

# Researching on the Grey Incidence among the Macroscopic Agents in the Logistics Industry System

Yanfeng Chu , Ruizhen Zhang

**Abstract**—Quantitative researching on the degree of incidence between the logistics industry and relevant macroscopic system elements is the basis of reasonable and scientific policy on industrial development. In the light of the macro-level, the logistics industry system is consisted of multiple macroscopic agents such as macro-economic, infrastructure, social environment, market demanding, the traditional industry, industry life cycle, policy , system and so on. This paper studies the grey incidence among the macroscopic agents in the logistics industry system. It is demonstrated that the releasing of the logistics services from the logistics outsourcing enterprises determines the growth of the logistics size. Although the information and communication technology is able to promote the formation of the modern logistics industry to some extent, the development of the modern logistics industry depends more on the development of national economy and the investment in the capital assets of the logistics industry.

**Keywords**—logistics industry; industrial system; industry incidence

## I. INTRODUCTION

AS the leading and basic industry in the development of national economy ,the modern logistics industry is called the “accelerator” for the economy development. Its Level of development has been one of the most important symbols to measure a nation’s degree of modernization and comprehensive national strength. In the meantime, the development of the economy determines the logistics needing and the development of the logistics industry. It is thus clear that the evolution of the logistics industry system is in close relationship with the development of the economy. The logistics industry system mainly consists of three sections one is the factor of macro-economy and social environment belonging to macrosystem factor one is the gather influence of the corporate behavior belonging to micro-dynamic factors; one is the inter-industry collaboration factor of the interaction and influence of the industry development belonging to the ordinary system factor. The article mainly studies the gray incidence among the macroscopic agents in the logistics industry system.

CHUYanfeng is with School of Economy and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, China (e-mail: yanfengc@nuaa.edu.cn).

Ruizhen ZHANG is with School of Economy and Management, Nanjing University of Aeronautics and Astronautics Nanjing, China (e-mail: a584348827@yahoo.cn).

## II. THE CONSTITUTION OF THE MACROSCOPIC AGENTS IN THE LOGISTICS INDUSTRY SYSTEM

### A. Logistics Industry System Is the Complex Adaptive System

The complex system can be summarized as multilevel nature, multiple factors, variability, interaction between different factors and subsystems, interaction between the system and the environment, subsequent overall behavior and evolution. It is generally acknowledged the source of the complexity is nonlinearity instability and uncertainty. The complex adaptive system CAS studied by Holland is a class of typical complex systems mentioned above. The core idea of the CAS theory is that adaptability leads to complexity. The so called “adaptability” indicates the system’s adaptation subject. It can make interactions with the environment and other subjects, accompanied by constant study and experience gathering in continual interactions, resulting in the change of its personal structure and behavioral pattern. It also produces the interaction between subjects and environments. This is the basic agent which pushes forward the system economy. In the view of the dynamic point, the logistics industry is a complex system and also a numerous and jumbled information system. It is not only a function of time, but also full of the interaction and interinfiltration with many other factors such as economy, science and technology and so on, presenting characters of nonlinearity, dynamic and nonequilibrium. The system elements of CAS are non-homogeneous. For instance, the quality of element A and B is a and b. So it is wrong to study element A and B’ feature by simple statistical methods of the sum. We can only do it by assembly methods in which different quality elements are not allowed to accumulate. The macrosystem elements of logistics industry are made up of different quality elements such as employees and communication technologies.

### B. Macrosystem's Characterization of the Logistics Industry System

In the view of macro level, the development of logistics industry is influenced by macro-economic, infrastructure, social environment, market demand, the traditional industry, industry life cycle, policy system and other aspects.

#### 1) Macro-Economy

Logistics industry exists in the environment of national economic development. The major factors which can reflect the national economic environment are GDP, total import and export of consumer goods retail sales, industrial production, primary industry, construction industry output value, output value of tertiary industry .The macro-economy characterized by GDP is the economic environment for the development of the

logistics industry.

### 2) Market Demanding

The market demand is the demand of the logistics service indeed. Volume of rail freight and tonnage mileage represents the market demand. The evolution of the industry is premised on the existence of the demand. With the growing division of labor, the increasing demand for logistics, the performance of logistics service is diverse. Figure 1 describes the three stages of the logistics service updates. The first stage is the competition phase of basic logistics services, and the second stage is the competition phase of value-added logistics services, and the third stage is the competition phase of integrated logistics services. The first stage is the competition phase of basic logistics services. Each logistics enterprise provides the basic logistics services. At this stage, the logistics enterprises determine whether to disburse funds for the value-added logistics services. The second stage is the competition phase of value-added logistics services, and the third stage is the competition phase of integrated logistics services. The need of logistics service puts forward the development of logistics industry.

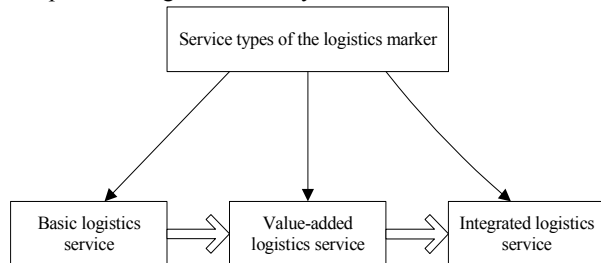


Fig. 1 Three stages of the logistics service upgrades for the Logistics market

### 3) Fixed Investments

The subject of the logistics industry macrosystem includes Transport, storage, postal investment in fixed assets and information transmission, computer services and software industry investment in fixed assets, as shown in Table II.

### 4) Logistics Employee

Table II shows the employees for communications and transportation and post industry from 2003 to 2007.

According to complex adaptive systems theory, the macrosystem factors of logistics industry system evolution include five kinds of Agent : GDP Agent, the logistics industry Agent, transport, storage, postal investment in fixed assets Agent, information transmission, computer services and software investment in fixed assets Agent, Market Agent. Build the overall model on the basis of five kinds of Agent shown in Figure 2. Logistics industry Agent acquires the power of the industrial development by means of meeting the market need. The increase of GDP Agent asks for the rapid development of logistics industry Agent, and at the same time provides a guarantee for increasing investments in fixed investments Agent Information transmission computer services and software Agent. In turn, logistics industry Agent promotes the increase of GDP.

TABLE I  
INVESTMENT IN FIXED ASSETS[1]  
UNIT : A HUNDRED MILLION

Industry	2007	2006	2005	2004	2003
Transport, Storage, Postal Industry	12997.1	11224.5	8860.4	7091.5	4892.71
Railway ransport	2492.7	1966.5	1267.7	846.3	616.38
Road Transport	6926.6	6481.6	5581.4	4665.5	3162.01
Urban Public Transportation	1073.0	800.6	531.1	391.3	360.13
Water Transport	1109.5	995.1	779.3	534.6	299.11
Air Transport	607.6	463.1	302.4	272.4	180.73
Pipeline Transportation	69.1	71.3	79.6	107.0	139.52
Loading, unloading And Other Transport Services	93.4	54.3	43.5	58.6	29.36
Storage	611.1	370.9	258.5	186.9	84.88
Post	14.2	21.0	16.9	28.8	20.57
Information TransferComputer Service And Software	1819.4	1772.0	1561.6	1638.0	506.93
TelecomAnd Other Information Transfer	1702.0	1661.1	1490.2	1589.9	479.07
Computer Service	31.7	33.5	18.5	11.7	5.13
Software	85.7	77.5	52.9	36.4	22.74

TABLE II  
THE EMPLOYEES FOR COMMUNICATIONS AND TRANSPORTATION AND POSTINDUSTRY[1]  
UNIT : TEN THOUSAND

Industry	2003	2004	2005	2006	2007
Communications And Transportation And Post industry	636.5	631.8	613.9	612.7	623.1

The most important difference between the traditional logistics and modern logistics industry is the applications of information transmission, computer services and software system made in the logistics industry. Therefore, the national investments of information transmission, computer services and software can contribute to the development of modern logistics industry in a certain extent.

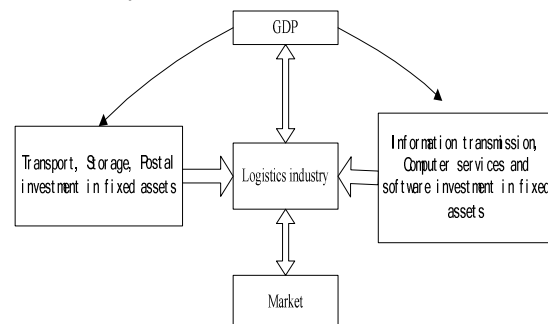


Fig. 2 The relational model of the logistics industry system macro agents

### III. GREY INCIDENCE AMONG THE MACROSCOPIC AGENTS IN THE LOGISTICS INDUSTRY SYSTEM

#### A. Basic Step of Grey Incidence Analyzing[2]

Suppose systematic behavior sequence is  $X_0 = (x_0(1), x_0(2), \dots, x_0(n))$ ,  $n=1,2,3,4,5$ , related factors sequence is

$$X_i = (x_i(1), x_i(2), \dots, x_i(n)), \quad i=1,2,3,4,5,6,7,$$

for  $\xi \in (0,1)$ , make

$$\gamma(x_0(k), x_i(k)) = \frac{\min_k \min_k |x_0(k) - x_i(k)| + \xi \max_k \max_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \xi \max_k \max_k |x_0(k) - x_i(k)|}$$

$$i = 1, 2, 3, 4, 5, 6, 7$$

$\gamma(X_0, X_i) = \frac{1}{n} \sum_{k=1}^n \gamma(x_0(k), x_i(k))$ ,  $\xi$  is called as the distinguishing coefficient.  $\gamma(X_0, X_i)$  are called as grey incidence degree between  $X_0$  and  $X_i$ . On this foundation, we can resolve grey absolute incidence degree and grey relative incidence degree and synthesizing incidence degree further.

Grey absolute incidence degree only can measure the relation level between  $X_0$  and  $X_i$  and do not consider other factors.

Grey relative incidence degree reflects the relation of the changing speed between sequence  $X_0$  and  $X_i$  relative to beginning, the changing speed of sequence  $X_0$  is more close and the grey absolute incidence degree is the more big, otherwise the more little.

Synthetic degree of incidence not only has embodied the similar level of sequence  $X_0$  and  $X_i$  but also reflected the near level of the change speed  $X_0$  and  $X_i$  relative to beginning point, is relatively overall a quantitative index that can reflect the connection level of sequences.

#### B. Grey Incidence between the Fixed Investments and Employees in the Logistics Industries

The posts and telecommunications was separated from each other in 2003. Therefore, selecting the data since 2003 to analyze the problem, Table III has been got by calculating the data from Table III and Table IV.

It can be found that the incidence between the fixed investments and employees is quite small from table III. Chinese logistics industry is still at the stage of industrial upgrading. The equipments of the traditional logistics industry are also obsolete. For the reason the increasing on the fixed investments can enhance the hardware condition of logistics industry.

TABLE III  
THE GREY INCIDENCE BETWEEN THE FIXED INVESTMENT AND EMPLOYEES IN THE LOGISTICS INDUSTRY

Degree of Grey Incidence	Relative Degree of Incidence	Absolute Degree of Incidence	Synthetic Degree of Incidence
0.572985	0.562917	0.500015	0.531466

#### C. Grey Incidence among the Subject of the Market

*Demanding, GDP and the Subject of Fixed Assets Invested*

Figure out that the incidence of GYi and GXj is  $\epsilon_{ij}, i=1,2; j=1,2,3$  from table IV, and get the Grey incidence degree as follows.

The grey incidence matrix:

$$A = \begin{bmatrix} \epsilon_{11} & \epsilon_{12} & \epsilon_{13} \\ \epsilon_{21} & \epsilon_{22} & \epsilon_{23} \end{bmatrix} = \begin{bmatrix} 0.867693 & 0.674383 & 0.505301 \\ 0.938024 & 0.753554 & 0.501578 \end{bmatrix}$$

The relative grey incidence matrix:

$$B = \begin{bmatrix} \epsilon_{11} & \epsilon_{12} & \epsilon_{13} \\ \epsilon_{21} & \epsilon_{22} & \epsilon_{23} \end{bmatrix} = \begin{bmatrix} 0.826772 & 0.668738 & 0.62949 \\ 0.922884 & 0.805273 & 0.734268 \end{bmatrix}$$

The absolute grey incidence matrix:

$$C = \begin{bmatrix} \epsilon_{11} & \epsilon_{12} & \epsilon_{13} \\ \epsilon_{21} & \epsilon_{22} & \epsilon_{23} \end{bmatrix} = \begin{bmatrix} 0.580619 & 0.506528 & 0.500912 \\ 0.746439 & 0.582142 & 0.511474 \end{bmatrix}$$

The comprehensive incidence matrix:

$$D = \begin{bmatrix} \epsilon_{11} & \epsilon_{12} & \epsilon_{13} \\ \epsilon_{21} & \epsilon_{22} & \epsilon_{23} \end{bmatrix} = \begin{bmatrix} 0.703695 & 0.587633 & 0.565201 \\ 0.834661 & 0.693707 & 0.622871 \end{bmatrix}$$

According to the Table IV, the grey incidence among the macroscopic agents in the logistics industry system shows the degree of grey incidence among logistics industry and GDP, transportation, storage and postal industry investment in fixed assets, information transmission, computer services and software industry investment in fixed assets was larger. The degree between the logistics industry and the investment in fixed assets of logistics industry is greater than the degree between the logistics industry and the information transmission, computer services and software industry investment in fixed assets. Although the information and communication technology is promoting the formation of the modern logistics industry, the formation and development of the modern logistics industry depends more on the development of the national economy and the investment in fixed assets in the logistics industry.

The absolute grey incidence of tonnage mileage and fixed assets invested in logistics industry is lesser, just as that of Information transmission, computer services and software industry. It shows that for the increment speed of the logistics scale the fixed assets invested in logistics industry information transfer computer services and software industry, their relevance of increment speed is lesser too. It indicates that the logistics scale mainly depends on the release of the logistics services provided by the logistics outsourcing enterprise. Although in some extent, the information and communication technology promotes the development of the logistics industry, its degree of absolute relation between the velocity of increase and the logistics industry is weak.

TABLE IV  
THE STATISTICAL DATA OF LOGISTICS INDUSTRY  
SYSTEM MACRO SUBJECT [1]

Project	Mark	2003	2004	2005	2006	2007
<i>Haul(ten thousand Tons )</i>	<i>GY<sub>1</sub></i>	15644 92	17064 12	18620 66	20370 60	2275822
<i>Tonnage Mileage (One hundred million Tons /kilometer</i>	<i>GY<sub>2</sub></i>	53859	69445	80258	88840	101419
<i>GDP(One hundred million yuan )</i>	<i>GX<sub>1</sub></i>	13582 2.8	15987 8.3	18321 7.4	21192 3.5	249529. 9
<i>The fixed assets investment of communications and transportation, storage and Post (One hundred million yuan )</i>	<i>GX<sub>2</sub></i>	4892. 71	7091. 5	8860. 4	11224 .5	12997.1
<i>The fixed assets investment of Information transmission, computer services and software industr ( Onehundred million yuan )</i>	<i>GX<sub>3</sub></i>	506.9 3	1638	1561. 6	1772	1819.4

#### IV. CONCLUSION

The article has studied the development of the logistics industry by a new way (CAS), and used the grey incidence method to analyze the incidence degree among the macro subjects of the logistics industry system, which has concluded some significant conclusions. It is very useful for providing references for the development of the market of the logistics industry, and the establishment of the development policy of the logistics industry.

#### ACKNOWLEDGMENT

The article has been assisted by the philosophy and social science fund of the Nanjing University of Neronautics and Nstronautics(V0981-092).

#### REFERENCES

- [1] "China Statistical Yearbook 2009 [M]," China Statistics Press, Beijing, 2009.
- [2] Sifeng Liu, Yaoguo Dang, and Zhigeng Fang, "Grey system theory and its application[M]," Science Press. Beijing, , 2004, pp. 125—142.