Digital Marketing-Enabled Simulation Research on the E-commerce Development Path of Small and Medium-Sized Enterprises in the Internet Economy

Lin Ji[1], Fang Wei[2*], Peng Wang[3] and Liang Liu[4]

[1,2]School of Humanities, Shandong Agriculture and Engineering University, Jinan, Shandong, 250100, China
[1]Lin_ji666@163.com,[2]lynnlinji@163.com
[3]School of Economics and Management, Shandong Agriculture and Engineering University, Jinan, Shandong, 250100, China
Peng.Wang2021@outlook.com
[4]State Grid Jinan Electric Power Company, Jinan, Shandong, 250100, China
Liang_Liuedu@163.com

Corresponding author: Fang Wei, lynnlinji@163.com

Abstract. In order to improve the scientificity of the e-commerce development path of small and medium-sized enterprises, this paper simulates and analyzes the e-commerce development path of middle and lower enterprises under the background of the Internet economy, and discusses the evolutionary dynamics, evolution process and self-organization evolution mechanism of MLS. The research results show that the interaction of five internal mechanisms such as mutualism, competition, parasitism, partiality, and predation in MLS, and three external factors such as regional economy, technological environment, and political system jointly act as intensifiers and triggers of system evolution. Moreover, they jointly drive the MLS forward, and explore the instability of the system structure in the fluctuation, thus forming a new MLS structure. Finally, this paper simulates the development path of e-commerce for small and medium-sized enterprises. According to the experimental analysis, it can be seen that the simulation effect of the e-commerce development path of small and medium-sized enterprises proposed in this paper is relatively obvious, which can provide a reference for the development of cross-border e-commerce of small and medium-sized enterprises.

Keywords: internet economy; small and medium-sized enterprises; e-commerce; development path; Digital Marketing
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1 INTRODUCTION

Cross-border e-commerce can effectively drive the growth of foreign trade. From a macro perspective, in addition to effectively promoting the formation of a unified global market, cross-border e-commerce is also conducive to the sustainable development of the international division of labor mechanism. Based on the support of information technology, cross-border e-commerce not only greatly reduces transaction costs in the process of foreign trade, but also simplifies the overall trade process [10]. In addition, relying on big data technology, cross-border e-commerce companies analyze consumers' behavior habits in detail, and carry out precise marketing according to their transaction needs. From a micro perspective, with the rapid development of cross-border e-commerce, some small and medium-sized enterprises have seized the opportunity to participate in international competition because of their low entry threshold. Under the background of the big data era, both parties to the transaction complete the transaction through logistics distribution and electronic payment. At this time, personalized products and precise services are the key to gaining consumer recognition, which will prompt the transformation of the foreign trade model of small and medium-sized enterprises to direct sales, and will help strengthen the brand awareness of cross-border e-commerce companies [9]. By incorporating digital marketing strategies, cross-border e-commerce can further optimize its impact and enhance the success of international transactions.

Improve the operation and management mode. Traditional foreign trade enterprises rely on middlemen such as dealers or agents to facilitate transactions when buying and selling products, while cross-border e-commerce businesses use electronic payment or the Internet to complete transactions. At the same time, there are also great differences in logistics forms between the two. Cross border e-commerce trade is a new business management mode integrating logistics, information flow and commodity flow [1]. Under this development situation, relevant enterprises, in order to better carry out foreign trade, build online trading platforms, promote products through websites or other forms, integrate online marketing, logistics and payment, and form a new marketing model with strong controllability, convenience and low cost. With the continuous expansion of the scale of cross-border e-commerce, its international market influence has increased with EI. While promoting the remodeling of the international industrial chain, it provides more convenient and intuitive interaction modes and trading methods for both parties to promote the innovative development of China's foreign trade [12].

Promote the development of information trade and service trade. With the development of cross-border e-commerce, the trade related to information products and services has gradually formed a new type of independent service trade, mainly involving tourism, transportation, law, finance and other aspects. Trade activities, including technical services and information commodity services, can promote transactions between buyers and sellers through cross-border e-commerce [6]. Based on the development of such new forms of trade, domestic small and medium-sized enterprises can provide products and services for foreign consumers through the Internet. Based on the support of Internet technology, cross-border e-commerce trade has changed the traditional mode of product sales promotion, namely offline transaction mode, and opened up new sectors such as electronic payment and logistics services. This mode of relying on the network to facilitate transactions has prompted small and medium-sized enterprises to strengthen the importance of information technology, promote the transformation and development of their foreign trade model, and optimize and upgrade their trade structure [7]

Restricted by the level of multiple production factors, despite the relative advantages of products, no country in the world can manufacture all different goods. With the globalization and rapid economic development, the purchase demand of consumers from different countries in the world market has become increasingly diversified. The diversification of consumption has led to the diversification of market demand. For the same kind of goods from different countries, countries will also have mutual demand, Thus, intra industry trade is generated based on the heterogeneity of similar products [8]. Compared with traditional trade means, cross-border e-commerce exchanges between buyers and sellers are more efficient and direct. With the use of Internet technology, the information exchange between suppliers and buyers is more comprehensive. In the face of consumers' demand for differentiated products and personalized services, cross-border e-commerce uses its advantages in resource exchange and information communication to pass them on to producers and enterprises, and integrates and classifies decentralized differentiated needs, From the perspective of producers, integrate differentiated product production of a certain scale to cater to consumers in different markets. Even through big data, cloud computing and other methods, analyze customer preferences, transform passive change into active adjustment, and achieve continuous improvement in supply side optimization and customization capabilities [2]. From the perspective of the demander, when using cross-border e-commerce to make cross-border purchases, consumers can grasp more information and further determine their own purchase needs and intentions through relatively intuitive comparison of the differences between various products. To sum up, cross-border e-commerce has further solved the increasingly sharp contradiction between the increasingly diversified consumer demand and the gradually expanded standardized supply of producers by expanding the market, strengthening communication, highlighting product differences and other ways [4].

From the theory of scale economy, it can be concluded that if cross-border e-commerce affects the economies of scale of enterprises, if they blindly expand the production scale, the producers may have problems such as mismatching or declining management and cooperation efficiency levels, which will cause the average production cost to rise rather than fall, that is, the stage of "scale without economy" [14]. The application and development of cross-border e-commerce will promote the management level of producers, gradually improve their foreign cooperation capabilities, and the movement of the long-term cost curve will lead to the continuous expansion of the optimal scale. Producers will conduct production activities at the optimal scale, and obtain the best economic benefits [13].

For enterprises at the micro level, after the introduction of cross-border e-commerce, their commodity information will be presented to consumers more openly and transparently through the Internet. In traditional trade, especially cross-border retail trade, the situation of low transaction efficiency between buyers and sellers due to information asymmetry should be improved. Foreign consumers can browse and select more products in the broader online market and enjoy lower prices [5]. The process of consumers using cross-border e-commerce is seen as the process of consumers searching for low-cost goods with more efficient means. Based on this, the development of cross-border e-commerce will lead to the redistribution of market shares of similar enterprises with different production costs, thus increasing market competition between manufacturers, which will produce selection effect and resource redistribution effect, namely: in the competition, due to the market selection effect, The fierce competition mechanism in the international market will gradually eliminate high cost enterprises; The retained low-cost enterprises will seize more resources and markets based on the redistribution effect, adjust the enterprise scale and management mode, and form a stronger competitive advantage [15].

Due to the limitations of their own management, scale and other aspects, as well as the high threshold for participation, small and medium-sized enterprises will face many drawbacks in traditional foreign trade activities, such as low efficiency, high cost and low profits. Although some enterprises have independent production capacity, they can only rely on foreign trade services provided by professional trading companies. It is difficult to compete with large enterprises in terms of autonomy and adaptability in marketing, payment, customs clearance and other transaction links, It is impossible to directly carry out foreign trade, and large-scale development is difficult [11]. After introducing cross-border e-commerce, SMEs can communicate with buyers more efficiently through online platforms, thus completing cross-border transactions. Cross border e-commerce uses the open network system of the Internet to simplify the processes and links of international trade, save the information costs of communication between enterprises and customers, further reduce some transaction costs in the past trade process, such as marketing costs, coordination costs, supervision costs, etc., thus reducing the total costs in export activities [3].

This paper simulates and analyzes the development path of e-commerce for middle and lower enterprises under the background of the Internet economy, and provides an effective path for the development of e-commerce of small and medium-sized enterprises under the background of the post-epidemic.

2 THE MODEL OF E-COMMERCE DEVELOPMENT PATH OF SMALL AND MEDIUM-SIZED ENTERPRISES

2.1 MLS Causality

1) MLS block diagram

Starting from the core problems that need to be solved in the establishment of the model, this paper combines the boundaries of MLS, considers the concept of the model, and finally determines the block diagram of MLS, as shown in Figure 1.

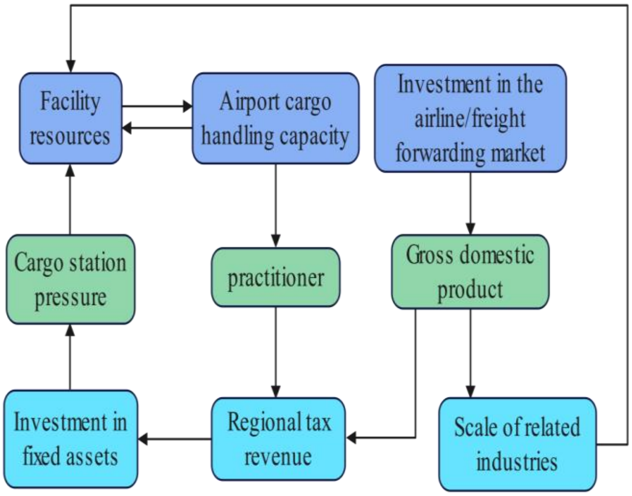
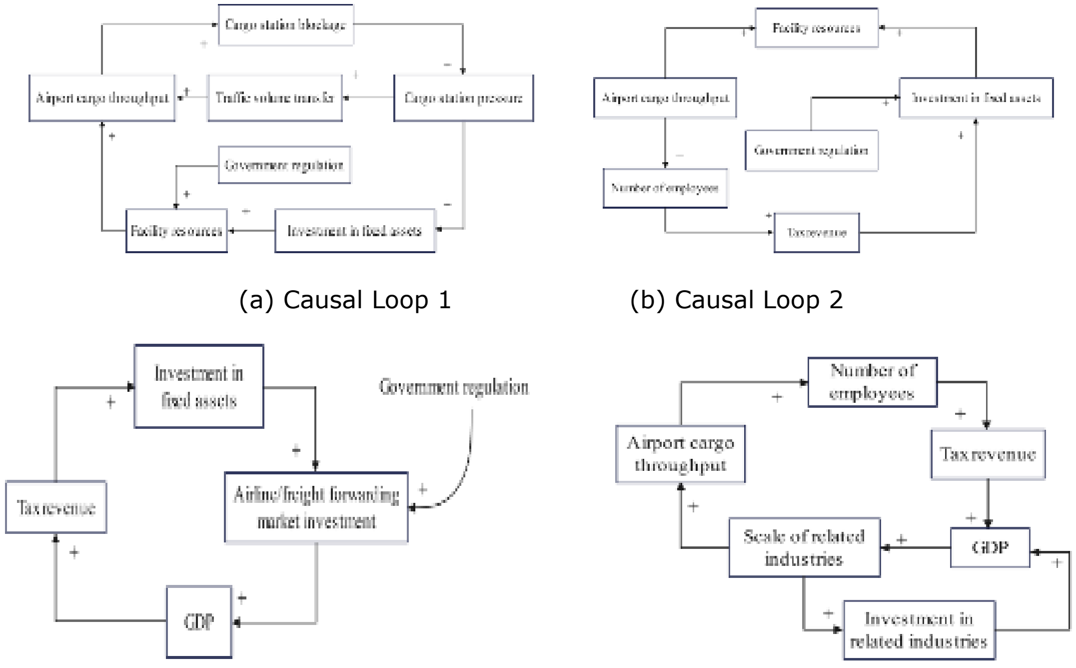


Figure 1: MLS block diagram.

2) Causality diagram

System dynamics believes that the structure of the system determines the behavior of the system. The construction of the system is based on causal loops. The key link of system dynamics modeling is to scientifically analyze the causal relationship within the system. MLS can be divided into four essential causal subsystems. The four causality subsystem diagrams are shown in Figure 2.



(a) Causal Loop 1 (b) Causal Loop 2

(c) Causal Loop 3 (d) Causal Loop 4

Figure 2: MLS causality loops 1-4.

By synthesizing the above four causal relationship modules, the overall causal relationship diagram of MLS is obtained, as shown in Figure 3.

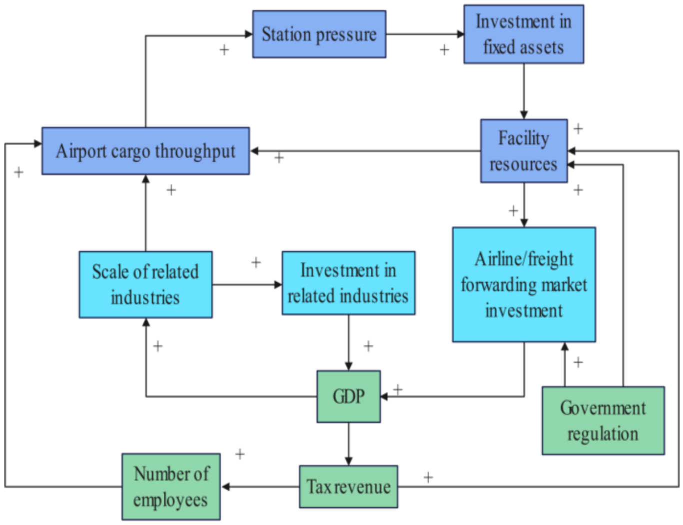


Figure 3: MLS total causality diagram.

By changing the causality loop of MLS into a flow diagram and integrating four modules, a dynamic MLS system dynamics model can be obtained, as shown in Figure 4.

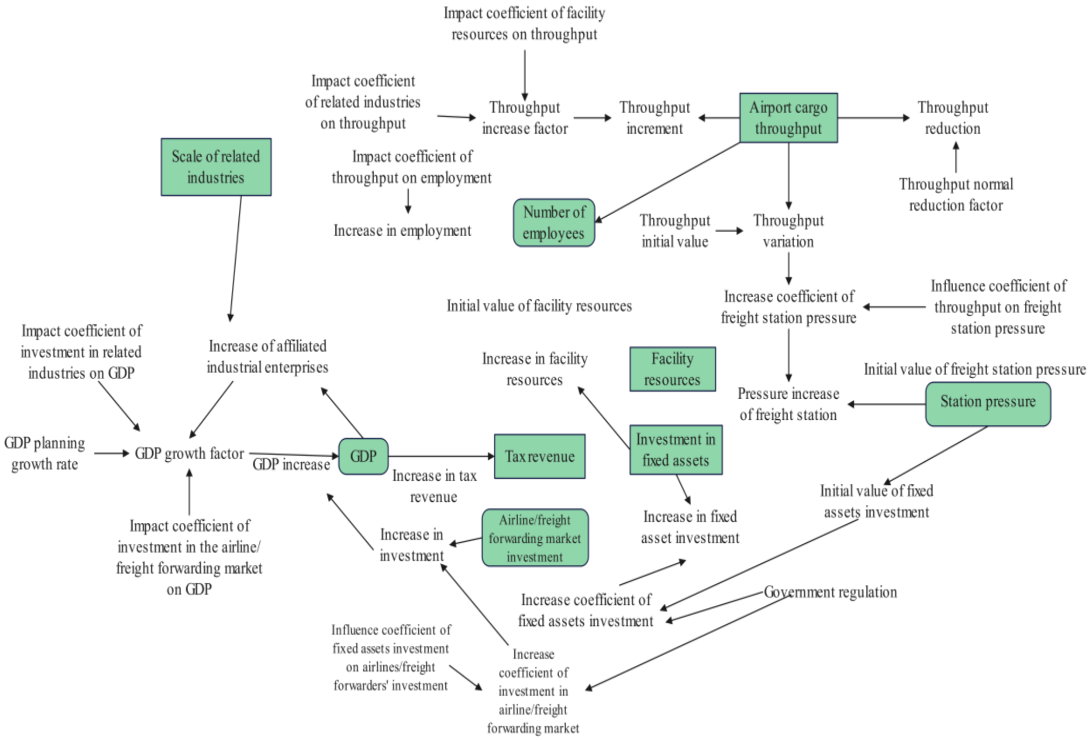


Figure 4: MLS system dynamics model.

2.2 Evolutionary Process Of MLS

When the MLS is far from the equilibrium state, its evolution presents an irreversible process. This irreversible evolution is produced by the irreversible flow and irreversible force in the system. The reason for this is that the various forces in the system are responsible for the various flows. According to relevant research, various flows in MLS can be described by functions of various forces, which can be specifically expressed as:

$$F = F\left(X_k\right)(k = 1,2,\cdots) \tag{1}$$

In equation (1), F represents various flows in MLS, such as material flow, energy flow and information flow. X_k represents various types of forces in MLS. The supporting force of system evolution can be technological progress, the driving force can be government policy guidance, the pulling force can be the increase in regional aviation logistics market demand, and the pressure comes from the main body of aviation logistics competition within the group.

$$F\left(X_k\right)=F(0)+\sum_k\left(\partial F/\partial X_k\right)_0\cdot X_k+\frac{1}{2}\sum_k\left(\partial^2 F/\partial X_k^2\right)_0\cdot X_k^2$$
$$+\sum_k\sum_l\partial^2 F/\partial X_k\partial X_l X_k X_l \qquad (k=1,2,\cdots)$$

(2)

When the various forces of MLS evolution are weak, it means that the internal disturbance of the system is weak. If the interference from the outside is not strong, then in this case, the MLS deviates little from the equilibrium state, which means that the higher-order episode in equation (2) can be ignored. Thus, there are:

$$F\left(X_k\right)=\sum_k\left(\partial F/\partial X_k\right)_0\cdot X_k(k=1,2,\cdots)$$

(3)

At this point, it indicates that MLS has entered an unbalanced linear segment.

Generally, hyper-entropy is used to measure the uncertainty of entropy. This conclusion shows that the steady-state stability analysis and determination of MLS can be carried out by using hyper-entropy. Entropy S and entropy generation P are perturbatively expanded in a steady state, and derived to get:

$$\frac{dP}{dt}\cdot\left[\frac{1}{2}\left(\delta^2 S\right)\right]=\int dv\cdot\left[\sum_k\delta F_k\delta X_k\right]=\delta_k P(k=1,2,\cdots)$$

(4)

The quadratic variation of entropy S is denoted as $\delta^2 S$, and the super-entropy generation $\delta_k P$ is the time derivative of super-entropy.

According to the Liapunov stability theorem, in the non-equilibrium nonlinear region, there are three situations: when $\delta_k P<0$, MLS is in an unstable state; when $\delta_k P>0$, MLS is in a stable state; when $\delta_k P=0$, MLS is in a critical state.

In the continuous development of MLS, some random factors are constantly changing, such as market, technology, policy, system, etc., and the fluctuation of MLS will change. This change is a discontinuous mutation, and the MLS then bifurcates to form a new stable ordered structure. The bifurcation provides multiple options for the MLS evolution path. Specifically, nonlinear differential equations can be used to describe the mutation and bifurcation evolution process of MLS:

$$\partial X/\partial t=f(X,\lambda)$$

(5)

Among them, the state parameter is $X=\left(X_1,X_2,X_3,\cdots,X_n\right),\lambda$ is the constraint condition, indicating the degree of system control and deviation from equilibrium. The process of MLS evolution and sorting is shown in Figure 5. This evolution is not unique to MLS, but conforms to the results of general system theory.

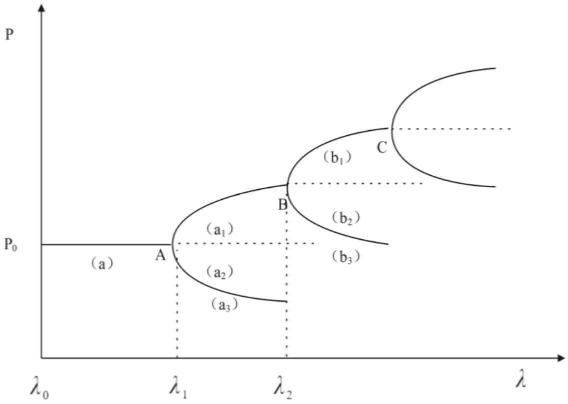


Figure 5: The evolutionary bifurcation of MLS.

The important basis for judging the formation of system dissipative structure is the condition and mechanism of structural instability caused by system fluctuation factors. The Brusselator model of the Belgian Brussels School can be borrowed, and the dynamic evolution of MLS can be described as the process shown in Figure 6.

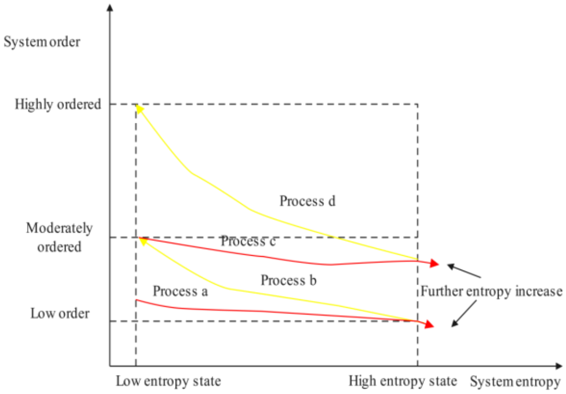


Figure 6: The dynamic process of the ordered state of MLS.

A represents the initial resources, policies, systems and top-level design of MLS, and is the subjective control factor of MLS. B represents regional economy, technological environment, political system and other factors, and is an objective control factor of MLS. X, Y represent the intermediary factors of interaction in MLS. Among them, X can represent the investment of MLS, Y can represent the output of MLS, D represents the new ordered result of MLS, E represents the new, higher-level final ordered result achieved by MLS, and k_1、k_2、k_3、k_4 represents the change of process a-d respectively speed. Among them, A and B can be continuously and fully supplemented with consumption, and a high concentration can be obtained immediately after supplementation. The products D and E are taken away as soon as they are generated, so the system as a whole is far from equilibrium. The reaction path of the MLS Brussels model is shown in Figure 7.

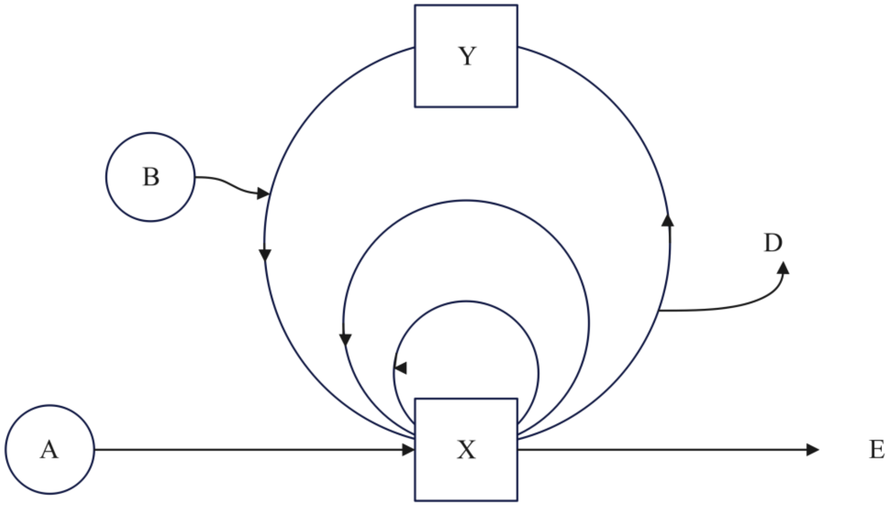


Figure 7: Schematic diagram of the reaction path of the MLS Brussels apparatus model.

The above reaction process is described as a set of irreversible reaction equations, so as to establish a simplified MLS Brussels model:

$$\left.\begin{array}{l} A \xrightarrow{k_1} X \\ 2X + Y \xrightarrow{k_2} 3X \\ B + X \xrightarrow{k_3} Y + D \\ X \xrightarrow{k_4} E \end{array}\right\} \tag{6}$$

In short, the above evolution model indicates that the evolution of MLS is carried out under the influence of objective factors such as resource endowment and subjective control factors such as system and technology, and under the interaction of various subjects in MLS. The evolution of MLS is the formation of new ordered structures. Among them, giant fluctuations and bifurcations are the key to make MLS evolve to a higher-level ordered structure. In order to further explore the evolution mechanism of MLS, the kinetic equation of reaction-diffusion can be established according to the Brussels model:

$$\begin{cases} \frac{\partial X}{\partial t} = k_1 A - k_2 BX + k_3 X^2 Y - k_4 X + M_1 \nabla^2 X \\ \frac{\partial Y}{\partial t} = k_2 BX - k_3 X^2 Y + M_2 \nabla^2 Y \end{cases} \quad (7)$$

In equation (7), the system response time is represented by t, and M_1 and M_2 represent the actual diffusion coefficients of X and Y respectively, and these two coefficients are constant and independent of each other. This simplifies the discussion when only one-dimensional systems are considered. If the system length is l, then $\nabla^2 = \frac{\partial^2}{\partial r^2}, 0 < \$\$r < 1$. In order to further change the variables of equation (7), the following scale variables can be introduced: $a = \left(k_1^2 k_3 / k_4^2\right)^{\frac{1}{2}} A$, $b = \left(k_2 / k_4\right) B, x = \left(k_3 / k_4\right)^{\frac{1}{2}} X, y = \left(k_3 / k_4\right)^{\frac{1}{2}} Y, \tau = k_4 t, m_1 = M_1 / k_4, m_2 = ^M / k_4$. In order to simplify the discussion of the evolution mechanism of MLS, if the internal interaction between objective elements is ignored, that is, the diffusion item in equation (7), then equation (7) is transformed into:

$$\begin{cases} \frac{\partial x}{\partial \tau} = a - (b+1)x + x^2 y \\ \frac{\partial y}{\partial \tau} = bx - x^2 y \end{cases} \quad (8)$$

In equation (8), under the assumed conditions, the aviation logistics supply capacity corresponding to the input of MLS aviation logistics resource elements can be expressed by a. $x^2 y$ represents the supply capacity of aviation logistics formed under the symbiotic mechanism of mutual benefit, bx represents the waste of supply capacity due to the scattered input of MLS aviation logistics resource elements, and x represents the consumption of resources. Since the demand and supply of MLS aviation logistics are always in a process of dynamic adjustment, this also makes the evolution process represented by equation (8) a dynamic process about time. The steady-state solution of equation (8), namely $x_0 = a, y_0 = b / a$, can be obtained, which shows that there is an equilibrium steady-state in MLS. In order to perform Taylor series expansion near the steady-state solution $\left(x_0, y_0\right)$, $x = x_0 + u, y = y_0 + v$ can be made, and x, y, and t are used to replace u, v, τ, and the following equation can be obtained:

$$\begin{cases} \frac{\partial x}{\partial t} = (b-1)x + a^2 y + \frac{b}{a} x^2 + 2axy + x^2 y \\ \frac{\partial y}{\partial t} = -bx - a^2 y - \frac{b}{a} x^2 - 2axy - x^2 y \end{cases} \quad (9)$$

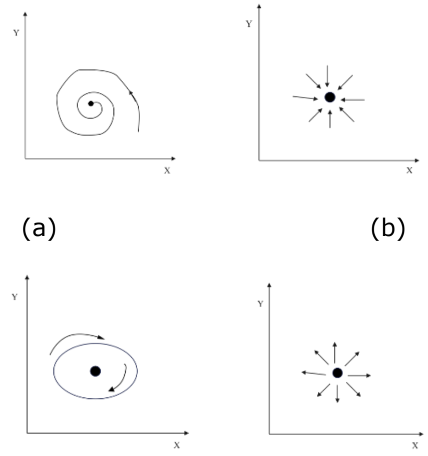
Equation (9) can be further simplified into a linear approximation equation:

$$\begin{cases} \dfrac{\partial x}{\partial t} = (b-1)x + a^2 y \\ \dfrac{\partial y}{\partial t} = -bx - a^2 y \end{cases} \tag{10}$$

The feature equation of the linear approximation equation can be expressed as:

$$\lambda^2 - \left(b - 1 - a^2\right)\lambda + a^2 = 0 \tag{11}$$

If $\varpi = b - 1 - a^2$, the characteristic root $\lambda_{1,2} = \frac{1}{2}\left(\varpi \pm \sqrt{\varpi^2 - 4a^2}\right)$ can be obtained. The stability of MLS depends on the stability parameter coin, which is determined by two parameters a and b. That is to say, whether MLS can form a dissipative structure depends on whether the steady-state solution is unstable. When the steady-state solution becomes unstable depends on two control parameters a and b. Therefore, by analyzing the values of the two parameters, the formation and main forms of the MLS dissipative structure can be further discussed.



(a) (b)

(c) (d)

Figure 8: Stability of MLS dissipative structure.

1) When $b < a^2 + 1$, namely $\sigma < 0$:

If $\varpi^2 - 4a^2 < 0$, the feature equation has two conjugate complex roots with negative real parts, MLS has a unique asymptotically stable focus $\left(x_0, y_0\right)$, and the MLS evolution state converges in a spiral phase orbit around $\left(x_0, y_0\right)$, and the limit is 0. The stationary point $\left(x_0, y_0\right)$ is the center of attraction, and the MLS can always approach the stationary state from different phase orbits, as shown in Figure 8(a).

If $\varpi^2 - 4a^2 > 0$, the feature equation has two negative real roots, the evolution of MLS can always approach the steady state solution (x_0, y_0), the steady state solution (x_0, y_0) at this time is a stable node, and MLS can approach the steady state from different phase orbits, as shown in Figure 8 (b) shown.

When $b > a^2 + 1$, namely ϖ >0:

If $\varpi^2 - 4a^2 < 0$, the feature equation has two conjugate complex roots of the positive real part, the perturbation near the stationary point (x_0, y_0) will form a limit cycle centered on (x_0, y_0), the MLS will continue to oscillate within a certain range, and the MLS may exhibit the characteristics of a dissipative structure. That is, when the fluctuation of MLS reaches the threshold, the system state will evolve from the initial state to a new state (x, y), as shown in Figure 8(c).

If $\varpi^2 - 4a^2 > 0$, the characteristic equation has two positive real roots, any perturbation to the steady-state solution can make the MLS evolve away from the steady-state solution (x_0, y_0). At this time, the steady-state solution (x_0, y_0) is an unstable node, and the MLS presents the characteristics of a dissipative structure, as shown in Figure 8(d).

2.3 MLS Self-Organized Evolution

The capability of air logistics service (or output) includes two aspects: one is to meet the supply scale requirements of the air logistics service demand in the region, and the other is the quality and efficiency of the service provided. $X_i(t)$ represents the air logistics capacity of the i-th airport in the MLS at time t, and $dX_i(t)/dt$ represents the instantaneous change rate of the i-th airport's air logistics capacity.

$$dX_i(t)/dt = G\{X_i(t)\} + \xi(t) \tag{12}$$

$G\{X_i(t)\}$ represents the relationship function of the MLS evolution state change, $\xi(t)$ is the fluctuation of the system at time t, $E(\xi(t)) = 0$, that is, the mean value is 0. Obviously, determining the function expression of $G\{X_i(t)\}$ becomes the crux of the problem.

If X(t) is the sum of all aviation logistics capabilities in MLS at time t, then:

$$X(t)=\sum_{i=1}^{n}X_i(t) \tag{13}$$

According to the definition of the derivative, the change rate of the aviation logistics capacity of the i-th airport at time t is:

$$\frac{dX_i(t)}{dt}=\lim_{\Delta t\to}\frac{X_i(t+\Delta t)-X_i(t)}{\Delta t}+\xi_i(t) \tag{14}$$

During the period from t to $t+\Delta t$, the air logistics capacity increment of the i-th airport can be expressed as $X_i(t+\Delta t)-X_i(t)$. The natural growth rate of the air logistics capacity of the i-th airport per unit time is expressed as r_i, which represents the endogenous endowment of the air logistics capacity of the airport, and $(r_i>0)$. Furthermore, the natural attenuation rate of the air logistics capacity of the i-th airport per unit time is expressed as μ_i, which means the degradation of the air logistics capacity of the airport due to the influence of the environment, and $(\mu_i>0)$.

$$X_i(t+\Delta t)-X_i(t)=(r_i-\mu_i)\cdot X_i(t)\cdot \Delta t \tag{15}$$

Due to resource and environmental constraints, airport i actually has to compete with other airports in the MLS for cargo sources in the cross hinterland, which makes the relative natural growth rate r_i lower than its relative growth rate r_i'. In the time interval of Δt, after considering the competitive factors, the air logistics capacity increment of the i-th airport is expressed as:

$$X_i(t+\Delta t)-X_i(t)=(r_i'-\mu_i)\cdot X_i(t)\cdot \Delta t \tag{16}$$

When the external development environment is given and remains unchanged, the natural state is the best state that can be achieved by making full use of various natural resources and production factors. In the natural state, the maximum aviation logistics capacity that the i-th airport can achieve is $K_i, and\ K_i$ is a fixed value, which can be obtained through economic development prediction. δ_{ij} represents the non-linear interaction exhibited between multiple airports during the development process. The remaining growth space of the aviation logistics capacity of the i-th airport is

$K_i-\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)$, and the remaining growth space share is $1/K_i\left(K_i-\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)\right)$, then the relative growth rate r_i' can be expressed as:

$$r_i'=r_i\cdot\left(1-1/K_i\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)\right) \tag{17}$$

By bringing formula (17) into formula (16), we get:

$$X_i(t+\Delta t)-X_i(t)=\left[r_i\cdot\left(1-1/K_i\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)\right)-\mu_i\right]\cdot X_i(t)\cdot\Delta t \tag{18}$$

When $\Delta t\to 0$, the time interval is infinitely subdivided, and the air logistics capacity of the i-th airport can be approximated as a continuous function of time t. When both sides of formula (18) are divided by Δt at the same time and the limit is obtained, we can get:

$$\lim_{\Delta t\to}\frac{X_i(t+\Delta t)-X_i(t)}{\Delta t}=\left[r_i\cdot\left(1-1/K_i\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)\right)-\mu_i\right]\cdot X_i(t) \tag{19}$$

By bringing formula (19) into formula (14), the evolution equation of airport i is obtained as:

$$\frac{dX_i(t)}{dt}=\left[r_i\cdot\left(1-1/K_i\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)\right)-\mu_i\right]\cdot X_i(t)+\xi_i(t) \tag{20}$$

That is, $G\left(X_i(t)\right)=\left[r_i\cdot\left(1-1/K_i\sum_{j=1}^{n}\delta_{ij}\cdot X_j(t)\right)-\mu_i\right]\cdot X_i(t)$. Then, the dynamical equation of MLS evolution can be expressed as:

$$\frac{dX}{dt}=\begin{bmatrix}\left[(r_1-\mu_1)-r_1/K_1\left(\delta_{11}\cdot X_1(t)+\delta_{12}\cdot X_2(t)+\cdots+\delta_{1n}\cdot X_n(t)\right)\right]\cdot X_1(t)\\ \vdots\\ \left[(r_i-\mu_i)-r_i/K_i\left(\delta_{i1}\cdot X_1(t)+\delta_{i2}\cdot X_2(t)+\cdots+\delta_{in}\cdot X_n(t)\right)\right]\cdot X_i(t)\\ \vdots\\ \left[(r_n-\mu_n)-r_n/K_n\left(\delta_{n1}\cdot X_1(t)+\delta_{n2}\cdot X_2(t)+\cdots+\delta_{nn}\cdot X_n(t)\right)\right]\cdot X_n(t)\end{bmatrix}+\xi(t) \tag{21}$$

Among them, $X_i(t)$ is the dependent variable, t is the independent variable, K_i is the fixed value, and $K_i\gg X_i;r_i,\mu_i,\delta_{ij}$ is the parameter. When $\delta_{ij}=1$, j=i means that airport i competes with itself and does not have the conditions to form an MLS. When $\delta_{ij} = 0$, airport i and airport j do not intersect the hinterland, which does not meet the formation conditions of MLS. When $0 < \delta_{ij} < 1$, airport j hinders the growth of air logistics capacity of airport i.

In the initial stage, the MLS seldom undergoes abrupt changes, and the fluctuations in the system are mainly micro-fluctuations, so they can be approximately ignored, that is, it can be expressed by removing the constant term in formula (21). However, regardless of the number of airports in the region, one of the airports can be regarded as subject A, and the other airports can be regarded as subject B, so as to simplify the discussion of the evolution process of MLS under the competitive development of subsystems. Therefore, this part takes n=2 as an example to discuss the model, which does not affect the utility of the model. The evolution equation of MLS is:

$$\begin{cases} \dfrac{dX_1(t)}{dt} = (r_1 - \mu_1) \cdot X_1(t) -^{r_1} / K_{K_1} \cdot X_1(t) \cdot (X_1(t) + \delta_{12} \cdot X_2(t)) \\ \dfrac{dX_2(t)}{dt} = (r_2 - \mu_2) \cdot X_2(t) -^{r_2} / K_{K_2} \cdot X_2(t) \cdot (\delta_{21} \cdot X_2(t) + X_2(t)) \end{cases} \tag{22}$$

When looking for a steady-state solution to formula (22), that is, when the air logistics capacity of the airport does not change with time, there is:

$$\begin{cases} X_1 + \delta_{12} X_2 = K_1 (1 - \mu_1 / r_1) \\ X_2 + \delta_{21} X_1 = K_2 (1 - \mu_2 / r_2) \end{cases} \tag{23}$$

The two equations in formula (23) can be viewed as equations of a line with respect to the variables X_1 and X_2. In the plane Cartesian coordinate system, the formula (23) corresponds to the straight lines L_1 and L_2 respectively, and the slopes of the two straight lines are $-1/\delta_{12}$ and $-\delta_{21}$ respectively. At the same time, according to the formula (23), the intercepts of the two straight lines can be obtained as follows:

$$\begin{aligned} L_1 &: (K_1(1 - \mu_1 / r_1), 0)(0, (1 - \mu_1 / r_1) K_1 / \delta_{12}) \\ L_2 &: ((1 - \mu_2 / r_2) K_2 / \delta_{21}, 0)(0, K_2 (1 - \mu_2 / r_2)) \end{aligned} \tag{24}$$

In the initial stage, the aviation logistics industry of each airport has just started, the agglomeration scale of aviation logistics resources and the radiation ability to the market are still weak, and compared with the aviation logistics market in the whole region, the development scale of each airport is relatively small. That is to say, at this stage, the development of the aviation logistics industry of each airport is almost not limited by the capacity of the external market. That is, the two airports $r_1 > \mu_1$ and $r_2 > \mu_2$ are in a competitive relationship, including the plundering of aviation logistics resources and the seizure of the aviation logistics market. At this time, $0 < \delta_{ij} < 1, -1/\delta_{12} < -1 < -\delta_{21} < 0$, and the relative positional relationship of the two function lines corresponding to formula (24) can be expressed in the plane Cartesian coordinate system.

$$\begin{cases} K_2\left(1-\mu_2 / r_2\right) > \delta_{21} K_1\left(1-\mu_1 / r_1\right) \\ K_1\left(1-\mu_1 / r_1\right) > \delta_{12} K_2\left(1-\mu_2 / r_2\right) \end{cases} \tag{25}$$

Only when the condition of formula (25) is met, there is a stable point P, as shown in Figure 9.

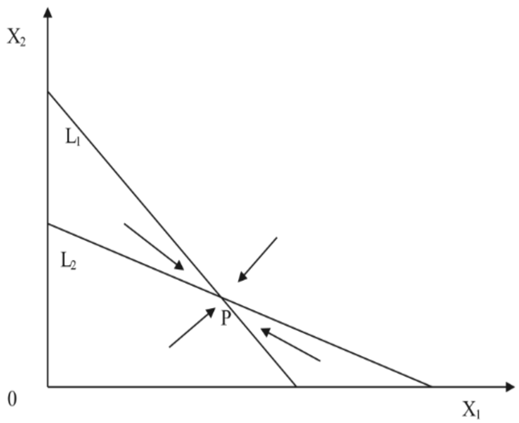


Figure 9: The equilibrium point in the initial stage of MLS.

At this point, the steady-state solution is:

$$\begin{cases} X_1^{\circ} = \dfrac{K_1\left(1-\mu_1 / r_1\right) - \delta_{12} K_2\left(1-\mu_2 / r_2\right)}{1-\delta_{12}\delta_{21}} \\ X_2^{\circ} = \dfrac{K_2\left(1-\mu_2 / r_2\right) - \delta_{21} K_1\left(1-\mu_1 / r_1\right)}{1-\delta_{12}\delta_{21}} \end{cases} \tag{26}$$

When the condition of formula (25) is not met, there are two situations. One is that the air logistics capacity of the new airport cannot be increased, and it has been restricted by the old airport until the new airport is eliminated in the development of regional air logistics. The other is that the air logistics capacity of the new airport continues to grow, and the old airport is at a disadvantage in the competition, and is gradually eliminated, and its position is replaced by the new airport in the development of regional air logistics. In both cases, the MLS cannot be formed.

By deriving formula (22), and setting the second derivative and the third derivative equal to zero, the inflection point of the MLS state curve evolution can be obtained, and the MLS development curve based on the aviation logistics service capability can be obtained, as shown in Figure 10.

Obviously, competition will prevent the air logistics service capacity of the two airports from growing, and cannot reach the maximum value that can be achieved by independent operations. Through the cooperation between the two parties, the benefits brought by both parties have been improved exponentially, which is not only significantly better than the air logistics service capabilities that can be achieved under the competitive state, but also higher than the air logistics service capabilities under the independent operation state.

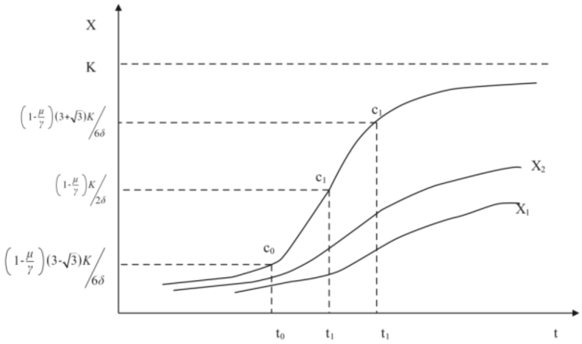


Figure 10: Schematic diagram of the evolution curve of MLS.

In order to achieve the sustainability of the entire system, MLS eventually moves toward collaborative development.

3 SIMULATION OF E-COMMERCE DEVELOPMENT PATH OF SMALL AND MEDIUM-SIZED ENTERPRISES

In terms of cross-border e-commerce mode, it focuses on building a supply chain management system, cross-border e-commerce online transaction system, cross-border e-commerce customs clearance treasury platform, cross-border e-commerce public service platform, cross-border e-commerce comprehensive service platform, and composite supervision warehouse. The specific process is shown in Figure 11:

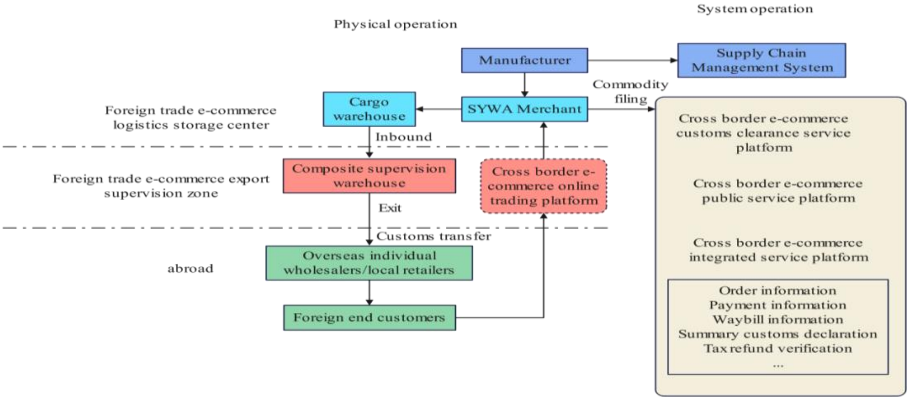


Figure 11: Flow chart of cross-border e-commerce model.

The key point of the supply chain management system is to solve the problem of supply of goods, and to select excellent suppliers through big data application technology, so as to lay the foundation for the construction of a complete ecological system, as shown in Figure 12. This article simulates the model proposed in this article, and this article combines the algorithm in the second part to conduct simulation analysis, and counts the simulation effect of the e-commerce development path of small and medium-sized enterprises, and obtains the simulation evaluation results shown in Figure 13.

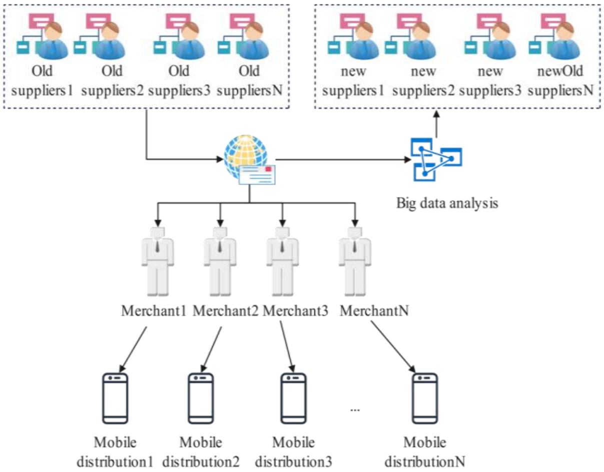


Figure 12: Schematic diagram of cross-border e-commerce supply chain management process.

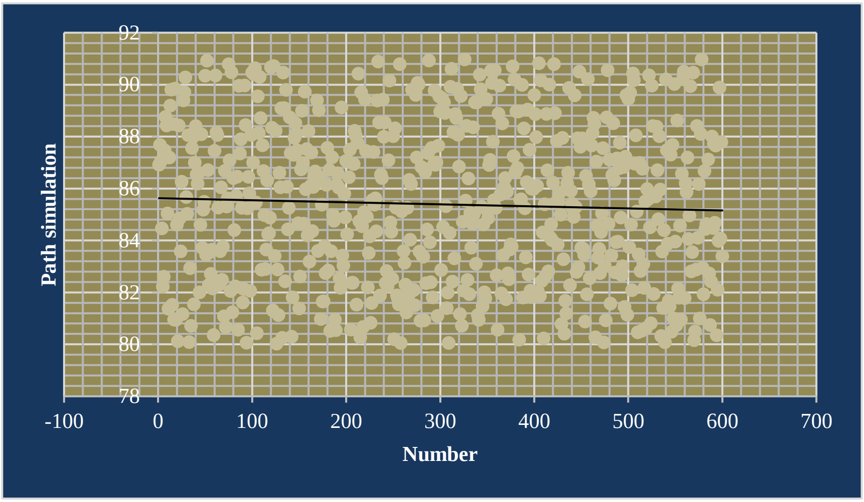


Figure 13: Simulation results of e-commerce development paths of small and medium-sized. enterprises.

From the above analysis, it can be seen that the simulation effect of the e-commerce development path of small and medium-sized enterprises proposed in this paper is relatively obvious, which can provide a reference for the development of cross-border e-commerce of small and medium-sized enterprises.

4 CONCLUSION

As an international business activity, cross-border e-commerce refers to enterprises or individuals in different countries reaching commodity transactions with the help of network technology and electronic data, and its transportation process relies on cross-border logistics. Cross-border e-commerce has many characteristics such as convenience, variety, and digitization. By breaking the constraints of time and space, it promotes direct connection between manufacturers and customers. Cross-border e-commerce foreign trade models include the following three. The first is to sell products with the help of large-scale e-commerce platforms, relatively mature logistics systems and third-party payment platforms. The second is that domestic merchants use overseas e-commerce platforms for product sales. The third is that foreign trade enterprises establish their own e-commerce platforms for product sales. With the development of cross-border e-commerce, small and medium-sized enterprises are gradually using e-commerce platforms to carry out foreign trade. At the same time, the development of cross-border e-commerce has had an important impact on the foreign trade model of small and medium-sized enterprises. According to the experimental analysis, it can be seen that the simulation effect of the e-commerce development path of small and medium-sized enterprises proposed in this paper is relatively obvious, which can provide a reference for the development of cross-border e-commerce of small and medium-sized enterprises.

Lin Ji, https://orcid.org/0009-0000-1959-437X
Fang Wei, https://orcid.org/0009-0006-4159-5663
Peng Wang, https://orcid.org/0009-0006-8839-202X
Liang Liu, https://orcid.org/0009-0002-0419-7747

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