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Development strategy of urban industrial diversification based on market potential and path dependence

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Abstract: Numerous studies conclude that urban industrial evolution depends on the technological relatedness-associated supply side. However, such industrial evolution may also be affected by market force-related demand side. To fill this gap, this research aims to examine whether market force, reflected by market potential and market segmentation, also has significant impacts on the diversification of regional industries, and whether such impacts differ among different regions of China. The data used export customs declaration data recorded by customs offices. We introduce the PROBIT binary variable model to explore the effects of technological relatedness, market motential, market segmentation on diversification of regional industry. The results show that the diversification of export industries was not only positively affected by technological relatedness, but also impacted by market potential and market segmentation positive and negative, respectively. Notably, the impact of technological relatedness on the innovation of export industry was weakened in areas with low market potential but strengthened in those with high market segmentation. Moreover, we found that the effect of technological relatedness was weakened in more developed cities, while the effects of market potential and market segmentation were relatively universal. Theoretically, this paper expands the framework of evolutionary economic geography. We understood the influential factors of industrial innovation from both the supply and demand side, instead of the solely supply side in most previous studies. Practically, this study points out a new development path for the industrial evolution of marginal areas.

1. INTRODUCTION

There have been longstanding debates regarding the influence of various kinds of agglomeration economies on the sustainability of regional growth (Glaeser et al., 1992; Henderson, Kuncoro, & Turner, 1995). One of the key arguments lies in whether regional specialization (Mashell's externalities) or regional diversification (Jacobs's externalities) is conducive to regional performance (Tao et al., 2019; Weidenfeld, 2018; Hu et al., 2019; Li & Li, 2018). In the past decades, China's economy has entered the stage of "high quality development" development while the economic growth model has shifted from "growth rate" to "quality improvement" and is moving towards

a more efficient, fair and sustainable direction. One of the important ways to achieve this goal is the optimization and upgrading of economic structure, which requires the transformation of industrial structure from factor endowment and investment-dependent to technology-intensive and innovation-driven. In recent years, evolutionary economic geographers have advocated the positive effects of related variety and have made great efforts to reach an extraordinary contribution to exploring the inner mechanism. Sectors with related variety have been regarded as they have shared, complementary competences, and a certain standard of cognitive proximity exists so that the knowledge base among industries is neither too near to form cognitive lock-in nor too far away to not be understood by each other.

This theory has focused on the supply side, without putting enough emphasis on the demand side. The establishment of this theory has been built on two underlying assumptions. One is the mutual independence between regions while the other is the unlimited power of consumption and acceptance of the markets occupied by regions. For the former one, traditional scholars have demonstrated that as a result of the remoteness between regions together with the unaffordable transportation costs, the institutions between different regions share extraordinary disparity while regional economy develops independently with each other (Jaffe, Trajtenberg, & Henderson, 1993). In line with this theoretical basis, evolutionary economic geographers have taken a step forward and have confirmed that factories and enterprises in different regions develop along different innovation tracks by their geographical limitation (Boschma, Ron et al., 2012). Therefore, it seems to be unnecessary to consider the intervening effect of far-away markets. For the latter assumption, it is believed that the market is limitless to consume and support any kind of new product in which regions are able to innovate and produce so that they are capable of choosing to either specialize or diversify their products according to their abilities. Such a prejudiced theoretical basis may largely originate from some empirical research that focuses on high-tech industries in a few developed countries in the past few decades (Boschma, Ron et al., 2012; Van Den Berge & Weterings, 2014). In that period of time, the total production capacity has been completely occupied by a few industrial clusters within a few developed countries which are far from enough to satisfy the vast world market so that the competition pressure is too limited to consider.

Considering the complexity of market demand that may drive regional product innovation in reverse, the path-dependence of a region that is focused on by evolutionary economic geographers is a necessary condition rather than a sufficient condition. It fails to take into account the competition and demand changes of the market. Will the demand fluctuation of the market itself stimulate the creation of new products in the region? What is the symbiotic relationship between the supply side and the demand side? It is necessary to bring the industrial base of the supply side and the market factors of the demand side into the research category simultaneously, to observe how the evolution of the regional industry is affected by the supply and demand relationship. It is possible to improve the theoretical framework of evolutionary economic geography on the effect of regional innovation, however, few previous empirical studies have investigated the impact of the demand side which is constituted by international and domestic markets. Faced with an unstable hierarchical environment which can be related to regions, countries or even global enterprises' performance may significantly be impacted by the approaching of external markets which is by a large

extent supported by the constructing of regional transportation infrastructures and the liberalization of markets determined by the local industrial institution. This perspective, therefore, provides a unique opportunity to broaden the understanding of the impact of power on the emergence of new industries from the supply side to the demand side which has not been explored before. China has been chosen for the case study as it has experienced a period of rapid economic growth over the last two decades. It is undergoing industrial upgrading from the low end of the international industrial chain to the medium and high end (Zhang, H. & Tang, 2017). Meanwhile, China is recognized as a country with unbalanced development as regions share large disparities in economic performance, market accessibility conditions and levels of local market liberalization controlled by local institutions, which may help to reveal the inner mechanism.

In this paper, we are committed to exploring the role of regional economic diversification and regional market force in promoting regional industrial agglomeration and evolution, to provide strategic support for the development of urban industrial clusters.

2. LITERATURE REVIEW

2.1 Path dependence based on technological relatedness——regional industrial diversification on the supply side

To examine the impacts of the supply side on urban industrial innovation and growth, it is necessary to provide a brief literature review of the core concept of EEG—Path dependence and technological relatedness.

Path dependence is regarded as the engine of regional industrial diversification (Boschma, Ron & Capone, 2016; Aguilar-Becerra et al., 2019; Luhas et al., 2019) where it presents an advanced way to explain the imbalanced development (Walker, 2000; Hidayati, Yamu, & Tan, 2019). Existing studies have demonstrated that the industries in the path have interaction due to upstream and downstream input and output relations, labour sharing, whole service, infrastructure externalities and knowledge spill overs together with the competition of land, capital and skilled labour (Martin & Sunley, 2006). When this interaction is too strong, exceeding a certain “threshold”, the components of the system would tend to be dominated by the path dependence of the system as a whole (Bassanini & Dosi, 2001).

Technology acts with a crucial enabling role for path-dependent processes and the innovation of local industries (Boschma, R. A. & Wenting, 2007; Cooke, 2017; Aldieri & Vinci, 2018). The emergence of new industries only occurs when enterprises are able to conprehend, assimilate and apply external knowledge which approach their own knowledge base (Cohen & Levinthal, 1989). Therefore, cognitive proximity between enterprises is identified as a requirement to make knowledge transfer effective between enterprises (Boschma, Ron, 2005). In general, new industries or new developing paths are more possible to appear in a region with more related pre-existing industries (Qin et al., 2019; Ali, 2017).

However, this kind of perspective, to illustrate the mechanism of regional industrial innovation, is soley based on the supply side, without putting enough emphasis on the demand side (Choe & Ji, 2019). Although evolutionary economic geographers do not specifically deny the effect of market forces with a wider range, it is to some extent supposed to be treated as if all regions are facing the same market (Hidalgo et al., 2007). Besides, on the theoretical level, enough academic considerations of the market effect on the emergence of new industries may be inconsistent with the repudiating of the core concept of equilibrium in evolutionary economic geography (Boschma, R & Martin, 2004). The productive abilities of local individual enterprises and their neighbours are a necessary condition to diversify their products but not a sufficient condition. The innovation of local products is not only a result of the production and innovation capability of the producers, but also the satisfaction of the demand of consumers. The curve of utility function designed by Krugman, P. (1980) in his research of economies of scale and comparative advantage under imperfect competition tells us that consumers usually have a preference for diversification. If goods show more diverse, consumers are willing to pay higher cost for foreign diversity (Krugman, P., 1980). On the realistic level, Gereffi (1999) has testified that industrial together with commercial capital forms global trade through two kinds of international economic networks: "producer-driven" and "buyer-driven" commodity chains. In producer-driven chains, manufacturers produce advanced products by exerting control over backward linkages composed with raw material and component manufacturers and forward linkages composed of distributors and retailers which are expected to be influenced by the supply side. On the contrary, buyer-driven commodity chains are influenced by severely competitive, locally owned together with globally distributed production networks in linking foreign factories which are supposed to be influenced by the accessibility of the demand side.

From this point of view, there appears to be a possibility that the larger the market was accessible by the producers, the higher the level of the heterogeneity of the consumers' demands and the more stimulating the effects for the enterprises to explore diversified products. This trend is expected to be particularly true for enterprises pursuing export markets, as they encounter different consumers in different nations with much higher heterogeneity with respect to the domestic market. In this research, based on Chinese export data, we are supposed to focus on the demand side and examine how Chinese regional industrial diversification is impacted by the accessibility and openness of external markets. We are trying to determine whether regions in China are able to seek for a more open apporach so that industrial trajectory based on the cohision of industrial structures in a region (Neffke, Henning, & Boschma, 2011) can be transcended. Two types of factors that may help regions to diversify their industrial products are identified: market potential and market segmentation.

2.2 Market potential and market segmentation—— regional industrial diversification on the demand side

2.2.1 Market potential oriented by regional transportation infrastructure

The notion of market potential was proposed by Harris (1954) who has claimed that the total demand for locally produced goods in a region is determined by the total purchasing power of other regions, which is weighted by transport costs. The core of the concept lies in the level of a region's performance of economic activity being determined by the region's access to the market for its products (Wu, Liang, & Wu, 2016; Li & Li, 2018). To begin with, consistent with Krugman's theory , the accessibility to larger markets makes enterprises encounter a higher level of heterogenous consumers who stimulate the enterprises to diversify their products, so satisfying their demands of variety (Krugman, P. R, Obstfeld, & Melitz, 2014); secondly, the accessibility of the market induces the agglomeration of industries (Fujita, Krugman, & Mori, 1999), the rise of incomes (Hanson & Xiang, 2004) and the diffusion of knowledge (Keller, 2002), thus helping the enterprises to share professional service providers, expertise labour, and knowledge spill overs which would all benefit the regional diversification; lastly, the accessibility of larger markets reduces the transportation costs of raw material input and product output which also help industries to discount producing and trade costs, thus to be capable of accumulating the capital to support innovating their products so that they can maintain the position of price among competitors.

This paper focuses on the effects of two types of market potential: international market potential and domestic market potential. We thus hypothesize that:

Regions with both stronger international market potential and domestic market potential have more capabilities to diversify their industries in exploring the international market (Hypothesis 1).

2.2.2 Market segmentation oriented by local protectionism

Market segmentation is another factor that has important implications on the demand side. Usually, it restricts the market scope which can be occupied by local industries (Shi, T. T., Liu, & Li, 2018; Deng & Li, 2019; Eiras-Franco et al., 2018). In China, market segmentation is usually formed by local protectionism which is originated by a government force (Wang, Li, & Liu, 2016). The local decentralization policy has led to competition among regions and thus has generated local protectionism in the process of marketization (Zhang, W. & Li, 1998). Young (2000) has confirmed that in the process of reform, various departments retain a large number of "rents" formed by the distortions of traditional systems. In order to protect the rents, local governments set up various barriers to obstruct the cross-regional circulation of goods. As a result, the division of specialization in the region is diminished, the market is segmented and the industrial structures of different regions become similar.

On the theoretical aspect, market segmentation restricts export activities. This is based on the hypothesis of new economic geography, which has

demonstrated that, against the background of increasing returns to economies of scale and consumers' preference of differentiated products, a country prefers to export products that occupy comparatively larger domestic markets, while the country would like to import products which occupy comparatively smaller domestic markets. In consequence, the high level of integration of the domestic market is the guarantee for local enterprises in improving their competitiveness to achieve good export performance (Krugman, Paul R, 1991). On the empirical research aspect, market segmentation with an administrative boundary as the basic unit is the main factor affecting the export performance between regions. As opposed to those theories and evidence, some of the existing empirical studies have proved that serious domestic market segmentation has a significant positive effect on export performance (Young, 2000). The reason lies in the restriction of the scale of the domestic market for enterprises to occupy due to the effect of severe market segmentation, which, distorted, encourages enterprises to turn to the international market as a substitute for the loss of domestic markets in pursuing economies of scale (Zhao & Xiong, 2009). But the distorted incentive mechanism is at the expense of efficiency loss while the higher the level of market segmentation, the lower the productivity of the export enterprises (Zhang, J., Zhang, & Huang, 2010). New research has already confirmed that, in the short term, it may encourage the export performance of local enterprises as a substitute brought on by the restriction of the domestic market, but in the long term, it would eventually hinder enterprises to acquire economies of scale through expanding to the domestic market, increasing the cost of large-scale production, thus ultimately reducing the productivity and international competitiveness of export enterprises and holding back export performance (He & Ma, 2014). The relation schema of the effect of market segmentation to export industries is shown in *Figure 3*.

In this study, we build on this insight to evaluate the role of market segmentation within the provinces in shaping the diversification processes of exported industries. Market segmentation may both constrain and promote the diversification of regional industries. In this study, we focus on the negative side as it may inhibit the ability to diversify their export products during the time we have chosen. We hypothesis that:

Regions with stronger market segmentation have significant negative effects causing them to diversify their industries in exploring the international market (Hypothesis 2).

3. RESEARCH METHODOLOGY

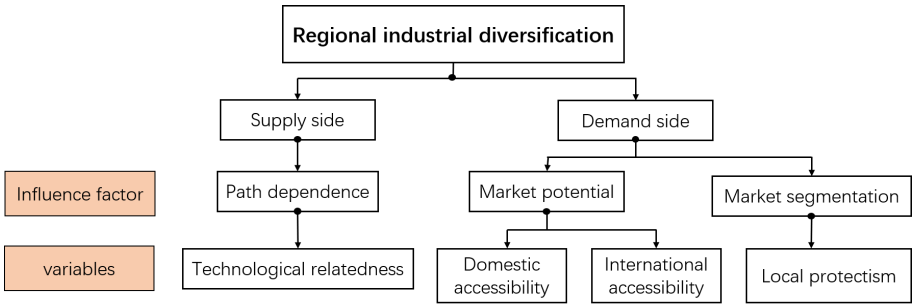
3.1 Data source

The data of the enterprises used in this paper come from the export customs declaration data recorded by customs offices in China in 2006 and 2011, which is the most original, accurate export trade data in China. The China customs import and export trade database records all merchandise transactions passing through Chinese customs and reports product codes (eight-digit), basic firm information, export/import value and quantity and so on. The basic data of the cities are from the statistical yearbook of Chinese prefecture-level cities in 2006.

Through screening, this paper selects 273,728 industrial data units of four-digit industrial data in 224 prefecture-level cities in China in 2006 and 2011.

3.2 Research Framework

Figure 1 shows the research framework of this paper. Based on the theoretical framework of evolutionary economic geography, this paper examines the influence of supply-side and demand-side on the evolution of local export products at the same time. On the supply side, we take "technological relatedness" as the proxy variable to test whether "path dependence" is the significant influencing factor for the evolution of local export products. On the demand side, we take "domestic market accessibility", "international market accessibility" and "local protectionism" as proxy variables to test whether "market potential" and "market segmentation" are significant influencing factors for the evolution of local export products. We introduce the PROBIT binary variable model, taking "the entry and exit of the new products" as dependent variables and putting each independent variable into the model successively to detect whether they have significant influence. In order to further research, we introduce cross variables to further demonstrate whether the market effect has strengthening or weakening effects on the effect of technological relatedness. Also, we divide the samples into east, middle, west and northeast China to detect the different performance of these independent variables in different regions.



Dependent variables	Independent variables	Across variables	Region
Industrial product entry	Technological relatedness	Technological relatedness* Domestic market accessibility	East
Industrial product exit	Domestic market accessibility	Technological relatedness* Domestic market accessibility	Middle
	International market accessibility	Technological relatedness* International market accessibility	West
	Local protectionism	Technological relatedness* Local protectionism	Northeast

Figure 1. The research framework

3.3 Variables

3.3.1 Dependent variables

The dependent variable ($C_{i,c,2011}$) of our model is a dummy variable. We evaluate it as *1* if city *c* has a revealed comparative advantage (RCA) in industry *i* in year 2011, and 0 if not. If the share of an export industry in a city is greater than the share of that industry in the whole country, the city is considered ot have a comparative advantage in this industry. In this paper, we use four-digit-level industries (1080 industries). China's prefecture-level cities is used as the geographical unit of analysis. RCA is measured as follows:

$$RCA_{i,c} = \frac{\frac{x(c,i)}{\sum_i x(c,i)}}{\frac{\sum_c x(c,i)}{\sum_{c,i} x(c,i)}} \quad (1)$$

3.3.2 Independent variables

3.3.2.1 Technological relatedness

Refer to the artical of Hidalgo et al. (2007), we employ a co-occurrence indicator to calculate the proximity of industrial techonology, which is expressed as

$$\phi_{jm} = min\,(Prob\,(RCA_j^r \mid RCA_m^r),\ Prob\,(RCA_m^r \mid RCA_j^r)) \quad (2)$$

Where the proximity ∅ between industry *j* and industry *m* refers to the minimum of the conditional probability that one has a local revealed comparative advantage (RCA) while the other also has a local RCA at the same place. Higher ϕ_{jm} means high possibility, that is , two industries with RCA are coordinated and gathered in one region, so that are more possible to have higher correlation with each other. Different from proxies that rely on traditional sector classifications to define linkages between industries, ∅ is more broadly and depicts the technological or cognitive proximity without considering their traditional official sector classifications.

In order to define the level of technological relatedness between regions in China, we introduced the concept of density, which is expressed as *X*.

$$w_{it}^r = \frac{\sum_j x_{jt}^r \phi_{ij}}{\sum_j \phi_{ij}} \quad (3)$$

Where w_{it}^r is the density surrounding industry *i* for region *r* in year *t*, x_{jt}^r=1 if RCA>1 and 0 if RCA<=1.In essence, density measurement combines the intrinsic relatedness information of products with the correlation information of local specialization patterns. The higher w_{it}^r is ,the closer sector *i is* to the productive advantage of city *r* in time *t*.

3.3.2.2 Domestic market potential as resulted in highway and railway transportation

Based on Harris's model, we design a model to measure the domestic market potential of every Chinese prefecture-level city as follows:

$$M_j = \sum_h aE_hT_x(j,h)^{-(\mu+1)} \quad (4)$$

E_h is the local total consumption of H, $T_x(j,h)$ is the transport index of J and H, and a is an alternative variable for market potential attenuation with distance. According to the method based on (Shi, M., Zhao, & Jin, 2007), this paper takes the space allocation rate of the cargo with distance as the substitution variable of a, while the formula is $a=5D_{jh}^{-0.001}$. E_h is the market size of H, which is expressed by the market consumption level of H. The transport index $T=r*D_{jh}$, in which r is the unit transport cost and D_{jh} is the transport distance between the two places. The transportation distance matrix of the cities is established by combining railway transportation and highway transportation. The measurement method is that the transportation between cities is mainly based on the shortest distance of railway transportation, while the cities in which the railway is not accessible are converted into railway distance according to the corresponding price of highway. According to the results of the market survey, the average freight rate of the railway is 0.08611 yuan/t.KM while the average highway freight is 0.27 yuan/t.KM. The parameter μ which characterizes the substitution of elasticity is 2.5.

3.3.2.3 International market potential as resulted in navigational transportation

This paper uses the method of Parsley and Wei (1996); Yang and Guo (2016) to measure international market potential as resulted in navigational transportation based on the FTSA value of the city. FTSA means the degree of difficulties in the city's international trade which relies on navigational transportation and the size of the overseas markets which can be linked. It is measured as follows:

$$AC_i^s=M_s^{\alpha}C_i^{s-\lambda} \quad (5)$$

AC_i^s is the value of FTSA from city i to region s overseas; M_s^a is the charm value of regions which is used to measure the market capacity of the overseas region and which is measured by the gross import of the exact region; C_i^s is the generalized transportation cost from city i to region s overseas. α and λ are given parameters.

3.3.2.4 International market potential as resulted in aerial transportation

Referring to the FTSA method for measuring the international market potential as resulted in navigational transportation, we calculate the international market potential as resulted in aerial transportation as follows.

The meaning of each index in the formula is consistent with the previous section.

$$AC_i^s=M_s{}^{\alpha}C_i^{s-\lambda} \quad (6)$$

The flight distribution of the international hub cities (mainly capital) of the major economic entity in China's 10 major airports is searched by scheduled flight software. We find that three international hub airports in Beijing, Shanghai and Guangzhou mainly take non-stop flights to the main hub cities of the five continents. The flights of the airports of the other seven domestic hub cities to the main hub cities of the five continents are mainly via transfer in Beijing, Shanghai or Guangzhou. We define that the export products of the cities without airports will be transported to the nearest cities with an airport by highway and then flown to the closest cities of Beijing, Shanghai or Guangzhou, and finally by a flight to the destination.

$$C_i^s=Air_i^s *4 \quad (7)$$

$$C_{i1}{}^s=(Air_{i1}+Air_i^s) *4 \quad (8)$$

$$C_{i2}{}^s=Road_i^{i1}*0.27+ \left(Air_{i1}{}^i+Air_i^s\right) *4 \quad (9)$$

C_i^s is the cost of aerial transportation from Beijing, Shanghai or Guangzhou to the region s overseas, $C_{i1}{}^s$ is the cost of air transportation from city i with an airport, with the exception of Beijing, Shanghai and Guangzhou, to the region s. $C_{i2}{}^s$ is the cost of air transportation from city i without an airport to region s. Air_i^s is the flight distance from Beijing, Shanghai or Guangzhou to region s overseas which is measured by the distance of the course line of the equator. $Air_{i1}{}^i$ is the flight distance from the city i with an airport with the exception of Beijing, Shanghai and Guangzhou to region s overseas. $Road_i^{i1}$ is the highway distance from city i without an airport to the nearest city with an airport. According to the market survey, the cost of unit air transportation is 4 yuan/t.km and the cost of unit highway transportation is 0.27 yuan/t.km.

3.3.2.5 Market segmentation

The theoretical basis of using the variance of relative prices (P_i / P_j) to measure the degree of market segmentation is from Samuelson's "iceberg" model (1954). This model shows that P_i and P_j can rise and fall together or one rise together with another fall. As long as the value of P_i / P_j does not exceed a certain range, it can be considered that the market between the two regions is integrated. The existence of transaction costs explains the failure of the law of one place between the two places. This shows that the standard deviation of price fluctuation adopted by Young is difficult to accurately reflect the degree of market integration. Parsley and Wei (1996) used the "iceberg" cost model and the variance changes of relative price in different regions to calculate the "boundary effect" between regions. They explored the path to research on market segmentation by observing the variance of relative prices (P_i / P_j).

4. EVOLUTION OF THE PRODUCTION NETWORK OF CHINA'S EXPORT INDUSTRY

Taking the total export volume of 4-digit industries in 31 provinces, autonomous regions and municipalities directly under the central government in China in 2006 and 2011 as the basic data unit, we identify the dominant products of each city and calculate the proximity of products, then we add the total export volume of each city in 2006 and 2011 respectively. We make a spatial map of export products of 2006 and 2011 using the software, Cytoscape. The products are used as the nodes and the product space is built with the proximity as the edges between the nodes. To make the space map clearer, we remove the edges of proximity less than 0.6 and the nodes of the export value of products less than $0.1 billion. The results are shown in the following figures.

Figure 2 and *Figure 3* are the production network of China's export products in 2006 and 2011 respectively. In *Figure 2*, the nodes are 2,615 and the edges are 610. There are two major cores in the production network. The left core consists of chemistry products, textile products, general machine products, food and beverage and base metal products which usually lie in the low and middle end of the industrial chain. The two cores are linked with each other through some sparse linkages. Besides, there are many linkages that exist at the edge of the production network. In *Figure 3*, there are some obvious changes in the production network in 2011 from in 2006. The nodes increase to 2,655 and the edges increase to 681. Compared with the left core, the right core reduces the middle and low-end products such as food and beverage and chemistry products while increasing the high-end products such as vehicle products, optics, lighting, film instrument and equipment. Overall, there are more links between industries. In particular, there are more links between the two cores so that the distance between the cores is smaller and the classifications of industries between the two cores become similar. The number of nodes in the two cores increases which implies that more industries relate tighter with each other.

To compare the regional differentiation in the production network, we hold the production space while *Figure 4* is fixed. *Figure 4* presents the production network of four regions in China's production network in 2006. We can see that the advantaged sector of the eastern region mainly exists in the right corner while the advantaged sector of the northeast, middle and west regions mainly exist in the left corner. As the sectors in the right corner are mostly more developed than those in the left corner, we can find that in the eastern region the introduction of new industrial types has maintained a leading level. That is to say, regional development in China has significant differences and needs to be classified studied. *Figure 5* presents the evolution of regional production structure from 2006 to 2011. The production space has been kept in *Figure 2* fixed. The solid triangle represents the new dominant plates in the region development from 2006 to 2011, the solid circle represents the existing dominant plates in 2006 while the hollow circle represents the rest of the plates. It is shown that the new advantageous industries within the eastern and north-eastern regions are widely distributed in the core and marginal areas of the product space while the new advantageous industries in the central and western regions are mainly concentrated in the two core areas while the marginal areas are less distributed. This shows that the newly added advantageous industries in the eastern and north-eastern regions are less affected by the level of

technological association of product space while the central and western regions are more affected by the level of technological relatedness of the product space, while the central and western regions are more influenced by the technological relatedness of product space. As cities in the eastern and north-eastern regions of China are closer to the coastline and the highway, railway and air transportation are more developed, the international market accessibility and domestic market accessibility are better than those in the central and western regions. This may reflect that the evolution of export products in regions with high access to domestic and international markets is less affected by technological relatedness, which is consistent with the argument in this paper.

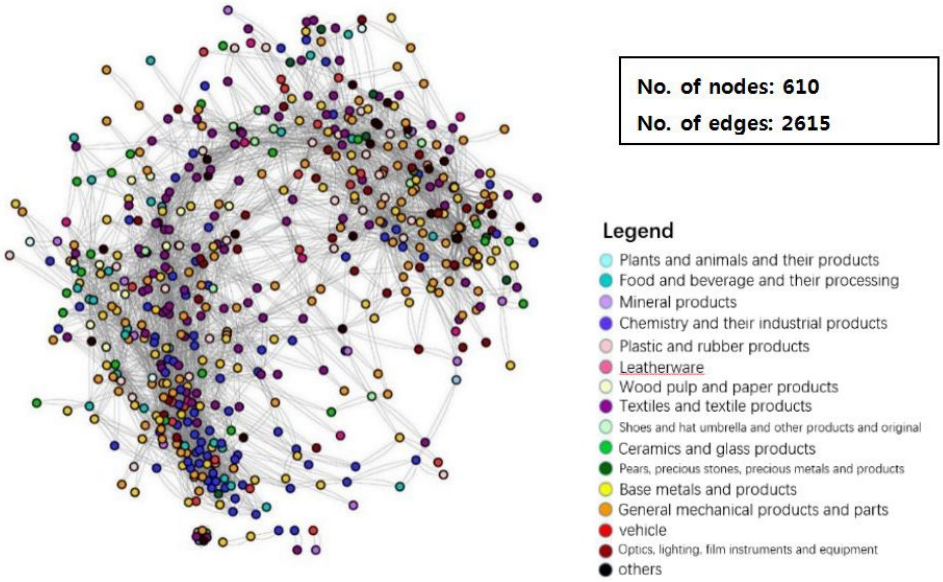


Figure 2. The production network of China's export products, 2006. Note: (1) Every four-digit manufacturing secto is represented by a node; (2) A four-digit industry of a category is represented by one color（3） There are 610 nodes and 2615 edges in total; (4) The threshold of relatedness is 0.6 while the data source is from the export customs declaration data recorded by customs offices in China.

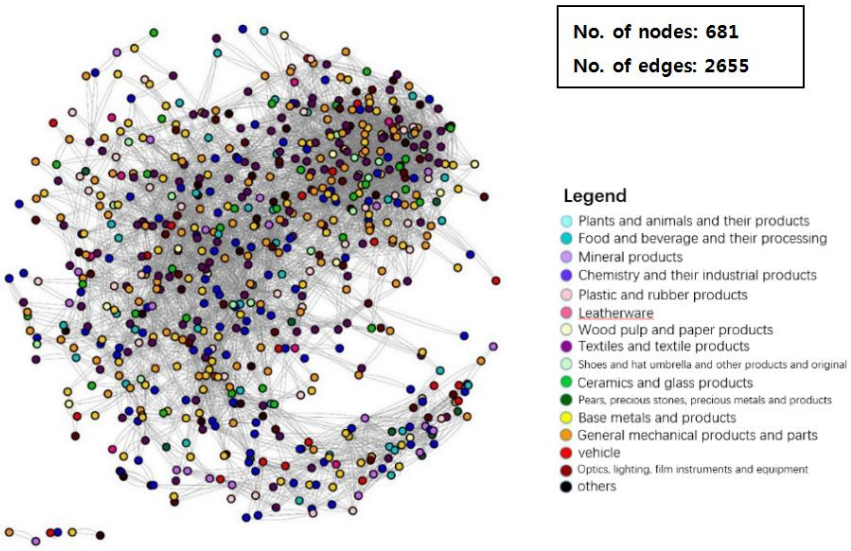


Figure 3. Product space in the entire country in 2011. Note: (1) There are 610 nodes and 2615 edges in total; (2) the threshold of relatedness is 0.6 while the data source is from the export customs declaration data recorded by customs offices in China.

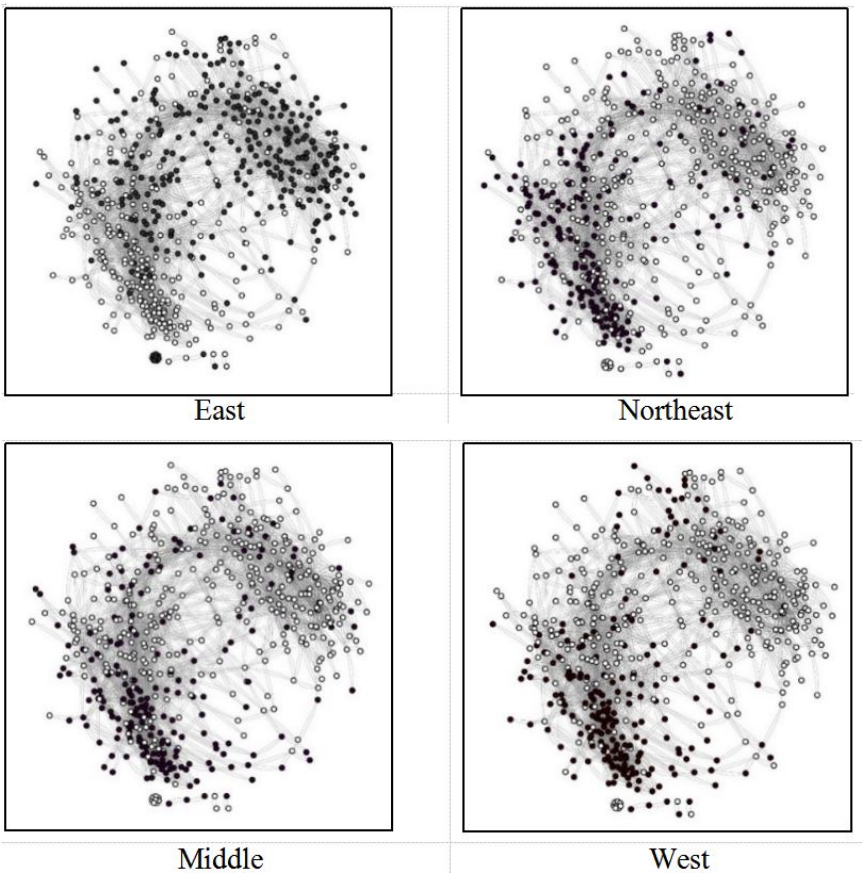


Figure 4. Localization of the production structure for different regions in the production space of China, 2006. Note: (1) Fixed the production space in *Figure 2* while the black solid circle represents the sectors with competitive advantages in (RCA>1) the region, and a hollow circle represents the remaining ones.

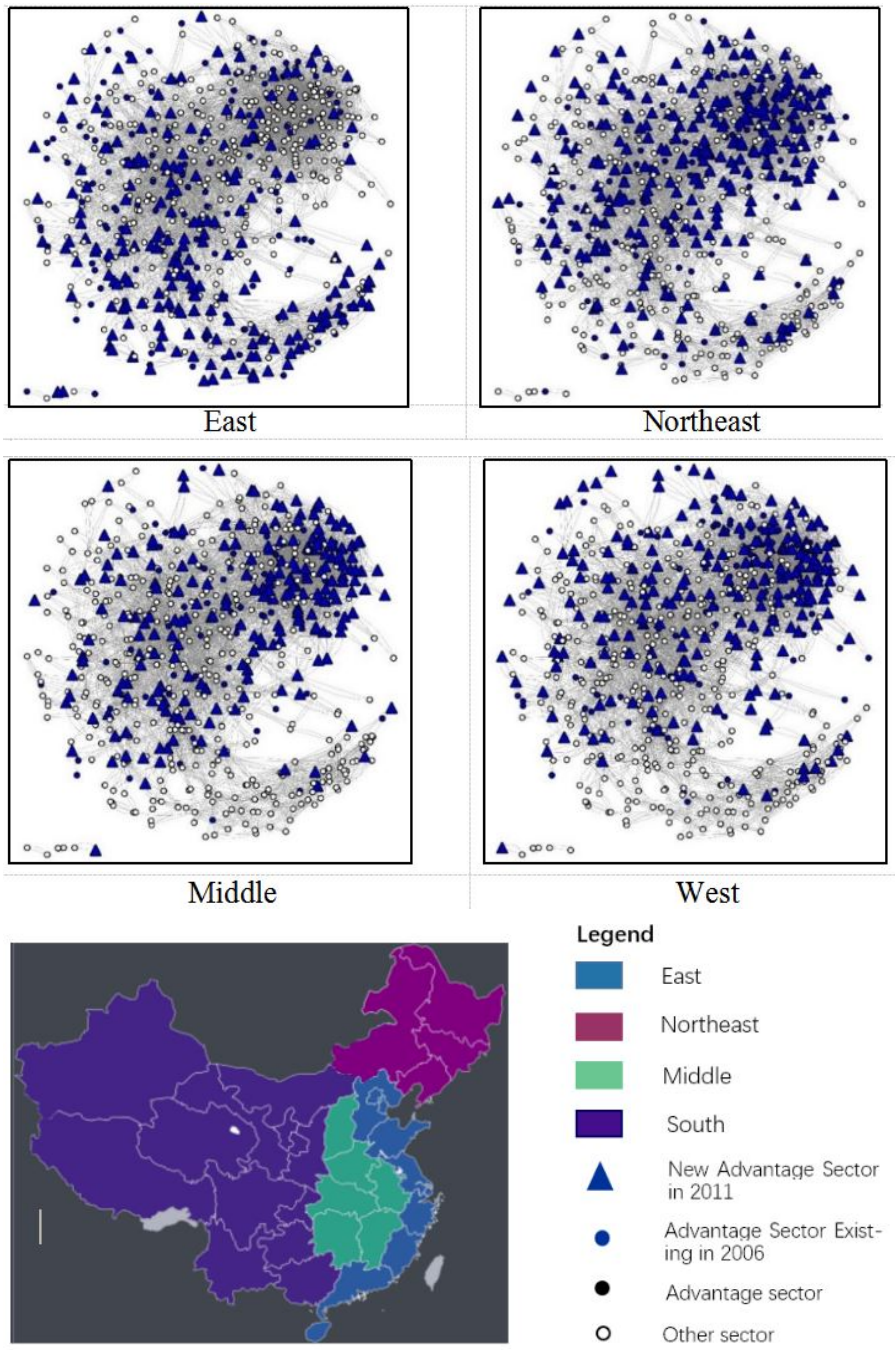


Figure 5. Production structure in different regions of China's production space in 2011. Note: (1) Fixed the production space in *Figure 4* , The solid triangle represents the new advantageous sector of regional development from 1999 to 2007,the solid circle represents the existing advantageous sectors in 1999, and the hollow

5. MODEL SPECIFICATION

Since our dependent variable is binary, the PROBIT model is used. The following econometric equation is estimated:

$$C_{i,c,2011} = \alpha + \alpha_1 \times C_{i,c,2006} + \alpha_2 \times \mathrm{ETR}_{i,c} + \beta_1 \times sea_c + \beta_2 \times air_c + \beta_3 \times domestic_c + \beta_4 \times segmentation_c + \gamma_1 \times C_{i,c,2006} \times \mathrm{ETR}_{i,c} \times sea_c + \gamma_2 \times (1 - C_{i,c,2006}) \times \mathrm{ETR}_{i,c} \times sea_c + \gamma_3 \times C_{i,c,2006} \times \mathrm{ETR}_{i,c} \times air_c + \gamma_4 \times (1 - C_{i,c,2006}) \times \mathrm{ETR}_{i,c} \times air_c + \gamma_5 \times C_{i,c,2006} \times \mathrm{ETR}_{i,c} \times domestic_c + \gamma_6 \times (1 - C_{i,c,2006}) \times \mathrm{ETR}_{i,c} \times domestic_c + \gamma_7 \times C_{i,c,2006} \times \mathrm{ETR}_{i,c} \times segmentation_c + \gamma_8 \times (1 - C_{i,c,2006}) \times \mathrm{ETR}_{i,c} \times segmentation_c + \delta X + \pi t + \varepsilon$$

The dependent variable ($C_{i,c,2011}$) and the first independent variable ($C_{i,c,2006}$) of our model are dummy variables. We evaluate it as 1 if city *c* has a revealed comparative advantage (RCA) in industry *i* in year 2011/2006 and 0 if not. *X* is a vector of the province and industry variables, which is used to control the province and industry characteristics. *Y* represents control variables, which are represented by $GDP_{c,2006}$ (GDP value in city *c* in 2006) and $population_{c,2006}$ (the total population of city *c* in 2006) respectively. sea_c is the international market potential as resulted in navigational transportation while air_c is the international market potential as resulted in air transportation. $domestic_c$ is the domestic market potential as resulted in railway and highway transportation. $\mathrm{ETR}_{i,c}$ is the level of technological relatedness of product *i* in city *c* in 2006, $segmentation_c$ is the level of market segmentation in city *c* in 2006. $\mathrm{GDP}_{c,2006}$ is GDP value in city *c* in 2006, $population_{c,2006}$ is the total population of city *c* in 2006. $GDP_{c,2006}$ and $population_{c,2006}$ represent two control variables of the model.

Following Boschma et al. (2013), we distinguish between the effect of independent variables on two kinds. One is developing a new comparative advantage industry of a city, while the other is keeping a comparative advantage in the existing industrial structure of a city. $\gamma_1,\gamma_3,\gamma_5,\gamma_7$ reflect the effect of independent variables in developing a new comparative advantage industry, while $\gamma_2,\gamma_4,\gamma_6,\gamma_8$ reflect the effect of independent variables in keeping a comparative advantage in an existing industry.

The significant positive effect of ETR means that regions are supposed to diversify into related industries which indicates that the regional economy evolves in a path-dependent way. sea_c, air_c and $domestic_c$ represent the market potential effect while $segmentation_c$ represent the segmentation effect. Furthermore, we introduce the interaction term between ETR and the other variables. A significant sign of the interaction term indicates that the specific market force enhances or restricts regions' reliance on technological relatedness. If this is the case, regions' reliance on path-dependent modes can be transcended by approaching the outside market in various ways so that market force is another factor to impact regional industrial evolution.

6. EMPIRICAL RESULTS

The correlation coefficients matrix of independent variables in *Table 1* presents that explanatory variables are moderately correlated. There is not a significant collinearity issue in the following model estimations.

Table 1. Correlation coefficients among independent variables

	$C_{i,c,2006}$	ETR	*sea*	*air*	*domestic*	*segmentation*
$C_{i,c,2006}$	1.0000					
ETR	0.2602	1.0000				
sea	0.1054	0.4219	1.0000			
air	0.1106	0.4348	0.5607	1.0000		
domestic	0.0737	0.2638	0.2326	0.2251	1.0000	
segmentation	-0.0207	-0.0738	-0.1283	-0.2647	-0.1655	1.0000

The descriptive statistics of the full sample and the four regions show that the distribution of the main variables is significantly different. For the ratio of transition industry, which is the industry with $RCA_{2006}=0$ while $RCA_{2011}=1$, the eastern region shares the highest ratio of 18.44%, which is more than three times that of the west. This illustrates that the most developing region has the most active performance of introducing new advantageous industries. The ratio of transition industry between the four regions is 18.44%, 10.57%, 8.56%, 5.69% relatively, which is 3.24:1.86:1.5:1 in proportion, as the mean values of ETR between the four regions are 0.1659, 0.1061, 0.0734 and 0.0518, which is 3.20:2.04:1.42:1 in proportion, and which is similar to the proportion of the ratio of a transition industry. This may suggest that the high level of technological relatedness may bring a high level of transition industries. Meanwhile, for the mean value of the variable of *sea, air* and *domestic*, the eastern region has the highest value, the western region has the lowest and the central and northeast regions are in the middle, which is also consistent with the relationship of the ratio of transition industries. This implies that the international market potential and the domestic market potential may also have positive roles in promoting the transformation of local industries. For the variable of segmentation, the western region has the highest mean value and the northeast has the lowest value, which may be partly in line with the expected side effect of market segmentation on industrial transformation.

Table 2. The descriptive statistics of the full sample and the four regions

	The ratio of transition industry	ETR		*sea*		*air*		*domestic*		*segmentation*	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
full sample	11.01%	0.1035	0.00016	531.40	3.5775	360.14	1.9381	1.5487	0.3419	0.0041	0.00015
east	18.44%	0.1659	0.00025	574.94	3.1.31	381.70	2.7041	3.6223	0.9596	0.0035	0.00021
northeast	10.57%	0.1061	0.00040	476.35	6.3267	354.18	3.5065	0.6883	0.0168	0.0025	0.00015
middle	8.56%	0.0734	0.00020	552.85	3.0548	358.86	2.7914	0.9117	0.1332	0.0045	0.00031
west	5.69%	0.0518	0.00019	475.28	5.1455	335.34	3.3414	0.2025	0.0269	0.0052	0.00030

Since the dependent variable is binary, the PROBIT model has been used. The regression results are as follows, while *Table 3* reports the econometric results:

From model (1) to model (6), we can see that technological relatedness has positive effects on having a comparative advantage in an industry, suggesting that regions tend to be specialized in industries that are closely related to pre-existing industrial structure, which echoes the conclusion of proponents of evolutionary economic geography. Besides, the international market potential resulted in navigational transportation and domestic market potential both have positive effects on having a comparative advantage of local export products. Market segmentation has a negative effect, which is consistent with our hypothesis. The results demonstrate that besides relying on the supply side, approaching the domestic and international market demand significantly promotes the emergence of new industries. Market segmentation is an unstable variable between the models in the full-sampled estimation, as it is significantly negative in models (2) and (4) while insignificant in models (1), (3) and (5), which may because the market segmentation force varies between regions. The international market potential resulted in air transportation is also unstable as it is insignificant in some models and even negative in others, which is contrary to expectations and which needs further exploration.

From model (3)-(7), the interaction term between ETR and other variables are introduced to the models. It is found that, in model (3), the interaction term between international market potential resulted in navigational transportation and technological relatedness being negative, and in model (5) the interaction term between the domestic market potential and technological relatedness is also negative. This illustrates that the role of both international and domestic market potential significantly reduces regions' reliance on technological relatedness on the diversification of regional export products. That is to say, when regions approach the domestic and international market, the effect of technological relatedness on the diversification of local export products will weaken. In model (6), The interaction term of technological relatedness and market segmentation is significantly positive which may demonstrate that the intervention of local government on the local industry will enhance the effect of technological relatedness on regional diversification. As the variable of segmentation is insignificant in model (6), it needs further research.

The products are divided by the regions into the northeast, the east, the middle and the west groups. The regressions are conducted separately among the four groups. The estimation results are as follows, and are shown in *Table 4.*

To begin with, we investigate the supply side. Density has a significantly positive effect on the city groups of the east and the west while it is insignificant on the city groups of the middle and the northeast which suggests that the effect is not universal across regions. Next, we turn to the demand side. It is found that the variable of sea_c is significantly positive in the northeast and middle regions while significantly negative in the east region and insignificant in the west region. Then, for the variable of *air*, we can see that in the city groups of the east, northeast and middle, the variable of *air* plays a significant positive effect while in the city group of the west, the variable of *air* plays a negative effect. From the results above we can conclude that in regions such as those in the northeast and middle, in which technological relatedness does not work, the international market potential does work. For the performance of the two variables of domestic market potential and market segmentation, the eastern, central and north-eastern regions all show relative consistency: domestic market potential has a significant positive effect on local products' diversification, while market segmentation has a significant inhibiting effect on it. However, the domestic market potential of northeast China has a significant promoting effect on the evolution of local products and market segmentation has a significant promoting effect on it, which may be explained by the special local centralized political system as the local government is the main supportive force to the development of its leading industry.

For the interaction term, we referred to model (1) and model (4), as only in these two groups is the variable of ETR significantly positive. In model (1), we can find that the international term between sea_c and ETR is significantly positive. The interaction term between $domestic_c$ and ETR together with the interaction term between *segmentation* and ETR are both negative. This means that in the region of the east, the international market potential has a significantly positive effect both on generating a new advantageous industry and sustaining an existing advantageous industry, while domestic market potential and market segmentation have a negative effect on both. In model (4), we can see that the interaction terms of ETR and domestic are significantly negative and the interaction terms of ETR and segmentation is significantly positive and the interaction terms of ETR and segmentation in maintaining an existing advantageous industry, which may indicate that in the region of west, domestic market potential will inhibit the effect of technological relatedness on regional diversification, and market segmentation will promote the opposite of which. This can give us a guideline that in the underdeveloped countries, if we want to break the path-dependent influence and create new influences, approaching the international and domestic market together with reducing local protection will be effective.

As a robust check, we re-estimate all models by using the Logit model. When considering the international and domestic market potential, we substitute GDP for gross import in calculating the charm value of foreign countries and domestic cities. When considering the market segmentation, we substitute the relative price index proportion of the output value of the state-owned enterprises in the city for the proportion of the output value of the state-owned enterprises. Compared with the results presented above, these changes produce only minor effects. Hence, estimation results for these robustness checks are not reported here.

Table 3. The estimation results of all sample statistical models (1)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	$C_{i,,c,2011}$	$C_{i,,c,2011}$	$C_{i,,c,2011}$	$C_{i,,c,2011}$	$C_{i,,c,2011}$	$C_{i,,c,2011}$
$C_{i,,c,2006}$	-0.0261	-0.0254	0.109	0.159**	-0.0283	0.0979
	(0.0403)	(0.0403)	(0.0740)	(0.0764)	(0.0551)	(0.0695)
ETR	9.299***	8.925***	29.72***	17.63***	13.81***	7.222***
	(0.422)	(0.445)	(2.628)	(2.945)	(0.590)	(0.553)
sea		0.00240**	0.00466***	0.00223**	0.00232**	0.00143
		(0.000996)	(0.00105)	(0.000998)	(0.00103)	(0.00101)
air		-0.00314**	-0.00429***	-0.00173	-0.0101***	-0.00151
		(0.00147)	(0.00148)	(0.00154)	(0.00158)	(0.00150)
domestic		0.166***	0.216***	0.169***	1.113***	0.176***
		(0.0626)	(0.0623)	(0.0625)	(0.0918)	(0.0628)
segmentation		112.8	-1,035***	-143.1	-2,033***	219.9
		(259.3)	(303.2)	(270.5)	(310.5)	(261.5)
population	-0.00124 ***	-0.00130 ***	-0.00168 ***	-0.00147 ***	-0.000760 ***	-0.00125 ***
	(0.000218)	(0.000234)	(0.000244)	(0.000245)	(0.000238)	(0.000234)
GDP	-1.58e-08 ***	-1.26e-08 **	-7.10e-09	-1.70e-08 **	-7.61e-09	-1.65e-08 ***
	(6.07e-09)	(6.35e-09)	(6.58e-09)	(6.65e-09)	(6.61e-09)	(6.39e-09)
$C_{i,c,2006}$*ETR**sea*			-0.0453***			
			(0.00536)			
(1- $C_{i,c,2006}$)*ETR**sea*			-0.0429***			
			(0.00530)			
$C_{i,c,2006}$*ETR**air*				-0.0300***		
				(0.00868)		
(1- $C_{i,c,2006}$)*ETR**air*				-0.0251***		
				(0.00846)		
$C_{i,c,2006}$*ETR**domestic*					-17.42***	
					(1.455)	
(1- $C_{i,c,2006}$)*ETR* *domestic*					-17.51***	
					(1.266)	
$C_{i,c,2006}$*ETR* *segmentation*						2.199*
						(1.249)
(1- $C_{i,c,2006}$)*ETR*						4.347***

segmentation						(0.832)
i.province	included	included	included	included	included	included
i.hs	included	included	included	included	included	included
Constant	-2.334***	-2.621**	-0.153	-2.290**	5.496***	-3.086***
	(0.338)	(1.147)	(1.201)	(1.147)	(1.311)	(1.157)
Observations	47,936	47,936	47,936	47,936	47,936	47,936

***p <0.01 **p <0.05 *p <0.1

Table 4. Results of regression analysis of PROBIT model in east, middle, west and northeast cities

	(1)	(2)	(3)	(4)
	east	northeast	middle	west
VARIABLES	$C_{i,,c,2011}$	$C_{i,,c,2011}$	$C_{i,,c,2011}$	$C_{i,,c,2011}$
$C_{i,,c,2006}$	0.150***	0.165*	0.121**	0.0946
	(0.0381)	(0.0883)	(0.0528)	(0.0837)
ETR	7.091***	3.690	-2.361	7.145**
	(2.476)	(3.199)	(5.509)	(3.480)
sea	-0.00230***	0.00362*	0.00283***	0.00123
	(0.000603)	(0.00199)	(0.000904)	(0.00121)
air	0.00687***	0.00637*	0.00359***	-0.00987***
	(0.000779)	(0.00340)	(0.000947)	(0.00186)
domestic	0.0301***	-2.327***	0.0356**	1.174***
	(0.00431)	(0.660)	(0.0172)	(0.117)
segmentation	-38.42***	134.4**	28.50	-1,849***
	(11.15)	(59.04)	(44.65)	(313.4)
population	0.000159**	-0.000293	0.000364	-0.000567**
	(6.84e-05)	(0.000194)	(0.000302)	(0.000262)
GDP	6.17e-09***	2.54e09***	-5.80e-09	-1.03e-08
	(3.95e-10)	(5.75e-10)	(7.37e-09)	(7.63e-09)
$C_{i,,c,2006}$*ETR**sea*	0.0212***	-0.00170	0.0189*	0.0257
	(0.00348)	(0.0309)	(0.0102)	(0.0164)
(1- $C_{i,,c,2006}$)*ETR**sea*	0.0228***	0.0151	0.0115	0.00636
	(0.00336)	(0.0221)	(0.00871)	(0.0113)
$C_{i,,c,2006}$*ETR**air*	-0.0430***	0.00454	-0.0196	-0.0191

	(0.00550)	(0.0429)	(0.0134)	(0.0208)
(1- $C_{i,,c,2006}$)*ETR**air*	-0.0427***	-0.0179	-0.00140	0.00869
	(0.00527)	(0.0319)	(0.0101)	(0.0143)
$C_{i,,c,2006}$*ETR**domestic*	-0.153***	21.02***	-0.259	-18.89***
	(0.0202)	(4.590)	(0.255)	(3.145)
(1- $C_{i,,c,2006}$)*ETR**domestic*	-0.161***	18.84***	-0.288	-18.70***
	(0.0204)	(4.465)	(0.203)	(2.035)
$C_{i,,c,2006}$*ETR**segmentation*	-1.625***	-3.835***	5.759***	0.393
	(0.454)	(1.106)	(1.650)	(2.046)
(1- $C_{i,,c,2006}$)*ETR**segmentation*	-2.605***	0.0723	2.602***	2.623***
	(0.258)	(0.550)	(0.628)	(0.907)
i.province	included	included	included	included
i.hs	included	included	included	included
Constant	-3.391***	-6.410***	-4.983***	5.354***
	(0.505)	(0.993)	(0.588)	(1.353)
Observations	88,996	26,656	63,424	47,936

***p <0.01 **p <0.05 *p <0.1

7. CONCLUSION AND DISCUSSION

In the context of “the new normal” of China's economy, to pursue the quality of economic growth and ensure sustainable economic growth in cities, economic geographers and urban planning scholars have put emphasis on the role of related variety and path dependence. They have concluded that new industry emerges in the regions primarily on the support of technology-related industrial structure. Such a perspective has only concerned the supply side but has not put enough emphasis on the demand side. This conclusion is unilateral as it only provides a sufficient condition but ignores the essential condition. It does not consider whether the attempt to improve the accessibility of the market of a region can stimulate the emergence of new industries so that the restriction of backward regions as resulted in the lack of technology-related industries can be transcended.

In this article, we define two types of variables to represent the accessibility level of the market, which are market potential and market segmentation respectively. Empirically, this research has proved that technological relatedness, which represents a path-dependent pattern, is effective on the innovation of the regional export industry, as well as market potential and market segmentation, which have positive and negative effects respectively. Meanwhile, market potential alleviates the positive effect of technological relatedness on the evolution of the export industry while market segmentation promotes the opposite of which. From the results, we are able to conclude that the market force on the innovation of local industries needs to be paid more attention to and be carefully examined,

especially in the regions that technological relatedness does not work or there is powerful intervention by local governments.

This research extends the perspective of evolutional economic geography empirically. It expands the theoretical framework of evolutionary economic geography and extends the research field of regional product innovation from the supply side to the demand side. By introducing the theory of new economic geography and the theory of local protectionism, this paper demonstrates that the local market can promote industrial evolution by approaching the large market and weakening the power of market segmentation. This conclusion provides a new path for local economic revitalization and expands the direction for further research in the future. Should we increase the number of countries with export markets, or focus on expanding to advanced economies? Should we expand the types of industries contained in the market, or focus on developing high-tech industries? In future, based on the results of this study, the matching research work can be conducted for both supply-side by path dependence and demand side by market forces to expand the theoretical framework of evolutionary economic geography. It demonstrates that regional industries can pursue regional industrial innovation by promoting their market accessibility and market liberalization. This is especially crucial for yet-to-develop countries or regions as they are facing industrial environments which are usually in peripheral industrial areas, and thus have little chance to reach the core area on a path-dependent theoretical basis. This paper presents a quantitative study that testifies to the effect of the demand side on regional economic diversification, which has already been discussed in evolutionary economic geography, but has not been proved. Therefore, we need to adopt some regional industrial development strategies, including supporting some advanced industries, approaching or building large regional transportation infrastructure to enhance market potential and create an open and fair market environment.

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