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RESEARCH ON THE CONSTRUCTION STRATEGY OF CROSS-BORDER E-COMMERCE COMPREHENSIVE PILOT AREA BASED ON SALOP MODEL

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Abstract. *With the construction advance of cross-border e-commerce comprehensive pilot area in China (CBECPA for short), 13 CBECPAs have been approved to establish by the state council. The competition among CBECPAs is increasingly fierce. Facing the increasingly fierce competition, what is the best investment of each CBECPA? Under what condition is cooperation beneficial for CBECPAs? From the national strategy, what is the optimal number of comprehensive pilot areas? These are the problems which must be considered. In this paper, a spatial competition model of cross-border e-commerce comprehensive pilot area is established based on Salop model. Through the equilibrium analysis, the results show that the endogenous value is affected by the agglomeration effect, the competition effect and the space structure effect. The endogenous value determines the best investment quota. Under some conditions cooperation is beneficial for CBECPAs. The optimal number of CBECPA is negatively related to the approval cost and positively related to the cost of mismatch.*

Keywords: Salop model, Cross-border e-commerce comprehensive pilot area, Construction strategy

1. **Introduction.** Cross-border e-commerce is the concrete realization form of "Internet + Traditional foreign trade". Under the "New Normal" of the stagnation of traditional foreign trade development, cross-border e-commerce is getting more and more attention. The general administration of customs has determined Shanghai, Hangzhou, Ningbo, Zhengzhou, Chongqing as cross-border e-commerce pilot cities in 2012. Since then, a large number of policies of the national level were densely issued to promote the development of cross-border e-commerce. Those policies are related to the cross-border payment facilitation, preferential tax, customs clearance facilitation and so on. In March 2015, marked by *The State Council's Reply on Approval of Setting up China (Hangzhou) Cross-border E-commerce Comprehensive Pilot Area*, our country launched the construction of cross-border e-commerce comprehensive pilot areas. *The State Council's Reply on Approval of Setting up Cross-border E-commerce Comprehensive Pilot Area in 12 Cities such as Tianjin* was released in January 2016, which formed a well arranged cross-border e-commerce comprehensive pilot area system over China. This reply particular emphasizes that the new CBECPAs should learn the experiences and practices of "six uniform systems" and "two platforms", which come from the construction of China (Hangzhou) cross-border e-commerce comprehensive pilot area. This leads to the inevitable competition among CBECPAs. And e-commerce has the characteristic of clustering and "winner-take-all" [1].

The researchers outside China focus their studies on the theories and practices of cross-border e-commerce. Azam examines the taxation challenges of e-commerce and discusses the current responses. In his article the author argues for the imposition of a global e-commerce tax on cross-border e-commerce income and designs the details of the tax [2]. Gomez-Herrera et al. put forward some measures to prompt the development of the cross-border e-commerce in EU [3]. Kawa and Zdrenka point out that the problems connected with cross-border e-commerce are delivery cost, time and quality of delivery, communication in a foreign language, payment terms, legal and tax conditionings, dealing with returns [4]. Kim finds that express delivery has positive effects on financial performance, as it leads to higher order incidence, larger order size, and higher repurchase rates in cross-border transactions [5]. Ding and Huo find that cross-border E-tailers should sub-outsource logistics for international and domestic [6]. The current literature from China is almost focusing on the interpretation of policies and providing countermeasures and suggestions to those cities, which has been approved to establish cross-border e-commerce comprehensive pilot area, for example, Zhao [7] and Xia and Sun [8]. Even so, the construction of the cross-border e-commerce comprehensive pilot area provides us the basis to build the theory competition model of cross-border e-commerce comprehensive pilot areas.

The core function of cross-border e-commerce comprehensive pilot area is to provide a full range of services for enterprises that engaged in cross-border e-commerce through the system and mechanism innovation. The competition among cross-border e-commerce comprehensive pilot areas is based on the endogenous value of the services provided by them. The endogenous value of the services is the largest value of their services provided by the cross-border e-commerce comprehensive pilot areas determined by their own resources endowment, the external environment and consumer's preferences. For example, Dalian, Tianjin, Shanghai, etc. in geography, culture, and historical evolution each has its own characteristics, which formed the basis of the endogenous value of the services they provided. Because the endogenous value is associated with a city's geographical location, culture and history and so on, it is not easy to change in the short term. That means it is hard to change the maximum value of the services provided by cross-border e-commerce comprehensive pilot area no matter how much is invested in short time. Although the maximum value of cross-border e-commerce comprehensive pilot area cannot be changed in short term, the endogenous value of CBECPAs has a direct relationship with investment size. This paper makes the following assumptions: when the investment is less than the maximum endogenous value, the endogenous value has completely positive correlation with investment; when the investment is more than the maximum endogenous value, it will lead to ineffective investment. It means investment more than the maximum endogenous value will be invalid. So $V_i = \begin{cases} V_{i-\max} & \text{if } I_i \geq V_{i-\max} \\ aI_i & \text{if } I_i < V_{i-\max} \end{cases}$, here let $a = 1$. So the problem that the cross-border e-commerce comprehensive pilot areas are facing is that what the best investment for a particular CBECPA is.

Considering the actual situation, the CBECPAs are based in 13 cities from north to south which has formed a circular distribution: Dalian, Tianjin, Qingdao, Hefei, Suzhou, Shanghai, Hangzhou, Ningbo, Shenzhen, Guangzhou, Chongqing, Chengdu, and Zhengzhou. This paper uses annular city model (Salop, 1979) to build the foundation competition space of the cross-border e-commerce comprehensive pilot areas [9]. Among these cities, there are very large economic center like Shanghai, provincial economic center, and also some vice provincial economic center, and these cities have differences on economic mass, the degree of development, and service level and so on. Due to the circular geographical distribution, there must be competitions between adjacent CBECPAs.

Generally, the competitions can exist both online and offline. Online competition refers to the competitions based on the information services provided by the CBECPAs; offline competition refers to the competitions based on the logistics, finance and other local services provided by the CBECPAs. As a result of the competitions, those pilot areas determine their own endogenous value.

On the other hand, at the same time of competitions, there is the possibility of cooperation between the CBECPAs. Taking Hangzhou and Ningbo as examples, if Hangzhou and Ningbo do not cooperate, then a cross-border e-commerce company in Ningbo must use the information platform of Ningbo while enjoying the local services in Ningbo. However, if Hangzhou and Ningbo are cooperating on the information service, then a cross-border e-commerce company can use the information service platform in Hangzhou, while enjoying the local service in Ningbo. This cooperation is beneficial to cross-border e-commerce companies, because there is a new more choice; at least not affect its current benefits. For Hangzhou and Ningbo, it could be good or bad. Based on the Salop model, this paper constructs a competition and cooperation model between those 13 CBECPAs, in order to explain under what kind of condition the CBECPAs should adopt cooperative attitude or hostile attitude.

From the national level, when the 13 cross-border e-commerce comprehensive pilot areas compete with each other, they have to develop coordinately at the same time to improve the cross-border e-commerce development level of the whole country. At present, there have been 13 cross-border e-commerce comprehensive pilot areas, so from the national strategy, the questions are that if it is necessary to continue to approve new pilot areas, and what the optimal number of cross-border e-commerce comprehensive pilot area is.

In conclusion, this article will focus on the construction of cross-border e-commerce comprehensive pilot area from three angles. First of all, what is the best investment of the CBECPAs? Secondly, under what condition will cooperation benefit the CBECPAs? Thirdly, from the national strategy, what is the optimal number of the CBECPAs? In this paper, a spatial competition model of the CBECPAs will be established based on Salop model. Through the equilibrium analysis, this paper proposes a method to determine the best investment quota, cooperation strategy and optimal number of cross-border e-commerce comprehensive pilot areas.

The structure of this paper is arranged as the following: the first part is the introduction, the second part is the investment model, the third part is the cooperation model, the fourth part is the optimal number model and the fifth is the conclusion and management implications.

2. **The Investment Model.** Suppose there are n CBECPAs and they are distributed uniformly on a circle with 1 unit length. Without loss of generality, we assume cross-border e-commerce sellers offer door-to-door delivery services, therefore, distance is not the primary problem for consumers to consider, so consumer is multi-homing to CBECPAs. The enterprises engaged in cross-border e-commerce are distributed uniformly on the circle with 1 unit length. They choose a CBECPA as their operation location according to the mismatch cost. Based on this, we can draw the competition diagram of those pilot areas. $i = 1, \ldots, n$ refers to each cross-border e-commerce comprehensive pilot area. I is all the cross-border e-commerce comprehensive pilot areas, as shown in Figure 1.

Assuming that v_i is the endogenous value of the services provided by the ith cross-border e-commerce comprehensive pilot area, $i = 1, \ldots, n$. Without loss of generality, we take the ith comprehensive pilot area as the object of modeling, let $v_{i+1} > v_i > v_{i-1}$, as shown in Figure 2. Because the cross-border e-commerce enterprises distributed uniformly on the circle with 1 unit length based on their preference, the distance between $i-1$ and i, i

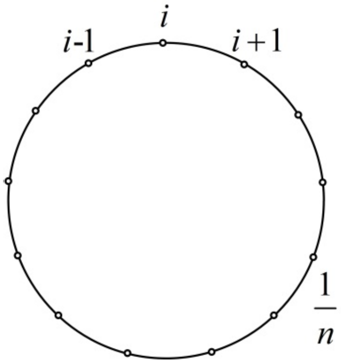

FIGURE 1. Competition diagram of n comprehensive pilot areas

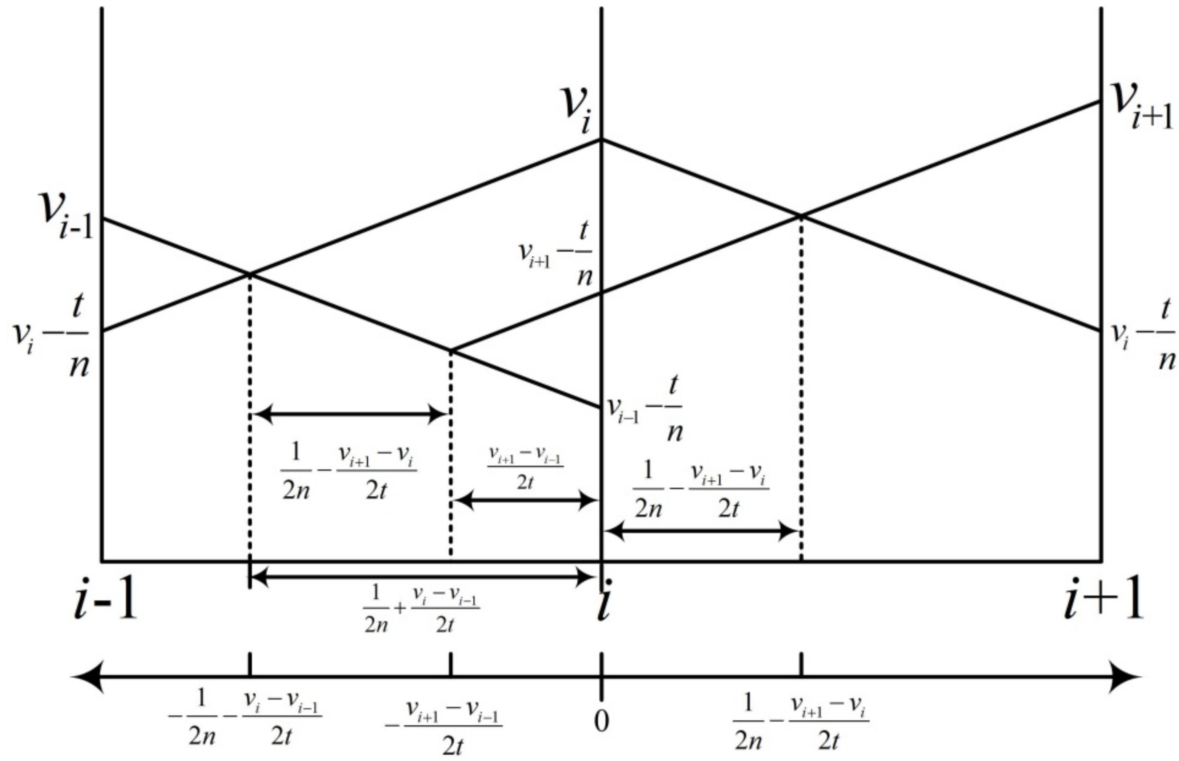

FIGURE 2. Equilibrium analysis of the investment model

and $i+1$ is $\frac{1}{n}$. Assume that the distance between cross-border e-commerce enterprise and a cross-border e-commerce comprehensive pilot area represents the degree of mismatch between them. At the same time, this paper assumes that the mismatching coefficient is t. In order to ensure that there are cross-border e-commerce enterprises in every cross-border e-commerce comprehensive pilot area, let the following relationship exist, if $v_i \geq v_{i-1}$, then $v_i - \frac{t}{n} \leq v_{i-1}$. For the convenience of analysis assume that the ith CBECPA is the origin of coordinates, namely $L_i = 0$. So, $L_{i-1} = -\frac{1}{n}$, $L_{i+1} = \frac{1}{n}$, let x represent the coordinates of any point between L_{i-1} and L_{i+1}.

Because the endogenous value is determined by the model, this paper uses the opportunity cost to measure the endogenous value of the CBECPAs. So the endogenous value of services provided by the ith CBECPA is equal to the maximum utility an enterprise has to give up when it chooses the ith CBECPA as their operation location not to choose other CBECPAs as their operation location. Based on the above assumptions we can build the following models.

(1) The utility when enterprises located between $i-1$ and i choose i as their operating location:

$$u_i^1 = v_i - t(-x) \tag{1}$$

(2) The utility when enterprises located between $i-1$ and i choose $i-1$ as their operating location:

$$u_{i-1}^1 = v_{i-1} - t\left(\frac{1}{n} + x\right) \tag{2}$$

(3) The utility when enterprises located between i and $i+1$ choose i as their operating location:

$$u_i^2 = v_i - tx \tag{3}$$

(4) The utility when enterprises located between i and $i+1$ choose $i+1$ as their operating location:

$$u_{i+1}^2 = v_{i+1} - t\left(\frac{1}{n} - x\right) \tag{4}$$

Solving the above model we can get:

The indifference point of the enterprises located between $i-1$ and i choosing $i-1$ or i as their operating location is $\widehat{x}_1$:

$$\widehat{x}_1 = -\frac{1}{2n} - \frac{v_i - v_{i-1}}{2t}$$

The indifference point of the enterprises located between i and $i+1$ choosing i or $i+1$ as their operating location is $\widehat{x}_2$:

$$\widehat{x}_2 = \frac{1}{2n} - \frac{v_{i+1} - v_i}{2t}$$

The indifference point of the enterprises located between $i-1$ and $i+1$ choosing $i-1$ or $i+1$ as their operating location is x^*:

$$x^* = \frac{1}{n} - \frac{v_{i+1} - v_{i-1}}{2t}$$

See Appendix Part A for the solution process.

The endogenous value is the opportunity cost when an enterprise chooses the ith CBECPA as their operation location not to choose other CBECPAs as their operation location. When an enterprise chooses the ith CBECPA as its operation location, it has to give up the opportunity to choose other CBECPAs as its operation location. In the above model, when an enterprise located at x, $x \in \left[-\frac{1}{2n} - \frac{v_i - v_{i-1}}{2t}, -\frac{v_{i+1}-v_{i-1}}{2t}\right]$, its opportunity cost is $v_{i-1} - t\left(x + \frac{1}{n}\right)$. In this situation the endogenous value of the ith CBECPA is $\int_{-\frac{1}{2n}-\frac{v_i-v_{i-1}}{2t}}^{-\frac{v_{i+1}-v_{i-1}}{2t}} \left[v_{i-1} - t\left(x + \frac{1}{n}\right)\right] dx$. When an enterprise located at x, $x \in \left[-\frac{v_{i+1}-v_{i-1}}{2t}, \frac{1}{2n} - \frac{v_{i+1}-v_i}{2t}\right]$, its opportunity cost is $v_{i+1} - t\left(\frac{1}{n} - x\right)$. In this situation the endogenous value of the ith CBECPA is $\int_{-\frac{v_{i+1}-v_{i-1}}{2t}}^{\frac{1}{2n}-\frac{v_{i+1}-v_i}{2t}} \left[v_{i+1} - t\left(\frac{1}{n} - x\right)\right] dx$. So we can get the endogenous value of the cross-border e-commerce comprehensive pilot area according to $\widehat{x}_1$, $\widehat{x}_2$, x^*:

$$\begin{aligned} V_i &= \int_{-\frac{1}{2n}-\frac{v_i-v_{i-1}}{2t}}^{-\frac{v_{i+1}-v_{i-1}}{2t}} \left[v_{i-1} - t\left(x+\frac{1}{n}\right)\right] dx + \int_{-\frac{v_{i+1}-v_{i-1}}{2t}}^{\frac{1}{2n}-\frac{v_{i+1}-v_i}{2t}} \left[v_{i+1} - t\left(\frac{1}{n}-x\right)\right] dx \\ &= \frac{v_i^2+v_{i+1}^2+2v_{i+1}v_{i-1}}{4t} + \left[\frac{v_i^2-v_{i+1}v_i}{4t} + \frac{v_i^2-v_iv_{i-1}}{4t}\right. \\ &\quad \left. + \left(\frac{v_{i+1}^2-v_{i-1}^2}{8t} + \frac{v_{i+1}-v_{i-1}}{4n}\right)\right] - \frac{3t}{4n^2} \end{aligned} \tag{5}$$

Lemma 2.1. *The endogenous value of the ith cross-border e-commerce comprehensive pilot area is:*

$$\frac{v_i^2+v_{i+1}^2+2v_{i+1}v_{i-1}}{4t} + \left[\frac{v_i^2-v_{i+1}v_i}{4t} + \frac{v_i^2-v_iv_{i-1}}{4t} + \left(\frac{v_{i+1}^2-v_{i-1}^2}{8t} + \frac{v_{i+1}-v_{i-1}}{4n}\right)\right] - \frac{3t}{4n^2}$$

When the reserve value of cross-border e-commerce comprehensive pilot area is symmetry, namely $v_1 = v_2 = \cdots = v_n$, the endogenous value of the ith cross-border e-commerce comprehensive pilot area is: $\frac{v_i^2}{t} - \frac{3t}{4n^2}$.

See Appendix Part B for the proof of Lemma 2.1.

From Lemma 2.1 we can see that the endogenous value of the ith CBECPA can be divided into three parts: the first part $\frac{v_i^2+v_{i+1}^2+2v_{i+1}v_{i-1}}{4t}$ indicates the overall value of the $i-1$th, ith and $i+1$th CBECPAs, namely the agglomeration effect. The second part $\frac{v_i^2-v_{i+1}v_i}{4t} + \frac{v_i^2-v_iv_{i-1}}{4t} + \left(\frac{v_{i+1}^2-v_{i-1}^2}{8t} + \frac{v_{i+1}-v_{i-1}}{4n}\right)$ explains the cross competition relation among the three CBECPAs, namely the competition effect. The third part $-\frac{3t}{4n^2}$ explains the value loss cost by the spatial structure and the quantity of CBCEPAs, namely, the space structure effect. When $v_{i-1} = v_i = v_{i+1}$, the competition effect disappeared, and the endogenous value is decided by the agglomeration effect and the spatial effect. From the angle of reality, the most obvious area the cross-border e-commerce enterprise aggregated is the Yangtze River Delta region, and in this region there are four CBECPAs Hangzhou, Shanghai, Ningbo and Suzhou. 36.6% of the cross-border e-commerce enterprise of the whole country is located there. So the value of every CBECPA is correlated with the regional agglomeration effect, and there exist completions among the four CBECPAs. Hangzhou is currently in the leading position for it is the first CBECPA of the whole country. The existence of spatial effects enabled the area to accommodate four CBECPAs instead of merging into a single CBECPA.

Because $V_i = \begin{cases} V_{i-\max} & \text{if } I_i \geq V_{i-\max} \\ aI_i & \text{if } I_i < V_{i-\max} \end{cases}$, the best investment of cross-border e-commerce comprehensive pilot area is $I_i^* = V_{i-\max}$.

3. **The Cooperation Model.** Assume that each CBECPA can provide online information service and offline local service. At the same time we assume that utility is separable, i.e., the reservation utility of online services is v_{i-on}, the reservation utility of offline is v_{i-off}, and $v_i = v_{i-on} + v_{i-off}$. Unit mismatch cost of online service is $\frac{t}{2}$ unit mismatch cost of offline service is also $\frac{t}{2}$, and $t = \frac{t}{2} + \frac{t}{2}$. Without losing generality assume that $v_{i+1} > v_i > v_{i-1}$, the model is shown in Figure 3.

Based on the above assumptions we can build the following models.

(1) The utility when enterprises located between i and $i+1$ choose i as their operating location:

$$u_i = v_i - tx \tag{6}$$

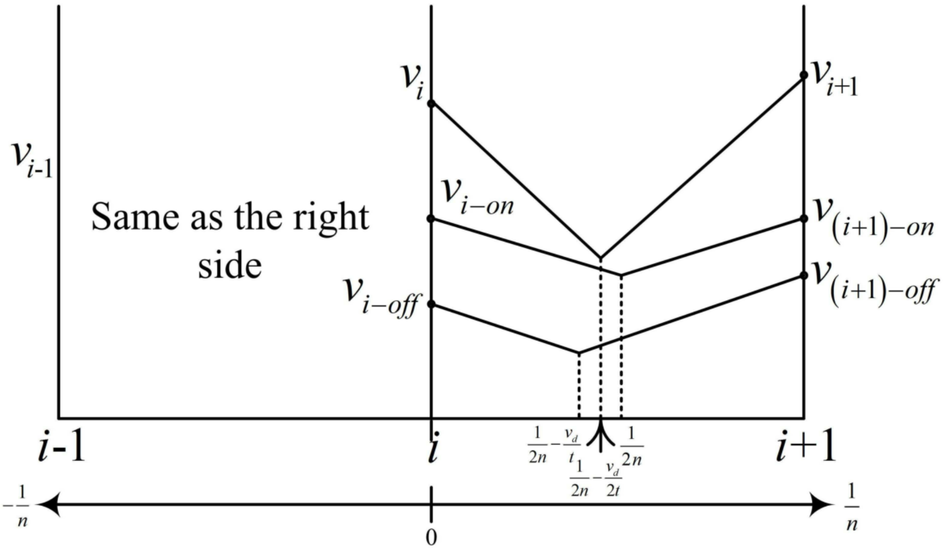

FIGURE 3. Equilibrium analysis of the cooperation model

(2) The utility when enterprises located between i and $i+1$ choose $i+1$ as their operating location:

$$u_{i+1} = v_{i+1} - t\left(\frac{1}{n} - x\right) \tag{7}$$

(3) The utility when enterprises located between i and $i+1$ choose i as their online operating location:

$$u_{i-on} = v_{i-on} - \frac{t}{2}x \tag{8}$$

(4) The utility when enterprises located between i and $i+1$ choose $i+1$ as their online operating location:

$$u_{(i+1)-on} = v_{(i+1)-on} - \frac{t}{2}\left(\frac{1}{n} - x\right) \tag{9}$$

(5) The utility when enterprises located between i and $i+1$ choose i as their offline operating location:

$$u_{i-off} = v_{i-off} - \frac{t}{2}x \tag{10}$$

(6) The utility when enterprises located between i and $i+1$ choose $i+1$ as their offline operating location:

$$u_{(i+1)-off} = v_{(i+1)-off} - \frac{t}{2}\left(\frac{1}{n} - x\right) \tag{11}$$

Solving the above model we can get Formulae (12) and (13):

$$\Delta U_i = -\frac{v_d^2}{8t} + \frac{v_i v_d}{2t} - \frac{v_{i-off} v_d}{t} \tag{12}$$

$$\Delta U_{(i+1)} = -\frac{v_d^2}{8t} - \frac{v_{i+1} v_d}{2t} + \frac{v_{(i+1)-off} v_d}{t} \tag{13}$$

See Appendix Part C for solution process.

According to Formulae (12) and (13) we can obtain Lemma 3.1 and Lemma 3.2.

Lemma 3.1. *When $v_d < 4\left(v_{i-on} - v_{i-off}\right)$ and $v_d \neq 0$, the cooperation of the ith CBECPA and the $i+1$th CBECPA can improve the enterprise's utility, so cooperation is a better choice for the ith CBECPA; when $v_d = 4\left(v_{i-on} - v_{i-off}\right)$ or $v_d = 0$, cooperation or nonco-operation is indifferent for the ith CBECPA; when $v_d > 4\left(v_{i-on} - v_{i-off}\right)$ and $v_d \neq 0$, the*

ith CBECPA chosen to cooperate with the $i+1$th CBECPA will reduce the enterprise's utility, so noncooperation is a better choice for the ith CBECPA.

See Appendix Part D for the proof of Lemma 3.1.

From Lemma 3.1 we can see that the ith CBECPA is in disadvantage, and comparatively its online service is more advantageous than its offline service. Only when its online service is a certain degree advantageous over its offline service, the cooperation of the ith and $i+1$th CBECPA is possible. That means the ith CBECPA can give up part of the offline service, in exchange for a part of the online service to increase its total service value.

Lemma 3.2. *When $v_d < 4\left(v_{(i+1)-off} - v_{(i+1)-on}\right)$ and $v_d \neq 0$, the cooperation of the ith CBECPA and the $i+1$th CBECPA can improve the enterprise's utility, so cooperation is a better choice for the $i+1$th CBECPA; when $v_d = 4\left(v_{(i+1)-off} - v_{(i+1)-on}\right)$ or $v_d = 0$, cooperation or noncooperation is indifferent for the $i+1$th CBECPA; when $v_d > 4\left(v_{(i+1)-off} - v_{(i+1)-on}\right)$ and $v_d \neq 0$, the $i+1$th CBECPA chosen to cooperate with the ith CBECPA will reduce the enterprise's utility, so noncooperation is a better choice for the $i+1$th CBECPA.*

See Appendix Part E for the proof of Lemma 3.2.

From Lemma 3.2 we can see that the $i+1$th CBECPA is in advantage, and comparatively its offline service is more advantageous than its online service. Only when its offline service is a certain degree advantageous over its online service, the cooperation of the $i+1$th and ith CBECPA is possible. That means the $i+1$th CBECPA can give up part of the online service, in exchange for a part of the offline service to increase its total service value.

The intuition of Lemma 3.1 and Lemma 3.2 is that: because the ith CBECPA is in a disadvantage situation, only when the online service utility is greater than the offline service utility and is greater than a certain value, i.e., $\frac{v_d}{4}$, the ith CBECPA can attract the enterprises between $\left[\frac{1}{2n} - \frac{v_d}{2t}, \frac{1}{2n}\right]$ from using the $i+1$th CBECPA's online service to use the ith CBECPA's online service, and cooperation is a better choice for the ith CBECPA. Because the $i+1$th CBECPA is in a dominant position, only when the offline service utility is greater than the online service utility and is greater than a certain value, i.e., $\frac{v_d}{4}$, the $i+1$th CBECPA can attract the enterprises between $\left[\frac{1}{2n} - \frac{v_d}{t}, \frac{1}{2n} - \frac{v_d}{2t}\right]$ from using the ith CBECPA's offline service to use the $i+1$th CBECPA's offline service, and cooperation is a better choice for the $i+1$th CBECPA.

Take Tianjin and Dalian as examples to explain the managerial implications of Lemma 3.1 and Lemma 3.2. Assuming form the angle of cross-border e-commerce that the endogenous value of Tianjin is greater than Dalian, two enterprises A and B in Qinhuangdao is ready to engage in cross-border business, two enterprises have implemented customs clearance in Dalian but their sales are in Beijing, Tianjin and Hebei province. An analysis of the situation of cooperation or non-cooperation between the two CBECPAs is as follows.

If Tianjin and Dalian do not cooperate with each other, for the total preferences A company chooses Dalian as its operating location, which means company A will use Dalian's online service and offline service at the same time. Similarly, for the total preferences B company chooses Tianjin as its operating location, which means company B will use Tianjin's online service and offline service at the same time.

If Tianjin and Dalian cooperate with each other, then, for A company, Dalian's offline services are at a disadvantage, so they will abandon Dalian's offline services and switch to using Tianjin's offline services. In this way, the Dalian will lose some of its offline services. Tianjin will get this part of offline service. For B company Dalian's online services are at an advantage, so they will abandon Tianjin's online services and switch to using Dalian's online services in this way, and the Dalian will get some of the online services. Tianjin will lose this part of online services.

Therefore, cooperation between the two cities will be realized as Dalian gives up some offline services, in exchange for some online services, while Tianjin gives up part of online services, in exchange for some of the offline services.

According to Lemma 3.1 and Lemma 3.2, we can get Corollary 3.1.

Corollary 3.1. *Only when $v_d < 4\left(v_{i-on} - v_{i-off}\right)$ and $v_d < 4\left(v_{(i+1)-off} - v_{(i+1)-on}\right)$, the cooperation between the ith and the $i+1$th CBECPAs can be realized.*

Corollary 3.1 means that cooperation can only be achieved when the relative comparative advantage is satisfied for both sides.

4. **The Optimal Number Model.** From the perspective of the central government, the cost of every approval for a cross-border e-commerce comprehensive pilot area is f. So the total utility for the central government is:

$$\overline{U} = \frac{\sum\limits_{i=1}^{n}(v_{i+1} - v_{i-1})}{4n} - \frac{3t}{4n} + \frac{\sum\limits_{i=1}^{n}\left(6v_i^2 + 3v_{i+1}^2 - v_{i-1}^2 + 4v_{i+1}v_{i-1} - 2v_{i+1}v_i - 2v_iv_{i-1}\right)}{8t} - nf$$

Suppose: $v_i \sim N\left(\bar{v}, \sigma^2\right)$, then:

$$\frac{\sum\limits_{i=1}^{n}\left(v_{i+1} - v_{i-1}\right)}{4n} = \frac{1}{4}\left(\frac{\sum\limits_{i=1}^{n} v_{i+1}}{n} - \frac{\sum\limits_{i=1}^{n} v_{i-1}}{n}\right) \approx 4\left(\bar{v} - \bar{v}\right) = 0$$

Then:

$$\overline{U} = -\frac{3t}{4n} + \frac{\sum\limits_{i=1}^{n}\left(6v_i^2 + 3v_{i+1}^2 - v_{i-1}^2 + 4v_{i+1}v_{i-1} - 2v_{i+1}v_i - 2v_iv_{i-1}\right)}{8t} - nf$$

The central government maximizes its own utility, let $\frac{\partial \overline{U}}{\partial n} = 0$, so:

$$\frac{3t}{4n^2} - f = 0$$

Solve it: $n = \sqrt{\frac{3t}{4f}}$.

Corollary 4.1. *The best quantity of cross-border e-commerce comprehensive pilot area is negatively related to the cost f.*

See Appendix Part F for the proof of Corollary 4.1.

Corollary 4.1 means when the government approves new CBECPA it should consider the approval cost. These costs include pre investment of applying for the CBECPA, government inspection and verification costs, the cost of non-cooperation between regions due to local protectionism. The higher the cost is, the less number of CBECPA should be approved.

Corollary 4.2. *The best quantity of the cross-border e-commerce comprehensive pilot area has positive correlation with the cost of mismatch t.*

See Appendix Part G for the proof of Corollary 4.2.

Corollary 4.2 means when the government approves new CBECPA it should consider the mismatch cost coefficient. When the mismatch cost coefficient is great, that means we need more CBECPAs to reduce the location mismatch. When the mismatch cost coefficient is small, we should reduce the number of CBECPA.

The intuition of Corollary 4.1 is when the approval cost f increases the utility of center government will decrease. The intuition of Corollary 4.2 is when mismatch cost t increases we need more CBECPAs to fit the cross-board e-commerce enterprises.

Take Hangzhou, Ningbo economic circle and Shenyang, Dalian economic circle as examples to explain the managerial implications of Corollary 4.1 and Corollary 4.2. The four cities have applied for the establishment of CBECPAs, both Hangzhou and Ningbo have passed the approval, while for Dalian and Shenyang only Dalian is ratified. First of all, there is furious competition and serious local protectionism between Shenyang and Dalian, resulting in high approval cost, so in this area only one CBECPA is approved. Hangzhou and Ningbo have strong economic complementarity; their cooperation degree is high, resulting in low approval cost, so the two cities are both approved as CBECPA. This is consistent with Corollary 4.1. Secondly, from the cross-border e-commerce point of view, the Shenyang and Dalian economic circles are mainly import cross-border e-commerce. Due to the development of modern logistics the mismatch cost coefficient is small so only one CBCEPA is approved. The Hangzhou and Ningbo economic circles are mainly export cross-border e-commerce. Export cross-border e-commerce needs to close to the production base, and the mismatch cost coefficient is larger; the two cities are both approved as CBECPAs. This is consistent with Corollary 4.2.

5. **Conclusion and Management Implication.** Based on the analysis of Salop spatial competition model, this paper draws the following conclusions.

(1) The endogenous value is affected by the agglomeration effect, the competition effect and the space structure effect. The agglomeration effect is $\frac{v_i^2+v_{i+1}^2+2v_{i+1}v_{i-1}}{4t}$, the competition effect is $\frac{v_i^2-v_{i+1}v_i}{4t}+\frac{v_i^2-v_iv_{i-1}}{4t}+\left(\frac{v_{i+1}^2-v_{i-1}^2}{8t}+\frac{v_{i+1}-v_{i-1}}{4n}\right)$, and the space structure effect is $-\frac{3t}{4n^2}$. That means a CBECPA's endogenous value is not only determined by its own economic size location etc. but also affected by the agglomeration effect, the competition effect and the space structure effect. And the best investment should be equal to the endogenous value.

(2) Only when $v_d < 4\left(v_{i-on} - v_{i-off}\right)$ and $v_d < 4\left(v_{(i+1)-off} - v_{(i+1)-on}\right)$, the cooperation between CBECPAs can be realized. That means cooperation can only be achieved when the relative comparative advantage is satisfied for both sides.

(3) The best quantity of cross-border e-commerce comprehensive pilot area is negatively related to the cost f. The best quantity of the cross-border e-commerce comprehensive pilot area has positive correlation with the cost of mismatch t. That means when the government approves new CBECPA, it should not only consider the approval cost but also the mismatch cost coefficient.

This suggests that the cross-border e-commerce comprehensive pilot area should invest according to their endogenous value, the CBECPAs should chose cooperation strategy according to different situation and when the government determines the quantity of the comprehensive pilot areas, they should consider the cost of the approval of a cross-border e-commerce comprehensive pilot area, the reserve value of cross-border e-commerce of the city and the traffic between the economic hinterland to the city, the user's preferences and other factors.

Future research: this paper also has some limitations, for example: (1) this model is a theoretical model, which need empirical test; (2) some assumptions are to some extent strong, and the author will take further research from this two aspects in the future.

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Appendix.

A. Solution process of the investment model

First of all, calculate the indifference point $\widehat{x}_1$ of the enterprises located between $i-1$ and i choosing $i-1$ or i as their operating location.

Let Formula (1) equal Formula (2):

$$v_i - t(-x) = v_{i-1} - t\left(\frac{1}{n} + x\right)$$

Solve the equation:

$$\widehat{x}_1 = -\frac{1}{2n} - \frac{v_i - v_{i-1}}{2t}$$

Second, calculate the indifference point $\widehat{x}_2$ of the enterprises located between i and $i+1$ choosing i or $i+1$ as their operating location.

Let Formula (3) equal Formula (4):

$$v_i - tx = v_{i+1} - t\left(\frac{1}{n} - x\right)$$

Solve the equation:

$$\widehat{x}_2 = \frac{1}{2n} - \frac{v_{i+1} - v_i}{2t}$$

At last, suppose there is no CBECPA on location L_i, calculate the indifference point x^* of the enterprises located between $i-1$ and $i+1$ choosing $i-1$ or $i+1$ as their operating location:

$$v_{i-1} - t\left(\frac{1}{n} + x\right) = v_{i+1} - t\left(\frac{1}{n} - x\right)$$

Solve the equation:

$$x^* = \frac{1}{n} - \frac{v_{i+1} - v_{i-1}}{2t}$$

B. Proof of Lemma 2.1.

Proof: The first half of Lemma 2.1 can be obtained directly from Formula (5).

For the second part of Lemma 2.1, let $v_{i-1} = v_{i+1} = v_i$, and substitute them into Formula (5):

$$V_i = \frac{v_i - v_i}{4n} - \frac{3t}{4n^2} + \frac{6v_i^2 + 3v_i^2 - v_i^2 + 4v_i^2 - 2v_i^2 - 2v_i^2}{8t} = \frac{v_i^2}{t} - \frac{3t}{4n^2}$$

□

C. Solution process of the cooperation model

When the ith CBECPA and the $i+1$th CBECPA do not cooperate, let x^{**} be the indifference point when enterprises located between i and $i+1$ choose i or $i+1$ as their operating location, then:

$$u_i = u_{i+1}$$

$$v_i - tx = v_{i+1} - t\left(\frac{1}{n} - x\right)$$

Solve it, then:

$$x^{**} = \frac{1}{2n} - \frac{v_{i+1} - v_i}{2t}$$

Let $v_d = v_{i+1} - v_i$, then:

$$x^{**} = \frac{1}{2n} - \frac{v_d}{2t}$$

That means the enterprises between $\left[0, \frac{1}{2n} - \frac{v_d}{2t}\right]$ will choose i as their operation location, and the enterprises between $\left[\frac{1}{2n} - \frac{v_d}{2t}, \frac{1}{n}\right]$ will choose $i+1$ as their operation location.

When the ith CBECPA and the $i+1$th CBECPA do cooperate, for enterprises the online operation location and the offline operation location can be decided separately, which means the enterprises can choose their online operation location according to preference, and the enterprises also can choose their offline operation location according to preference.

For the online operation location, let x_{on}^* be the indifference point when enterprises located between i and $i+1$ choose i or $i+1$ as their online operating location, then:

$$u_{i-on} = u_{(i+1)-on}$$

$$v_{i-on} - \frac{t}{2}x = v_{(i+1)-on} - \frac{t}{2}\left(\frac{1}{n} - x\right)$$

$$x_{on}^* = \frac{1}{2n} - \frac{v_{(i+1)-on} - v_{i-on}}{t}$$

As the cross-border e-commerce online information service is mainly reflected in the "single window" service, while the "single window" service of every CBECPA is a copy of the Hangzhou experience, we assume that the reservation utilities of online services of each CBECPA are equal, so $v_{i-on} = v_{(i+1)-on}$ that is:

$$x^*_{on} = \frac{1}{2n}$$

For the offline operation location, let x^*_{off} be the indifference point when enterprises located between i and $i+1$ choose i or $i+1$ as their offline operating location, then:

$$u_{i-off} = u_{(i+1)-off}$$

$$v_{i-off} - \frac{t}{2}x = v_{(i+1)-off} - \frac{t}{2}\left(\frac{1}{n} - x\right)$$

$$x^*_{off} = \frac{1}{2n} - \frac{v_{(i+1)-off} - v_{i-off}}{t}$$

Because $v_i = v_{i-on} + v_{i-off}$, $v_{i+1} = v_{(i+1)-on} + v_{(i+1)-off}$ and $v_{i-on} = v_{(i+1)-on}$, $v_{(i+1)-off} - v_{i-off} = v_{i+1} - v_i = v_d$. So:

$$x^*_{off} = \frac{1}{2n} - \frac{v_d}{t}$$

Under the condition of noncooperation, the total utility of all the enterprises which choose the ith CBECPA as their operation location is:

$$U_{i-NC} = \int_0^{\frac{1}{2n} - \frac{v_d}{2t}} (v_i - tx)\, dx$$

$$U_{i-NC} = v_i\left(\frac{1}{2n} - \frac{v_d}{2t}\right) - \frac{t}{2}\left(\frac{1}{2n} - \frac{v_d}{2t}\right)^2$$

$$U_{i-NC} = \frac{v_i}{2n} - \frac{v_i v_d}{2t} - \frac{t}{8n^2} - \frac{v_d^2}{8t} + \frac{v_d}{4n}$$

Under the condition of noncooperation, the total utility of all the enterprises which choose the $i+1$th CBECPA as their operation location is:

$$U_{(i+1)-NC} = \int_{\frac{1}{2n} - \frac{v_d}{2t}}^{\frac{1}{n}} \left[v_{i+1} - t\left(\frac{1}{n} - x\right)\right] dx$$

$$U_{(i+1)-NC} = \frac{v_{i+1}}{2n} + \frac{t}{n^2} + \frac{v_{i+1} v_d}{2t} - \frac{v_d}{4n} - \frac{t}{8n^2} - \frac{v_d^2}{8t}$$

Under the condition of cooperation, the total utility of all the enterprises which choose the ith CBECPA as their operation location is:

$$U_{i-C} = U_{i-C-on} + U_{i-C-off}$$

Here:

$$U_{i-C-on} = \int_0^{\frac{1}{2n}} \left(v_{i-on} - \frac{t}{2}x\right) dx$$

$$U_{i-C-on} = \frac{v_{i-on}}{2n} - \frac{t}{16n^2}$$

$$U_{i-C-off} = \int_0^{\frac{1}{2n} - \frac{v_d}{t}} \left(v_i - \frac{t}{2}x\right) dx$$

$$U_{i-C-off} = \frac{v_{i-off}}{2n} - \frac{v_{i-off} v_d}{t} - \frac{t}{16n^2} - \frac{v_d^2}{4t} + \frac{v_d}{4n}$$

so:

$$U_{i-C} = \frac{v_i}{2n} - \frac{v_{i-off} v_d}{t} - \frac{t}{8n^2} - \frac{v_d^2}{4t} + \frac{v_d}{4n}$$

Under the condition of cooperation, the total utility of all the enterprises which choose the $i+1$th CBECPA as their operation location is:

$$U_{(i+1)-C} = U_{(i+1)-C-on} + U_{(i+1)-C-off}$$

Here:

$$U_{(i+1)-C-on} = \int_{\frac{1}{2n}}^{\frac{1}{n}} \left[v_{(i+1)-on} - \frac{t}{2}\left(\frac{1}{n} - x\right)\right] dx$$

$$U_{(i+1)-C-on} = \frac{v_{(i+1)-on}}{2n} - \frac{t}{16n^2}$$

$$U_{(i+1)-C-off} = \int_{\frac{1}{2n}-\frac{v_d}{t}}^{\frac{1}{n}} \left[v_{(i+1)-off} - \frac{t}{2}\left(\frac{1}{n} - x\right)\right] dx$$

$$U_{(i+1)-C-off} = \frac{v_{(i+1)-off}}{2n} + \frac{v_{(i+1)-off}\,v_d}{t} - \frac{v_d}{4n} - \frac{v_d^2}{4t} - \frac{t}{16n^2}$$

so:

$$U_{(i+1)-C} = \frac{v_{i+1}}{2n} + \frac{v_{(i+1)-off}\,v_d}{t} - \frac{v_d}{4n} - \frac{v_d^2}{4t} - \frac{t}{8n^2}$$

Let $\Delta U_i = U_{i-C} - U_{i-NC}$, then:

$$\Delta U_i = \left[\frac{v_i}{2n} - \frac{v_{i-off}\,v_d}{t} - \frac{t}{8n^2} - \frac{v_d^2}{4t} + \frac{v_d}{4n}\right] - \left[\frac{v_i}{2n} - \frac{v_i v_d}{2t} - \frac{t}{8n^2} - \frac{v_d^2}{8t} + \frac{v_d}{4n}\right]$$

so:

$$\Delta U_i = -\frac{v_d^2}{8t} + \frac{v_i v_d}{2t} - \frac{v_{i-off}\,v_d}{t} \tag{12}$$

Let $\Delta U_{(i+1)} = U_{(i+1)-C} - U_{(i+1)-NC}$, then:

$$\Delta U_{(i+1)} = \left(\frac{v_{i+1}}{2n} + \frac{v_{(i+1)-off}\,v_d}{t} - \frac{v_d}{4n} - \frac{v_d^2}{4t} - \frac{t}{8n^2}\right) - \left(\frac{v_{i+1}}{2n} + \frac{v_{i+1} v_d}{2t} - \frac{v_d}{4n} - \frac{v_d^2}{8t} - \frac{t}{8n^2}\right)$$

so:

$$\Delta U_{(i+1)} = -\frac{v_d^2}{8t} - \frac{v_{i+1} v_d}{2t} + \frac{v_{(i+1)-off}\,v_d}{t} \tag{13}$$

D. Proof of Lemma 3.1

Let $\Delta U_i > 0$, then:

$$-\frac{v_d^2}{8t} + \frac{v_i v_d}{2t} - \frac{v_{i-off}\,v_d}{t} > 0$$
$$v_d^2 < 4v_i v_d - 8v_{i-off}\,v_d$$

According to assumption, $v_d > 0$, so:

$$v_d < 4v_i - 8v_{i-off}$$

because, $v_i = v_{i-on} + v_{i-off}$,

$$v_d < 4\left(v_{i-on} - v_{i-off}\right)$$

Then $\Delta U_i = U_{i-C} - U_{i-NC} > 0$, cooperation is a better choice for the ith CBECPA; otherwise, noncooperation is a better choice for the ith CBECPA. □

E. Proof of Lemma 3.2

Let $\Delta U_{(i+1)} > 0$, then:

$$-\frac{v_d^2}{8t} - \frac{v_{i+1} v_d}{2t} + \frac{v_{(i+1)-off}\,v_d}{t} > 0$$
$$v_d^2 < -4v_{(i+1)} v_d + 8v_{(i+1)-off}\,v_d$$

According to assumption, $v_d > 0$, so:

$$v_d < -4v_{(i+1)} + 8v_{(i+1)-off}$$

because: $v_{i+1} = v_{(i+1)-on} + v_{(i+1)-off}$,

$$v_d < 4\left(v_{(i+1)-off} - v_{(i+1)-on}\right)$$

Then $\Delta U_{(i+1)} = U_{(i+1)-C} - U_{(i+1)-NC} > 0$, cooperation is a better choice for the $i+1$th CBECPA; otherwise, noncooperation is a better choice for the $i+1$th CBECPA. □

F. Proof of Corollary 4.1

Because n and n^2 have the same monotonicity, we test the relationship between n^2 and f.

$$n^2 = \frac{3t}{4f}$$

So:

$$\frac{\partial n^2}{\partial f} = -\frac{3t}{4f^2} < 0$$

□

G. Proof of Corollary 4.2

Because n and n^2 have the same monotonicity, we test the relationship between n^2 and i.

$$n^2 = \frac{3t}{4f}$$

So:

$$\frac{\partial n^2}{\partial t} = \frac{3}{4f}$$

Because: $f > 0$,

$$\frac{\partial n^2}{\partial t} > 0$$

□