Economic Benefit Analysis of Symbiosis between Logistics Enterprises and Financial Institutions

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Abstract   Based on the symbiosis theory, this paper makes a preliminary study on the composition and economic benefits of symbiosis between logistics enterprises and financial institutions to promote their cooperation, gives logistic symbiosis model of earning growth of the symbiotic system, obtains equilibrium point and stable conditions for earning growth, that is, the symbiotic equilibrium points are higher than non-symbiotic model and increase with the benefit factor increasing, and benefit factors are less than one, the closer the benefit factors, the smaller the different between the amount of benefit increased. Finally, the paper analyzes the influence factors of economic benefits, namely, information abundance, the energy distribution of symbiosis, instability of symbiotic model.
Key words   Logistics enterprises; Financial institutions; Economic benefits; Symbiosis theory

1 Introduction

With the increasingly fierce market competition, the traditional business of financial industry and logistics industry have reached saturation, profit margins also reduce to minimum, both are actively exploring new markets, creating new value-added service, logistics finance is a promising new business for two parties. Logistics finance refers to that effectively organize and transfer funds in the logistic field through development and application of various financial products in the process of the operation of logistics industry. The movement of funds occurred in logistics process, including all deposits, loans, investments, trust, lease, mortgage, discounts, insurance, securities insurance and transaction, and various of middle business involved in logistics industry which handled by financial institutions, ect.

In foreign they named it "Financial Supply Chain Management (FSCM)", this business is promoted earlier, and relevant research is also more abundant. Albert (1948), Dunham (1949), Eisenstadt (1966) summarized the legal environment, business models, storage methods, monitoring methods and procedures of the development of logistics finance such as inventory financing and accounts receivable financing business in foreign countries. Rutberg (2002) introduced the main characteristics of logistics finance innovation model by making UPS as an example. Buzacott and Zhang (2004) discuss firm's inventory control and asset-based financing problem. They present interaction between a bank and a firm and show how asset-based financing helps the firm to grow. Srinivasa and Kumar (2009) show that a lender who finances the manufacturer has a motivation to finance the retailer as well and investigate lender's problem of financing both the firms by making a joint decision on the loan amount and comparing it with the case when lender makes independent decision on loan amount for both the firms.

Zai Yudong (2004), Hong Yuan and Wang Wei (2005) show that the development of logistics finance is favorable for logistics companies and financial institutions. Tang Shaolin, Qiao Tingting (2006) study banks by game analysis and point out that the the commercial banks in a strong position while logistics enterprises in a weak position between the cooperation relationship of commercial banks and logistics companies. The income distribution is asymmetry and not in Nash equilibrium. Yang Yu (2007) indicates the media role of logistics finance in the symbiotic relationship between manufacturing and logistics enterprises by using the concept of symbiotic media in symbiosis theory, which integrates material flow, capital flow and information flow, and value increment is a form of energy growth of the symbiotic system, logistics finance is essential medium for manufacturers and logistics companies to mutualism symmetry model. Wei Guili, Wang Yaoqiu (2009) pointed out that the efficiency of logistics finance determines that of logistics industry.

Ju Songdong and Huang Fang (2006) point out that the logistics need for financial support and protection, the financial sector is also dependent on the development and innovation of logistics industry. Logistics and finance need each other, promote each other, and form the premise and conditions of logistics financial ecosystem. The combination of logistics and finance creates a new cross-industry, cross-cutting areas. Mutually collaborative development is the beneficial choice for Logistics companies and financial institutions. From the logistics point of view, Logistics Finance is the measure which promotes the integration of modern logistics, supports and enhances the efficiency of funds usage throughout the supply chain. From the financial point of view, Logistics Finance has opened up a new

business growth area and become an important channel for expanding services. Logistics companies and financial institutions can use the information advantages and capital management strengths of banks to improve logistics efficiency while to improve funding efficiency in the whole process of supply chain, provide an ideal financial plan and form a highly efficient financial management system. Logistics Finance not only solves the financing problem of SMEs to a certain extent, but also enhances competitiveness for third-party logistics enterprises and improves the intermediary business revenue for banks, and achieves a win-win situation. The two sides based on the division of labor, complementary advantages, the usage of their respective core competencies to enhance their survival, and bring more benefits for them. Most of the existing literature study on the operation model and risk analysis of the logistics finance, or advantage for carrying out the logistics finance, but study on the economic benefits of cooperation from symbiotic perspective is less. This paper makes a preliminary study on the economic benefits of symbiosis between logistics companies and financial institutions based on symbiosis theory.

2 The Components of Logistics Finance Symbiotic System

According to symbiosis theory, collaboration and cooperation are essences of symbiosis, collaboration is one of the engineers for development of natural and human society. Biology symbiosis is a matter of different species living by links. In general sense, symbiosis is a formed relationship between the symbiotic units by a symbiotic model in symbiotic environment. Symbiotic unit, symbiosis model and symbiotic environment are the three elements of symbiosis, symbiotic model is the key element, symbiotic unit is the basis of symbiosis, symbiotic environment is conditions.

Logistics companies and financial institutions form a two-dimensional logistics finance symbiotic system. U_1, U_2 respectively represent financial institutions and logistics companies which are symbiotic units, M_i is the symbiotic model under certain space-time, E_a, E_n, E_p (positive environment, neutral environment, the reverse environment) is symbiotic environment surrounding the symbiotic units. These positive financial environment which includes Fierce market competition, product homogeneity, the formation of supply and demand market, China's different national conditions, all of the support and so on promotes the formation of logistics finance symbiotic system, while reverse environmental such as lack of self-construction of logistics industry, small enterprises lacking real estate and low credit, imperfect our credit system, imperfect laws and regulations related to the business hinders the further development of the symbiotic system. The three elements of symbiotic system are shown in Figure 1.
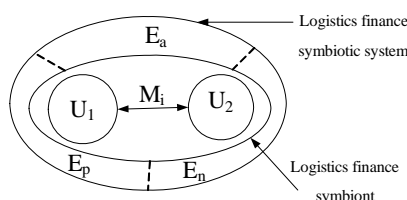

Figure 1　Logistics Finance Symbiotic System

Symbiosis model is divided into two kinds, one reflecting the degree of pattern is symbiosis organizational model, namely point symbiosis, intermittent symbiosis, continuous symbiosis, integrated symbiotic; the other reflects the symbiotic behavior, namely parasitic, deviated symbiosis, asymmetric mutualism, symmetric mutualism. The current cooperation state of logistics companies and financial institutions is in continuous, non-symmetric mutualism model, to achieve integrated and symmetric mutual symbiotic mode is the goal, which is shown in Table 1.

Table 1　The Combination of Symbiosis Models (From Symbiosis Theory and Small Economy)

Symbiotic model	Point Symbiosis	Interval symbiosis	Continuous symbiosis	Integrated symbiosis
parasitism				
commensalism				
Asymmetric symbiosis mutual			Current model	
Symmetrical symbiosis mutual				Ideal model

It is known that some large domestic logistics companies with solid assets and good credit, such as DHL, COSCO, Zhongchu, establish partnerships with banks. In the banking sector, the largest and earliest banks developing this business are Shenzhen Development Bank and Guangdong Development

Bank, but SPD Bank, Bank of Communication, Industrial Bank, China CITIC Bank, Minsheng Bank constantly enter the field, insurance and other financial institutions in this business is rare. The business they cooperated is most advanced in the collection, storehouse finance, Confirming storehouse, warehouse receipts pledge, logistics factoring, such as providing credit union, export procurement alternative, and other offshore docking arranged are yet developed. This makes the space of logistics finance symbiotic system is much, while the number of the symbiotic units entering is little, which results in small coexistence density (N, the number of symbiotic unit, V, symbiotic space), and this also means that the field has larger space for development.

3 The Economic Analysis of Logistics Finance Symbiotic System

Symbiotic process of logistics companies and financial institutions brings new energy for both sides of the symbiotic system, where the symbiotic energy is net energy, that is, $e_n = e_{ln} + e_{fn}$. e_{ln} is added value for logistics companies, e_{fn} is added value for financial institutions. For logistics, its new services benefits e_{ln} derived from traditional business income, income and reduction of the risk loss; for financial institutions, its new energy e_{fn} derived from loan interest income, income and reduction of loan losses and monitoring costs. Meanwhile, logistics finance services can broaden the financing channels for SMEs, reduce financing costs, enable enterprises to activate movable property, improve capital utilization, achieve optimal allocation of capital, reduce procurement costs and increase sales and business benefits. There are some data from the national we can see the growth in business receipts, such as the cooperation between China Chengtong Group and financial institutions, revenue growth of business warehouse receipts pledged as shown in Figure 2; at the end of June 2009, the amount of trade credit is approximately 98.3 billion Yuan in Shenzhen development bank, the number of SMEs supported nearly achieve ten thousand, and logistics financial services maintain a good quality of assets, poor rate is less than 0.30%. Meanwhile, the financial network will be combined with the logistics network, financial network is lack of information flow and material flow, while logistics network is lack of capital flow, logistics finance just integrate material flow, capital flow, information flow, promote traditional logistics transfer to modern logistics enterprises, realize the rational allocation of resources, promote industrial upgrading and restructuring, form industrial linkage effects.
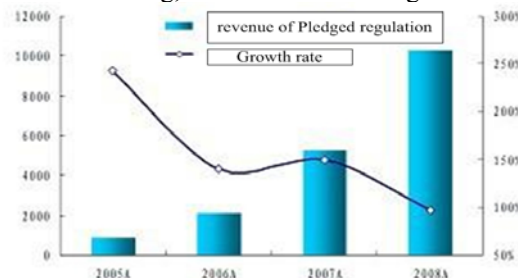

Figure 2   Earnings of Warehouse Pledged Business of Cheng Tong Group from 2005 to 2008 (Derived from Securities)

However, based on multiple symbiotic interface which is made of logistics service market, financial services market and commodity market, the symbiotic units communicate through material flow, capital flow and information flow these tangible and intangible media. Although the symbiotic process produced new energy, but due to risk sharing, the asymmetry energy distribution, and asymmetry information it bring the symbiotic resistance e_c in the symbiotic process (assessment costs of variety credit, financing costs, contract effectiveness and supervision cost, the loss of warehouse receipts in the circulation, the loss caused by risk, the assessment cost of the market situation on goods pledged).

Based on the equilibrium theory in economics, when the marginal density or dimensions of symbiotic energy equals to the marginal loss of density or dimensions the density or dimension coexistence reaches equilibrium. This also means that there will be more financial institutions and logistics companies to cooperate, while there will be more industries to join the symbiotic systems, such as the manufacture sector, but this article only discuss the two-dimensional symbiotic system of logistics

industry and the financial sector.

However, symbiotic balance does not guarantee symbiotic stability, which includes stability of symbiosis match and distribution. Symbiotic matching stability condition of logistics finance symbiotic system is that under incomplete information the unit with highest abundant information will firstly enter symbiotic system, with the information abundance increasing, the new unit will replace the lower unit; symbiotic stable distribution conditions is the relationship between ideal stability coefficient and partition coefficient meets $k_{di} = e_{fn}/e_{fc} = e_{ln}/e_{lc} = (1+\alpha)k_{df}$, $(\alpha \leq \alpha_0)$, where k_{di} is the ideal distribution factor of the symbiotic stability, k_{df} is the actual symbiotic stable distribution coefficient of the symbiotic system, α is the coefficient deviate from the ideal state of symbiosis. α_0 is the disintegration coefficients of the non-symmetrical distribution.

The symbiosis brings added value e_n. Let x as the total benefits. The symbiotic relationship between the units is complementary, therefore the logistic model of benefits growth of logistics finance symbiotic units as follow.

3.1 Model assumptions and parameters set

1) We define $x_1(t)$, $x_2(t)$ respectively as financial institutions benefits and logistics companies benefits at time t.

2) Let N_1, N_2 respectively as maximum benefits of financial institutions and logistics companies in the independent state determined by the market environment, N reflects the abundance of resources, because in the given time, a certain space, the total elements including technology, market demand, labor, capital and market size is certain, therefore, it is assumed that N is finite and a constant.

3) It is assumed that earnings growth rate declines and tends to zero as the earnings level of a company rising. Let r_1, r_2 respectively as the average earnings growth rate of financial institutions and logistics enterprises. And $r > 0$ is a constant, reflecting the average growth rate of industry itself.

4) $x_1(t)/N_1$, $x_2(t)/N_2$ is natural saturation, respectively represent the ratios for financial institutions and logistics enterprises at time t, $1 - x_1(t)/N_1$, $1 - x_2(t)/N_2$ respectively is the part that financial institutions and logistics companies have not yet achieved. In the established Constraints conditions, the natural saturation blocks the enterprise's own growth.

5) Let $\beta_1 \geq 0$ as the contribution on financial industry from natural growth saturation of the logistics industry, and $\beta_2 \geq 0$ as the contribution on logistics companies from natural growth saturation of the financial sector, which is named mutually beneficial factor, determined by the degree of symbiosis between the two, and change with it in the same direction.

3.2 Model and equilibrium points of the symbiotic system for economic benefits

Based on the logistic growth model, benefits growth rate of financial institutions and logistics companies in symbiosis process as follow:

$$\begin{cases} f(x_1, x_2) = \dfrac{dx_1}{dt} = x_1 r_1 (1 - \dfrac{x_1}{N_1} + \beta_1 \dfrac{x_2}{N_2}) \\ g(x_1, x_2) = \dfrac{dx_2}{dt} = x_2 r_2 (1 - \dfrac{x_2}{N_2} + \beta_2 \dfrac{x_1}{N_1}) \end{cases} \qquad (1)$$

When the growth rate function equal 0, the maximum value is achieved, the state of symbiotic model is steady. Making function (1) equals 0.

$$\begin{cases} f(x_1, x_2) = \dfrac{dx_1}{dt} = x_1 r_1 (1 - \dfrac{x_1}{N_1} + \beta_1 \dfrac{x_2}{N_2}) = 0 \\ g(x_1, x_2) = \dfrac{dx_2}{dt} = x_2 r_2 (1 - \dfrac{x_2}{N_2} + \beta_2 \dfrac{x_1}{N_1}) = 0 \end{cases} \qquad (2)$$

When $\beta_1 = 0$, $\beta_2 = 0$, there is no symbiosis, their earnings growth does not contribute to each other, there does not produce symbiotic energy. In this case, both revenue growths in line with Logistic equation, and the independent system equilibrium point is such that $x_1^* = N_1$, $x_2^* = N_2$. When

$\beta_1>0, \beta_2>0$, they are mutualism symbiosis and the equilibrium point is such that $x_1^*=N_1(1+\beta_1)/(1-\beta_1\beta_2), x_2^*=N_2(1+\beta_2)/(1-\beta_1\beta_2)$.

3.3 The stability conditions of the symbiotic system

Make Taylor expansion of equation (1) at the equilibrium point, delete the second-order and above. The equation is transformed into a linear equation as follows:

$$\begin{cases} f(x_1,x_2)=\dfrac{dx_1}{dt}=r_1(1-\dfrac{2x_1}{N_1}+\beta_1\dfrac{x_2}{N_2})(x_1-x_1^*)+r_1\beta_1\dfrac{x_1}{N_2}(x_2-x_2^*) \\ g(x_1,x_2)=\dfrac{dx_2}{dt}=r_2(1-\dfrac{2x_2}{N_2}+\beta_2\dfrac{x_1}{N_1})(x_2-x_2^*)+r_2\beta_2\dfrac{x_2}{N_1}(x_1-x_1^*) \end{cases} \quad (3)$$

The coefficient matrix **A** of the equation above:

$$A=\begin{pmatrix} r_1(1-\dfrac{2x_1}{N_1}+\beta_1\dfrac{x_2}{N_2}) & r_1\beta_1\dfrac{x_1}{N_2} \\ r_2\beta_2\dfrac{x_2}{N_1} & r_2(1-\dfrac{2x_2}{N_2}+\beta_2\dfrac{x_1}{N_1}) \end{pmatrix} \quad (4)$$

According to the stationary of differential equation ($\det A>0$), symmetry, and the relative growth rate is greater than 0, we can obtain the smooth condition for financial institutions and logistics companies to achieve a balanced symbiosis points such that $\beta_1\beta_2<1, \beta_1<1, \beta_2<1$.

It is known from the results, under the symbiotic situation, the financial institutions revenue is such that $N_1(1+\beta_1)/(1-\beta_1\beta_2)>N_1$, while the benefits of logistics companies is such that $N_2(1+\beta_2)/(1-\beta_1\beta_2)>N_2$. With the mutual benefit coefficient β_1, β_2 increasing, the benefits of financial institutions and logistics companies increase. The smooth symbiotic condition $\beta_1\beta_2<1, \beta_1<1, \beta_2<1$ which indicates that the earnings increase of the two make a contribution to each other, but added value not exceed their business can achieve in degree. Both on the revenue contribution from the other mainly caused by the expansion of market scale, technology and management improvement, information sharing, mutual trust increased between the quasi-organizational nature of the relationship. As the fierce competition emerged within the symbiotic units, original resources was divided, in order to better maintain the viability and profitability, they need to seek cooperation with other units, while the equality in status makes the internal heated Competition between the two become important conditions for the symbiosis maintaining.

4 Influence Factors Analysis of Economic Benefits of Logistics Finance Symbiotic System

Based on $e_n=f(\delta_s,\rho_s,\eta_s), e_c=f(\lambda,\rho_s,\eta_s,M)$, where η_s is the dimension of the symbiotic system, δ_s is the damping characteristic value such that $\delta_s=(\sum_{i=1}^{m}\delta_{si})/\lambda$, $\lambda(0\le\lambda\le+\infty)$ is the exchange interface of symbiotic resistance, the better the symbiotic media, the smaller exchanges drag. Symbiosis energy is a sufficient condition for survival and proliferation, which improve the quality of the symbiotic unit and form the premise of the quantitative expansion. As can be seen from the above expression, to make effective to achieve the expected growth effect, we need to identify factors can be improved in order to promote effective growth of the symbiotic system.

From the above analysis, when the symbiotic density or dimensions has not reached equilibrium, the increase of density or dimensions will make revenue increase. To make the resistance of symbiotic system decreases, it needs to strengthen information abundance to smooth the information exchange, Symbiosis between the two models now is not the best model, to enable the symbiotic mode change, it need to improve the symbiotic level of organization, enhance symbiosis, improve the distribution of symbiotic energy to move to the ideal symbiotic system model. Now the abundance of information, symbiotic energy distribution, and instability of symbiotic model will be analyzed in order to promote the benefits growth of the symbiotic system.

In a closed condition, unit A or B has accumulated amount of information about each other in a given temporal and spatial structure, or have the degree of all the information of each other is defined as

the degree of information abundance D_{ab} or D_{ba}. In any symbiotic system, any symbiotic unit cannot occupy all information of other unit, that is, there is incomplete information situation. Information abundance of symbiosis units only in the interval $\left[D_0, D_m\right]$, the symbiont can exist. D_0 indicates that the symbiotic unit does not contain any other information, D_m indicates all the information of other symbiotic units included. The average information abundance of logistics finance symbiotic system is such that $\overline{D} = (D_1 + D_2)/2$, the closer the average information abundance to the maximum, the smaller the marginal density loss, combined with principal-agent theory, the more information abundance can reduce possibilities of information asymmetry, reduce adverse selection and moral hazard. So the cost in the selection of trading partners and the performance of contracts, transaction costs, and the loss of the symbiotic interface reduce. This requires both sides to increase the construction and improve the information systems to improve efficiency, accuracy and transparency of information transmission. Internet of Things is greatly concerned right now. Credit rating system developed by China Federation also promotes the development of symbiotic system, which is favor for selecting logistics enterprises with good credit and reducing assessment cost. Until October 2009,519 logistics enterprises were assessed as A grade companies (Table 2).

Table 2   The Number of Logistics Enterprises Identified above a Grade by the End of 2009

grade	The number of logistics enterprises indentified	The number of logistics enterprises reviewed
AAAAA	44	25
AAAA	182	46
AAA	204	41
AA	89	12
A	170	0
total	519	124

Logistics companies with A class use the brand to guide resource integration and industry concentration, promote the construction of regional modern logistics system platform, participation in regional logistics development planning, create financing conditions for enterprises and become the main channel for finding market logistics provider.

The distribution of the symbiotic energy - logistics finance added value is an important factor affecting the symbiotic system. Ideal statue is symmetrical allocation, the allocated coefficient is smaller is better. energy distribution of logistics Finance symbiotic system is mainly the risk sharing process, in the process of cooperation both sides want to share smaller risk, less risk is the better, the smaller the loss, the higher the return, which lead to the distribution of the asymmetry. The proportion of the risk they shared is determined by SMEs and logistics enterprises, logistics companies and financial institutions gaming. The more risk of financial institutions spread, the greater actively granting loans to SMEs. Here using game theory explains. In accordance with the Nash equilibrium, changes in any choice cannot make worse the situation of other parties, the situation balance. Making the cooperation between banks and logistics companies for example, for financial institutions, assuming that a single small business loan interest income is 3, loan loss was 2, and supervision costs is 1, bank issuing SME loans have the following options:1) Released loans, bear all the risk, e_{fn}=3-2-1=0. 2) Loans, not to take risks, e_{fn}=3. 3) Loans, take a quarter of risk, e_{fn}=3-0.5-0.5=2. 4) Loans, take half the risk, e_{fn}=3-1-1=1. Suppose the total logistics service income is 3, the loss of all risks is 2, the cost of monitor is 1. It also has the following four options: 1) To provide services to, do not take risks, e_{ln}=3. 2) To provide services and take all the risks, e_{ln}=3-2-1=0. 3) To take three-quarters risk, e_{ln}=3-1.5-1=0.5. 4) To take half of the risk, e_{ln}=3-1-1=1.

The choices of banks and logistics companies are listed in the Nash equilibrium matrix (Table 3).

Table 3   Nash Equilibrium Matrix

Banks 0	Banks 3
Logistics enterprises 0	Logistics enterprises 0
Banks 2	Banks 1
Logistics enterprises 0.5	Logistics enterprises 1

Table 3 indicates the Nash equilibrium (1,1) state is symmetric mutualism state, then the distribution coefficient is $k = E_{fe} / E_{fc} = 1 / 2 = E_{le} / E_{lc} = 1 / 2 = 0.5$, and $e_n > 0$, so the symbiotic state stability.

Asymmetric distribution and not matched usage of symbiotic energy and the change of total symbiosis degree are the basic reasons for the symbiotic change, namely α phase change, β phase change, δ phase change. $\alpha = 1 - (\sum k_{si})$ $(m \cdot k_{sm})$ is the difference coefficient can be allocated, which mainly cause symbiotic behavior changes; $\beta = r / k$ is selection coefficient for the energy usage, which is a mixed phase transition, r is the energy value for number growth of the symbiotic unit, k is the energy value quality improvement; δ_s is symbiotic degree factor of all elements, which mainly cause symbiotic organizational model change, m is the number of symbiotic unit. Therefore, to achieve steady-state model, the value of these parameters must be changed effectively, reducing the difference coefficient can make the state of symbiotic the system evolve to the symmetry state; the change of the choice of the energy factor not only expand the scale of logistics enterprises and financial institutions, but also improve both the quality and enhance their capacity; the improvement of the self-construction promote the integration of their information systems to reduce information asymmetry and transaction costs, thereby reducing symbiotic interface resistance, increasing the degree of coexistence will promote symbiotic integration and the level of each other's earnings growth increase further, while let more companies to enter this symbiotic system, then making a fusion of the two industries.

5 Conclusion and Discussion

Symbiosis is a self-organization phenomenon and a self-organizing process, it is a necessary symbiotic links between units, so that they cooperate as a symbiont, according to demand of internal symbiotic mode, to product new symbiotic energy and promote the common evolution. Through the study on the symbiosis between logistics companies and financial institutions, the paper obtains equilibrium point and stable conditions for earning growth of the symbiotic system, that is, the symbiotic equilibrium points are higher than non-symbiotic model and increase with the benefit factor increasing, and benefit factors are less than one, the closer the benefit factors, the smaller the different between the amount of benefit increased. They through the division of labor, complement and leverage of their respective core competitiveness to strengthen each other's survival. And the paper analyzes the factors affecting the effectiveness benefits growth, the greater abundance of information, balanced energy distribution, symbiotic model makes an effective change in the symbiotic state of the symbiotic units and make them evolve towards the ideal state to enhance the level of earnings growth of symbiotic system.

However, there are some limitations in this paper. First of all, the logistic benefits growth model of the symbiotic system only considered that the symbiotic cooperation has brought benefits increased, without considering the increase in density resulting from the symbiotic cooperation between the parties, enterprises competition in the same industry result in market share declining. Secondly, in terms of resources, without considering the situation there is a resource update, but we assume that resources are certain. Thirdly, the lack of specific data, we use game theory to explain symmetric energy distribution of symbiosis, so we can not accurately calculate the specific differences that can be allocated.

This article only discusses the logistics enterprises and financial institutions coexist. However, small and medium enterprises for the symbiotic system are essential. Therefore, we can extend the dimensions of symbiotic system, to analyze three-dimensional mutualism symbiotic situation. After understanding the influence factors of the symbiosis, we can design operational framework for the joint development so that they can be further improved. Since the more and more emphasize low-carbon, environmental friendly, then we can further consider how to improve business viability and symbiotic profitability while achieving resource conservation and environmental protection, and realize ecological industrialization symbiosis.

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