EMPIRICAL STUDIES ON SYMBIOSIS EVOLUTION BETWEEN TRANSPORTATION SYSTEM AND INDUSTRY CLUSTER

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ABSTRACT. *Both transportation system and industry cluster are subsystems of regional ecosystem, and they are open complex systems similar to self-organizing system of dissipative structure theory. They both have developing and evolution processes from lower stage to higher one. In this paper, we construct an evolution mode of regional transportation system and make empirical analysis on global evolution of transportation system and degree of dependent between its evolutionary level and industry cluster from 1990 to 2006 in shanghai, a central city in the economic region of the Yangtze River Delta. The results show that evolution orbits of shanghai transportation system and industry cluster are both presenting s-type increasing states similar to helical structure. There is no significantly positive correlation between transportation system and industry cluster. Development and evolution of regional transportation system can only explain 29.3% of positive change tendency of agglomeration level of Industrial cluster. Therefore traffic factor is just one of external reasons of industry cluster. Besides, industry cluster is affected by a series of other environment factors. This paper supplys a valuable reference for us to reveal inherent link between transportation system and industry cluster.*

Keywords: Transportation System; Global Evolution; Dissipative Structure; Industry Cluster

1. Introduction. Many scholars at home and abroad studied evolution law of society phenomenon referring biological evolution thought methods in recent years. Overseas, Praveen Asthana (1995) applied logistic increasing regularity researching problems of technical advancement. Esben Sloth Andersen (1999) ever applied the logistic model difference form analyzing application and development process of railway as a new transporting technology. Murray B.Low et al., (1997) studied questions such as the origin of enterprise populations and an enterprise how to enter different evolution phases of enterprise population's question. Besides, Jocl.A.C.Baum (1995) studied telecommunication service industry's leading design and its populations' dynamic changes. P. A. Geroski (2001) applied population's conception analyzing changes of enterprises number in its industry population. In china, Huang and Zhang (2006) applied population theory and method analyzing technology innovation population's change laws inside industry and their evolution relationship between different technology innovation populations. Wang et al., (2006) constructed symbiosis evolution model about enterprise

clusters and applied the model to make an empirical analysis. Yao et al., (2006) investigated organizational learning mechanism applying organization evolution method. Zhu (2003), Xu and Wang (2005) revealed institution changes mechanism of industry ecological evolutionary progress.

Since Marshall firstly used the concept of agglomeration, economists have studied further into industry agglomeration from different viewpoints. Hoover (1937) decomposed agglomeration economy into internal scale economies and urbanization economies. Scott (1988) researched on industry agglomeration phenomenon centralizing on industrial districts or new industry spaces. Lundvall (1992) researched on a new system problem about industry agglomeration combining technology innovation and economic growth based on Schumpeter's innovation theory. Krugman (1996) applied theories such as the economics of imperfect competition theory and revenue increasing theory to interpret industry agglomeration phenomenon. In this paper, we construct global evolution model of transportation system based on evolution theory about self-organizing systems, and apply it to make an empirical analysis on symbiosis evolution between transportation system evolution and industry cluster level from Shanghai1990－2006 statistical materials. What's more, the degree of dependent between transportation system evolution and industry cluster level is disclosed.

2. Evolution Model and Methodology.

2.1. Model of Transporting Systems was Constructed. Before the model of transporting systems was constructed, we should set some assumption condition for it. We choose regional comprehensive transportation ability as total evolution level. It is time t continuous and differentiable function according with Logistic evolution laws when it is evolving.

The global evolution model can be denoted as (1) it is based on Logistic equations and assumptions above mentioned. Where x denotes regional comprehensive transportation ability at t moment, M denotes maximum value of regional comprehensive transportation ability while regional transportation increasing independently, r denotes the inherent growth rate of regional comprehensive transportation ability, and t denotes time. We solve differential equation and obtain equation (2).

$$\frac{dx}{dt} = rx(1-\frac{x}{M}) \tag{1}$$

$$x(t) = \frac{M}{1+ce^{-rt}} \tag{2}$$

Where $c = \frac{Mx_0}{M - x_0}$ is integral constant, x_0 is initial value of regional comprehensive transportation ability at moment $t = 0$. The global evolution curve is as figure 1 based on (2). We can see from figure 1 that the global evolution curve approximates to s-type and exhibits three development phrases. The phrase before t_1 is low speed development phrase, the phrase from t_1 to t_3 is high speed development phrase, when it develop

reaching its own half of whold value, whose speed gets to its maximum and its development speed is becoming relatively slow after t_3 phase.

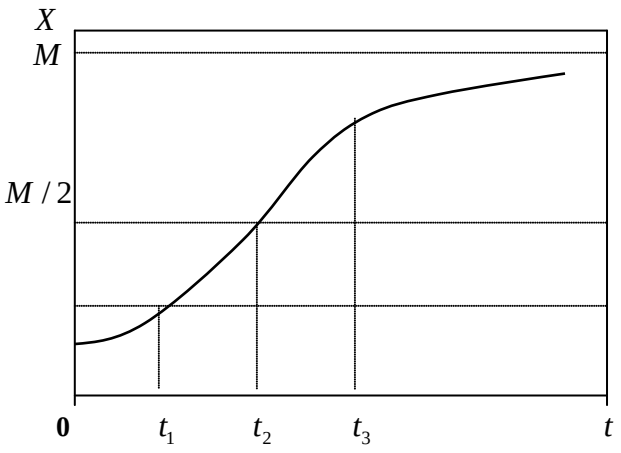

FIGURE 1. Global evolution curve of regional transportation

2.1. Industry Concentration Degree. Industry concentration degree is one of most brief and effective methods of various testing industry cluster level, which is an important mark on measuring competition of market. In this paper, we apply the method to test concentration degree of six industries in shanghai from 1990 to 2006. Industry concentration degree denotes some related indexes such as sales, delivery capacity or total assets of N largest enterprises of a certain industry occupying shares of the whole industry. Its calculation formula is follow as (3).Where CR_n denotes X industry's industry concentration degree of N most large enterprises. X_i is X industry's sales, delivery capacity or total assets of the i-th enterprise. N is enterprise number of X industry .

$$CR_n = \sum_{i=1}^{n} X_i / \sum_{i=1}^{N} X_i \tag{3}$$

3. Empirical Analyses.

3.1. Technical Route and Data Description. Firstly, we apply factor analysis method to obtain each year scoring of Shanghai comprehensive transportation ability from 1990 to 2006, then concentration degree of shanghai six industries from 1990 to 2006 is tested . Finally, the relationship between comprehensive transportation ability and industry concentration degree is revealed by regression analysis.

This study depends on the publication data from Shanghai Statistical Yearbook and issues data series from 1990 to 2007, China city Statistical Yearbook (2007). According to variability principle, quantitative principle, comprehensiveness principle and systematization principle and so on, we choose highway, railway, water way and civil aviation as first grade indexes under which fifteen secondary indexes are designed for measuring Shanghai comprehensive transportation ability series from 1990 to 2006.These

fifteen secondary indexes are as follow : x_1 is railway operation mileage(km), x_2 is railway main line extending mileage (km), x_3 is highway traffic mileage(km), x_4 is expressway length (km), x_5 is rail transit length (km), x_6 is annual output of freight automobiles per vehicle ton (million ton-km), x_7 is annual output of marine transport per vehicle-ton (million ton-km), x_8 is annual output of oceangoing freighter per ton-ship (million ton-km), x_9 is number of passengers originated (million person-time), x_{10} is passenger turnover volume（billion passenger- kilometer, x_{11} is cargo traffic volume (million ton), x_{12} is volume of cargo turnover (billion ton-kilometer), x_{13} is cargo throughput of port (million ton), x_{14} is passenger turnover amount of civil aviation (billion passenger- kilometer), x_{15} is possession quantity of civil automobile (million trucks).

3.2. Evolution Result Analysis. We apply SPSS15.0 to make a factor analyses based on the above mentioned data from Shanghai Statistical Yearbook issues data series from 1990 to 2007 and China city Statistical Yearbook (2007). We obtain three chief factors which are named as operation mileage factor , transport volume factor and turnover volume factor that whose loading reached 88.575％as table 1 shows. We can deduce equation (4) by calculating each factor information contribution rate, and calculation result is as Table 2 shows. In order to analyze, each annual factor score is treated by

TABLE 1. Score matrix of chief factor

YEAR	FAC1	FAC2	FAC3	Rotation Sums of Squared Loadings		
				Total	%of variance	Cumulative %
1990	-0.5240	-3.0199	0.0192	10.688	71.254	71.254
1991	-0.7449	-0.5498	0.0394	1.462	9.749	81.004
1992	-1.0600	0.6673	0.5411	1.136	9.571	88.575
1993	-0.8467	0.3560	0.6064			
1994	-0.8096	0.4745	0.1781			
1995	-0.2531	-1.7546	-0.2599			
1996	-0.5378	0.4525	0.1804			
1997	-0.6791	0.7243	0.9310			
1998	-0.4760	0.5272	1.0463			
1999	-0.2121	0.0504	0.7117			
2000	-0.0002	0.2962	-0.8766			
2001	0.1584	0.2982	-3.0461			
2002	0.1417	0.5359	-1.1933			
2003	0.3913	0.6092	-0.4240			
2004	0.9063	0.8505	0.0762			
2005	1.9291	-0.2558	0.7499			
2006	2.6167	-0.2618	0.7203			

normalization method, so that we can draw the global evolution track of shanghai transportation systems series from1990 to 2006. As can be seen from Figure 2 that evolution speed is very slow from 1990 to 2002, its speed is increasing from 2002 to 2006, and its evolution track presents spiral increasing curve accordance with Logistic growth law of evaluating. But its evolution curve is relatively smooth as a whole. We can draw a conclusion that Shanghai transportation systems are at the end of slow evolution stage and changing into the middle stage of fast evolutionary.

$$Z_i = 0.71254Y_{1i} + 0.09749Y_{2i} + 0.09571Y_{3i} \quad (4)$$

Where, Z_i is the main annual score of comprehensive transportation ability, Y_{ji} is the i-th annual score of the j-th chief factor. Each factor information contribution rate is the coefficient of Y_{ji} .

TABLE 2. Annual score of comprehensive transportation ability

YEAR	SCORE			TOTAL SCORE	NORMALIZATION
	F1	F2	F3		
1990	-0.3734	-0.2944	0.0018	-0.5807	0.1113
1991	-0.5308	-0.0536	0.0038	-0.6385	0.1454
1992	-0.7553	0.0651	0.0518	-0.5106	0.1631
1993	-0.6033	0.0347	0.0580	-0.5136	0.1621
1994	-0.5769	0.0463	0.0170	-0.3763	0.2079
1995	-0.1803	-0.1711	-0.0249	-0.3218	0.2261
1996	-0.3832	0.0441	0.0173	-0.3242	0.2253
1997	-0.4839	0.0706	0.0891	-0.1876	0.2708
1998	-0.3392	0.0514	0.1001	-0.0781	0.3073
1999	-0.1511	0.0049	0.0681	-0.0551	0.31498
2000	-0.0001	0.02889	-0.0839	-0.046	0.3180
2001	0.1129	0.0291	-0.2915	0.0391	0.3463
2002	0.1010	0.0522	-0.1142	0.2976	0.4325
2003	0.2788	0.0594	-0.0406	0.3659	0.5114
2004	0.6458	0.0829	0.0073	0.7360	0.5787
2005	1.3745	-0.0249	0.0718	1.4214	0.8071
2006	1.8645	-0.0255	0.0689	1.9079	0.9693

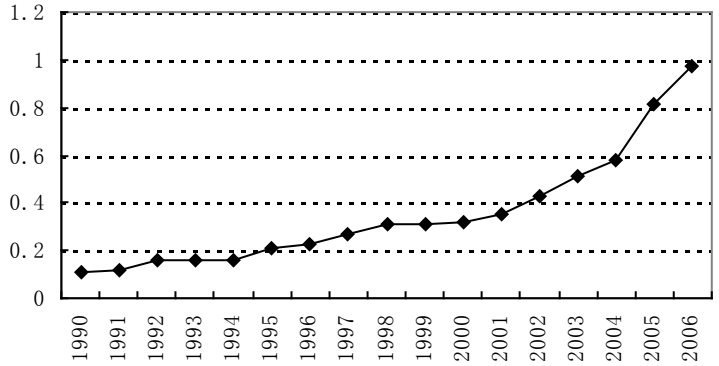

FIGURE 2. The global evolution track of Shanghai

3.3. Analyses on Symbiosis Evolution between Transportation System and Industry Cluster. We applied equation(3) to calculate out six industries CR_n of Shanghai as follow table (3) and figure (3), based on the above mentioned data from Shanghai Statistical Yearbook issues data series from 1990 to 2007 and China city Statistical Yearbook (2007), then we constructed regression model to reflect correlative relation between transportation system and industry cluster, the regression equation is as (5). As can be seen from table (3) that most of Shanghai six industries showed obvious cluster phenomenon except for C36 and C41,their evolution curve presented s-type rising trend. We tested hypothesis and obtained that t and f test were performed, however amendatory decision coefficient $\overline{R}^2 = 0.293$, which showed that there are not significantly positive correlation between transportation system and industry cluster. Development and evolution of regional transportation system can only explain 29.3% of positive change tendency of agglomeration level of Industrial cluster.

$$\hat{Y} = 13.528 + 0.939X \qquad (5)$$

TABLE 3. Six industries' concentration ratio CRn value of Shanghai

INDUSTRY /CODE	1990	1994	1998	2002	2006
DRUG C27	5.54	7.87	8.83	9.93	13.29
SPECIAL EQUIPMENT C36	22.47	20.39	17.45	14.85	9.43
TRANSPORTATION EQUIPMENT C37	6.72	8.81	20.67	20.68	23.47
MAVHINERY C39	7.36	9.47	12.62	13.51	15.37
ELETROMMUNICATION EQUIPMENT C40	9.48	12.42	8.79	12.46	17.32
INSTRUMENT AND CULTURE INVENTORY C41	13.38	16.21	28.69	12.41	11.16
AVERAGE CRn VALUE	10.83	12.53	16.18	13.97	15.01

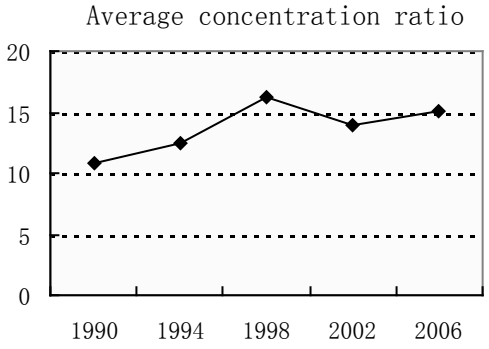

FIGURE 3. Six industries' average concentration ratio of Shanghai

4. Conclusions. The essence of transportation system global evolution is that there is an interdependence relation between transportation system and industry population, while the two are both complex systems and whose development is restricted by ecological equilibrium mechanism. Under their domination, transportation system and industry population are both presenting s-type increase state similar to helical structure. An empirical analysis was made by factor analyses and revealed that the speed of Shanghai transportation system global evolution was very slow from 1990 to 2002, and was increasing from 2002 to 2006. Its evolution track presents spiral increasing curve accordance with logistic growth law of evaluating, but its evolution curve is relatively smooth. So we can draw a conclusion that Shanghai transportation systems are in a slow evolution stage changing into a middle stage of fast evolutionary.

We made an empirical analysis on industry cluster degree of Six industries of Shanghai and found that the Six industries have obvious cluster phenomenon except for special equipment manufacture and instrument culture inventory manufacture, while other manufactures evolution curve presented s-type rising trend. We tested amendatory decision coefficient which showed no significantly positive correlation between transportation system and industry cluster, and development and evolution of regional transportation system can only explain 29.3% of positive change tendency of agglomeration level of Industrial cluster, then 70.7% industry cluster factors are from technical innovation, technical change, industrial policy and other environmental factors according to research results about industry cluster from home and abroad.

Acknowledgment. This paper is supported by National Natural science fund of China (71073079).

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