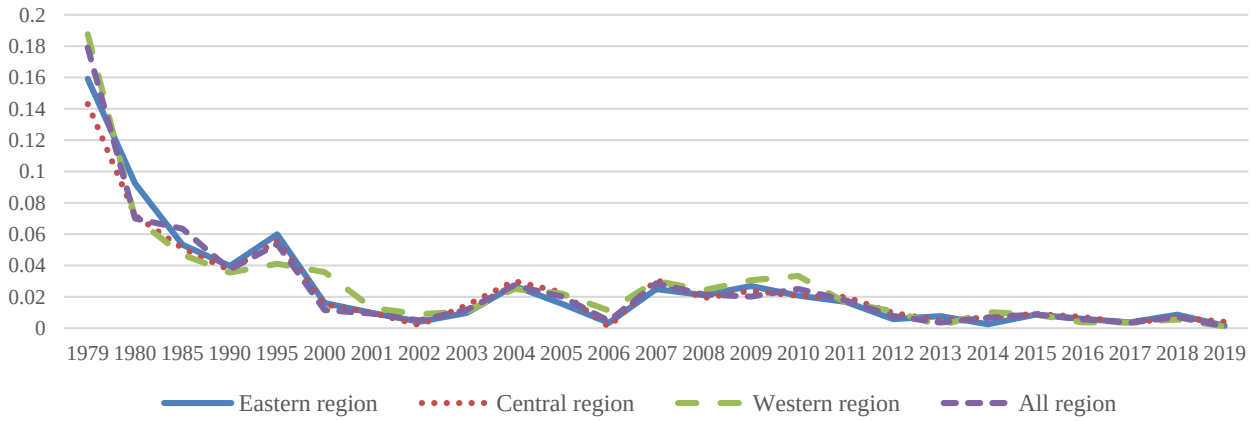

Figure 1: Market segmentation trend of the three regions in China.

From Figure 1, it can be seen that the national market as a whole shows a trend of integration, and the degree of market segmentation gradually decreases during 1979-2019, which is basically consistent with the existing research conclusions (Fan, 2017; Wang&Kong, 2020). The changing trend of the three regional market integration is basically consistent with the trend of the national market. And the market price may be sticky (Jiang et al., 2020)[9]. Market integration is in line with

the trend of transportation development. With the increase of transportation intensity, the level of market segmentation is reduced and the degree of integration is gradually improved. But we need to use econometric model to judge the impact of transportation on market integration more accurately.

3. The Mechanism of Transportation

Transportation is not only an important carrier of regional economic activities, but also an important mechanism of market formation. From the perspective of regional economy, the flow of elements affects the distribution structure of the whole social and economic resources between regions and industries, and affects the economic activities of each region. The factor flow can reflect the spatial distribution of the market, and the promotion of the factor flow will activate the supply and demand of the market, and provide the basic conditions for the market integration. The higher the level of transportation in the region, the higher the efficiency of its element flow, the more likely it will benefit from the scale economy and the agglomeration economy, thus improving the competitiveness in the market, and further promoting the economic development and population growth, forming a circular cumulative effect.

On the one hand, transportation can improve the proximity with large-scale market. According to the new economic geography theory, the scale economy of enterprises mainly comes from the proximity of enterprises and large markets (Krugman, 1991)[10]. Transportation directly promotes the circulation of regional factor market and commodity market, reduces the transaction cost among regions, improves the commercial radiation of central cities along the line, and expands the market scope. This effect will have an impact on the regional industrial structure and industrial organization, which is conducive to the formation of industrial value chain within and between regions, and to guide the spatial agglomeration of regional industries. The low and high quality factors of production have a great impact on the original production factors.

4. Empirical Study

4.1 Method And Data

The global Moran index (Moran I) is used to judge whether the market segmentation has the agglomeration degree of spatial correlation regions. The observed value of area I is recorded as Xi, and Moran index is calculated as formula 2.

$$Moran \quad I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\left(X_i - \overline{X}\right)\left(X_j - \overline{X}\right)}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{2}$$

$$S^2 = \sum_{i=1}^{n}(X_i - \overline{X})^2 \ , \ \overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \ ,$$

Moran index reflects the similarity of observations, which ranges from -1 to 1. Negative number means negative correlation, 0 means no correlation, and greater than 0 means positive correlation. The Moran index approximately obeys the normal distribution of $E(I)$ and $V(I)$. The test statistic is standardized Z value.

In equation 2, n is the number of observations, representing 31 provincial regions; Where X_i and X_j represent the market segmentation index of the i-th region and the j-th region respectively; W_{ij} is an element of the spatial weight matrix W. The spatial weight adopts the geographical distance index, that is, the reciprocal of the spherical distance (km) of the provincial capital city. The farther the

distance is, the weaker the role of spatial transmission mechanism is, and the smaller the influence between regions is. Combining with equation 2, we can get the corresponding Moran index from 2002 to 2019, as shown in Table 1.

Table 1: spatial correlation of market segmentation 2002 -2019.

2002	2003	2004	2005	2006	2007
0.1166 (0.0080)	0.1302 (0.0052)	0.1107 (0.0078)	0.1551 (0.0019)	0.1651 (0.0058)	0.1011 (0.0046)
2008	2009	2010	2011	2012	2013
0.1625 (0.0814)	0.1818 (0.1229)	0.1785 (0.1169)	0.1241 (0.0011)	0.1252 (0.0013)	0.1271 (0.0085)
2014	2015	2016	2017	2018	2019
0.1398 (0.0075)	0.1358 (0.0081)	0.1164 (0.0042)	0.1197 (0.0012)	0.1277 (0.0028)	0.1160 (0.0091)

It can be seen from table 2 that during the study period, Moran'I index of market segmentation is positive, and other results are significantly deviated from the random distribution except for 2009 and 2010, which indicates that there is obvious spatial correlation in China's market segmentation index.

Furthermore, Wald test and LR test are used to judge the spatial lag term and spatial error term. Wald spatial lag value and LR spatial lag value reject the original assumption that the model has no spatial lag term at the level of 1%, and Wald spatial error value and LR spatial error value also reject the original assumption that the model has no spatial error term at the level of 1%. Therefore, spatial Durbin model (SDM) is adopted in this study. The model based on SDM can be written as follows:

$$\ln Q_{it} = \rho\sum_{j=1}^{N} W_{ij}\ln Q_{jt} + \alpha \ln Q_{it-1} + \beta_1 \ln transP_{jt} + \beta_2 \ln transG_{jt} + \theta_1\sum_{j=1}^{N} W_{ij}\ln transP_{jt} + \theta_2\sum_{j=1}^{N} W_{ij}\ln transG_{jt}$$
$$+\alpha_{i1}\ln Control_i + \alpha_{i2}\ln\sum_{j=1}^{N} W_{ij}\ln Control_j + \varepsilon_{it} \tag{3}$$

In terms of variable selection, based on the influence of transportation on factor flow, passenger turnover and freight turnover are selected as the core independent variables. Considering the spatial differences of economic development and industrial structure in different regions of China, we should join the industrial division. Based on the fact that local protection is one of the main obstacles to market integration, this paper uses the method of Fan *et al*. (2017) to describe the proportion of fiscal expenditure and the proportion of fiscal expenditure excluding science, education, culture and health expenditure in GDP. The variable description is shown in Table 2.

Table 2: Variable description.

variable	symbol	explanation
Market segmentation	*Q*	price index
Passenger Turnover Quantity	*TransP*	Trillion person-kilometers
Goods Turnover Quantity	*TransG*	Trillion ton kilometers
Market segmentation of last year	Q_{t-1}	price index of last year
Industrial Division	*emp*	Ratio of secondary industry/tertiary industry
opening to world	*open*	Proportion of total import trade in local GDP (converted into current US dollars)
Government action	*Gov*	Proportion of fiscal expenditure excluding expenditure on science, education, culture and health in GDP
Spatial weight matrix	*W*	The reciprocal of spherical distance (km) of provincial capital city is the reciprocal of theoretical radius

The descriptive statistics of each variable are shown in Table 3. It can be seen from table 3 that through processing, the independent variables, core explanatory variables and control variables after taking logarithm are basically guaranteed to have the same number.

Table 3: Descriptive statistics of variables.

variable	samples	mean	standard deviation	maximum	minimum
Q	589	0.0274	0.0224	0.3575	0.0039
transP	589	0.0654	0.0501	0.2998	0.0005
transG	589	0.3915	0.4619	3.0325	0.0017
emp	589	0.9862	0.3758	1.8973	0.1910
open	589	0.0307	0.0014	0.1711	0.0013
gov	589	0.1811	0.0222	1.1157①	0.0502

4.2 Empirical results

In the spatial econometric method, Lesage and Pace divide the total effect into direct effect and indirect effect to better describe the existing spatial interaction[11]. The direct effect is the average influence of independent variables in this region, the indirect effect is the influence of independent variables in other regions, and the total effect is the average influence on all regions.

According to the results of Hausman test, fixed effect model was selected, and individual and time were fixed. In this part of the total variable regression process, in addition to the dynamic spatial Durbin model, this paper also makes a dynamic panel System GMM analysis, which can more comprehensively understand the impact of transportation and other variables on market segmentation, and also increase the robustness of the analysis results. The results are shown in Table 4.

Table 4: Regression results of all variable.

variable	GMM	Double fixed effect spatial Dobbin model	
		coefficient	Z value
ρ	—	0.8551***	36.8743
Q_{t-1}	0.1068***(0.0321)	0.1088**	2.5909
TransP	-0.0914**(-0.0394)	-0.0733**	-2.8538
TransG	-0.0318***(-0.0356)	-0.0449**	-2.3696
emp	0.2400**(0.0843)	0.2398***	3.5469
open	0.0295***(0.0288)	0.0384**	2.4685
gov	0.0225***(0.0369)	0.0241***	3.3942
W×*TransP*	—	-0.0912*	-1.4379
W×*TransG*	—	-0.0990*	-1.0290
W×*emp*	—	-0.4150**	-2.4660
W×*open*	—	0.2108**	2.2605
W×*gov*	—	0.2014	1.3676
R^2	0.7695	0.7796	
corr-squared	0.7446	0.7541	
log-likelihood	—	-199.7451	

*p < 0.1; **p < 0.05; ***p < 0.01.

The direct effect, indirect effect and total effect of each variable in SDM are shown in Table 5.

① The ratio of Tibet is more than 1.

Table 5: The effect of variable.

	direct effect	indirect effect	total effect
Q_{t-1}	0.1139***(2.9056)	0.1454(0.6950)	0.2593(1.2590)
transP	-0.0477**(-1.5164)	0.8898(1.1283)	0.8422(1.0701)
transG	-0.0330**(-1.1913)	-0.3798**(-0.6872)	-0.4129**(-0.7429)
emp	0.1976***(3.5439)	1.2290(1.3069)	1.4266(1.5118)
open	-0.0019**(-0.0849)	1.2113**(2.1189)	1.2095**(2.1048)
gov	1.2366*(1.7557)	0.0127(0.2085)	1.2493(1.8089)

*p < 0.1; **p < 0.05; ***p < 0.01.

From the model ρ On the whole, local market segmentation is more prominent. Despite the continuous improvement of market development and policy system in recent years, the problems left by history are still prominent, and administrative barriers can not be eliminated in a short time. The significant positive correlation of market segmentation coefficient in the lag period of 1% indicates that market segmentation is dependent, and the impact of external environment on market segmentation will take a period of time to reflect.

The coefficient of transportation turnover is significantly negative. Based on the above theoretical assumptions, large volume and long-distance transportation can transmit market price information, reduce the level of market segmentation to a certain extent, and then promote the process of market integration. Existing research through infrastructure investment, infrastructure density research, ignoring the actual traffic volume may play a role in market integration. In terms of direct effect, the coefficient of passenger transport turnover is negative and significant, which indicates that passenger transport can promote the integration of local market. The test results of indirect benefit and total effect show that passenger transport has no significant effect on market integration. The effect of freight is relatively significant, that is, freight transportation can promote the integration of regional market. Under the existing transportation conditions, the fixed demand for goods makes the specific area tend to form a commodity trade distribution center, and busy economic transactions will promote the dissemination of market information and expand the market scope; When the transportation cost is improved, the status of transportation node and commodity distribution center will be further consolidated and improved, forming a positive cycle and promoting market integration.

Table 6: Effects of transportation on market integration in different stages and regions

Region	Period	Variable	Direct effect	Indirect effect	Total effect
East and Middle	2001-2009	*transP*	0.0659(0.6409)	0.72726.3682	0.7931(6.7101)
		transG	-0.0698**(-0.8206)	-0.3079**(-3.4978)	-0.3787**(-3.2474)
	2010-2019	*transP*	-0.0464***(-0.0477)	0.7893*(3.2765)	0.7471*(3.4954)
		transG	-0.0431**(-0.5811)	-0.3101**(-3.1980)	-0.35342**(-3.0131)
West	2001-2009	*transP*	-0.1916**(-1.7439)	0.8743**(6.6830)	0.6827*(10.8683)
		transG	-0.0022**(-0.0246)	-0.5111**(-1.6043)	-0.5133**(-1.7327)
	2010-2019	*transP*	-0.0106(-0.0816)	0.5455*(2.5649)	0.5349(4.2776)
		transG	-0.0487***(-0.7593)	-0.5800***(-2.3667)	-0.6287***(-2.2626)

*p <0.1; **p < 0.05; ***p <0.01.

Due to the imbalance of regional economic development in China, the eastern and central regions are ahead of the western regions in terms of economic development level, marketization degree and infrastructure hardware conditions, which will also lead to differences in market integration among different regions. With the opening of Beijing-Tianjin Intercity in 2008, China's transportation has entered the era of high-speed railway. The next year, China put the high-speed rail construction in a strategic position. Therefore, the analysis of each period is divided into 2001-2009 period and 2010-2019 period. This paper discusses the impact of transportation on market integration in different time and different regions. The results are shown in Table 6.

In Table 6, from 2001 to 2009, the effect of passenger transport turnover in eastern China is not obvious, while freight transport turnover plays a role in promoting market integration. In Western China, both passenger traffic turnover and freight traffic turnover have significant effects. Passenger traffic turnover expands market segmentation and reduces market integration, while freight traffic promotes market integration. From 2010 to 2019, on the whole, the direct effect of passenger transport turnover is negative, the indirect effect and the total effect are positive, which indicates that China's passenger transport plays an integrated role in the local market, but expands the market segmentation of surrounding areas; Freight transport promotes market integration for both local and surrounding areas. From the coefficient of significant variables, the coefficient generally decreases after 2010, especially in the aspect of goods transportation. The main reason is that the rapid development of logistics industry and the deepening degree of network in recent years have reduced the transportation cost of factors, accelerated the agglomeration and diffusion of various factors among regions, and then affected the market integration.

5. Conclusion

Transportation cost impact market scope, and clarifies the endogenous influence mechanism of transportation on market integration from the space and time dimensions. Further, through the data from 2001 to 2019, the paper uses the spatial Dubin model to test the effect of traffic and transportation on market integration. The main conclusions are as follows.

The influence of rail and road to the market integration includes spatial effect and time effect. Transportation promotes the deepening of division of labor, and transmits market price information, thus creating conditions for market integration and development. The effect of road is significant on local, but the effect of spatial spillover is not significant. The effect of rail turnover is relatively significant and has the function of promoting market integration. The existing research through infrastructure investment and infrastructure density research, ignored the actual traffic on the market integration may play a role. The effect of spatial spillover effect of transportation is different in different stages. In the development of transportation to a certain stage, its impact on market integration will be gradually significant. From the theoretical logic, the influence of infrastructure on market integration is mainly through the traffic as the intermediary mechanism, and the research conclusions of the traffic infrastructure affecting market integration are different due to the different transportation.

There is spatial aggregation effect in the market segmentation in China, and the local market segmentation is outstanding. Because of the stickiness of market segmentation, although the market development degree has been improved and the policy system is constantly improving in recent years, the problems left behind by history are still outstanding, and administrative barriers cannot be eliminated in a short time. The government investment has restrained the market integration, and the increase of the proportion of the secondary industry relative to the tertiary industry will also restrict the development of market integration.

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