Applied research on the coexistence relationship between Tianjin Port and inland transportation system based on population ecology model

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Abstract: - First, this article takes container throughput of Tianjin Port as an example to estimate the future port scale by using genetic algorithms. Then this article applies BP neural network to compare the advantages and disadvantages of Tianjin Port and its competitors by analyzing the data of listed port companies. Finally, this article does some research on the coexistence relationship between port and transportation. The results show that Tianjin Port's scale is beyond the inflection point of Growth curve, its speed of development will slow down. High administration cost and the lag of inland transportation construction are two major factors which constrain Tianjin Port's development. After coexistence relationship analysis we find that the develop speeds of port and inland transportation should reach a reasonable proportion to remain symbiotic relationships.

Key-Words: - port, population ecology model, genetic algorithms, BP neural network, inherent complexities, mathmatics

1 Introduction

Port plays a very important role in national economy. The size of port scale and the economy development are closely related. Gao Qin applied improved population ecology model to analyze the relationship of co-opetition between Container Terminal Companies and stress on the importance of cooperation among competition [1]. Yang Wenzhi established a co-opetition model of ports in one group, and he got equilibrium condition which can achieve a win-win situation for every port after stability analysis [2]. Chen Tingting applied BP neural network to forecast the throughput of Nanjing port and her network model was really convincing [3]. Liao Lixin did some research on the container dispatching management by using genetic algorithms and focused on getting optimum result of dispatching problems [4]. Yang Bo proposed a modified approach which combined muti-factor dynamic product coefficients method and logistic model, and then he applied it to long term container prediction [5]. Mats Gyllenberg found a new equilibrium condition after analyzing the limit cycles for competitor–competitor–mutualist Lotka–Volterra systems [6]. Xinze Lian introduced the method of Automatic search to the research on finding multiple limit cycles in three-dimensional Lotka–Volterra competitive systems [7]. Based on the combination and improvement of genetic algorithms, population ecology model and BP neural network, this article do some deep researches on port scale prediction and the coexistence relationship of port and transportation.

2 The estimate of Tianjin port future scale

2.1 The similarities between ports and population

There are many similarities between ports and animal population: first, their existence conditions are similar, animal population live in some certain natural conditions and the development of ports also depends on channel depth, location, hinterland and so on; second, their development trajectories are similar, most animal population's trajectory likes "S" and the process of port also includes its slow start, fast development and bottleneck period; third, both of them have competitors, one port's development is often accompanying challenges from other ports which are in the same area.

2.2 Data source and analysis

The common standard which is used to compare the scale of a port is container throughput. The data of this article comes from Financial Statements of Tianjin Port Holdings Co., Ltd. We take the container throughput of first quarter of 2001 as the first study object.

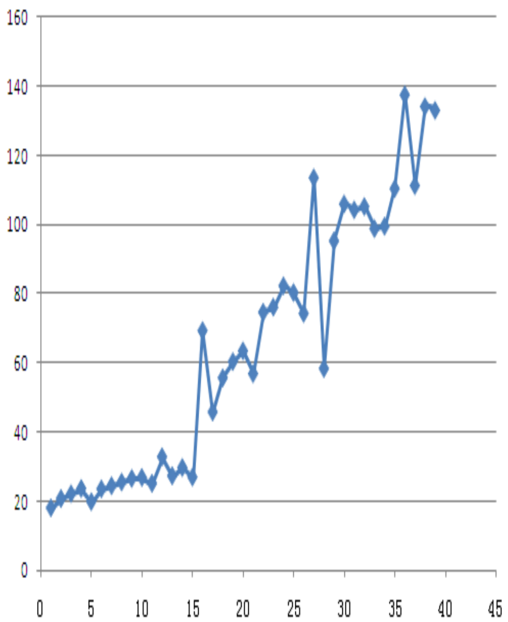

Fig 1: The scatter diagram of container throughput since the first quarter of 2001

From figure 1 we can get that the throughput has seasonal fluctuation, so we take seasonal model and moving average to modify the original data.

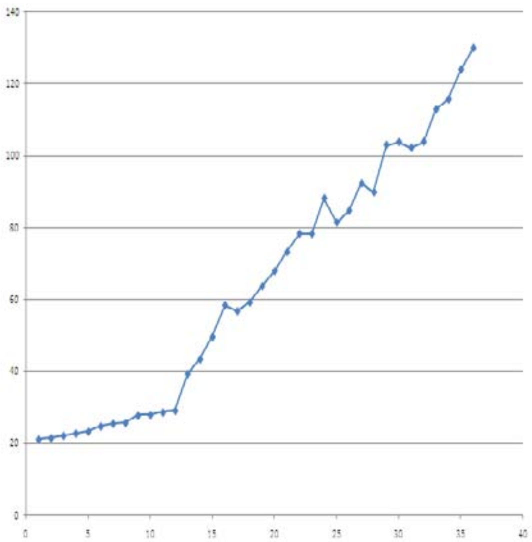

Fig 2: The scatter diagram of modified data

From figure 2 we can get that the development trajectory of Tianjin port's throughput is like "J" or "S". So this article applies Logistic growth model to predict Tianjin port's scale.

2.3 The construction of model

Logistic growth model:

$$\frac{dN}{dt} = rN(1-\frac{N}{K}) \qquad (1)$$

N means throughput, r means the fastest growth rate, K means the superior limit of throughput and T represents time.

This article makes some change of the original model:

$$\begin{aligned} &\frac{K}{N(K-N)}dN = rdt \rightarrow \\ &\ln\frac{N}{K-N} = rt - C \rightarrow \\ &N = \frac{K}{1+e^{-rt+C}} \rightarrow \\ &\frac{1}{N} = \frac{1}{K} + \frac{e^C \cdot e^{-rt}}{K} \end{aligned} \qquad (2)$$

Here we use some new symbols to make formula simple.

So $Y = \frac{1}{N}$, $a = e^C$, $X = e^{-t}$, $m = 1 - \frac{1}{K}$, $a = \frac{K}{N_0} - 1$, N_0 means the initial number of throughput.

Because of the lack of data, we cannot know N_0. Here we suppose N_0 is 1, so $a = K - 1$. Finally, we get the model changed: $Y = mX^r + 1 - m$.

2.4 The results

This article applies genetic algorithms to fit the changed Logistic growth model. M's range is 0.993-0.9995, and r's range is 0-10000, we use Euclidean distance to calculate the error.

The result is that m=0.996, r=0.24, the error is 0.01 and k=250.

Table 1: Original data

Y	X
0.047197	0.049787068
0.046335	0.018315639
0.044944	0.006737947
0.043754	0.002478752
0.042781	0.000911882
0.040256	0.000335463
0.039019	0.00012341
0.038741	4.53999E-05
0.035889	1.67017E-05
0.035665	6.14421E-06
0.034806	2.26033E-06
0.034242	8.31529E-07
0.02536	3.05902E-07
0.022998	1.12535E-07
0.020127	4.13994E-08
0.017094	1.523E-08
0.01759	5.6028E-09
0.016869	2.06115E-09
0.015671	7.58256E-10
0.014713	2.78947E-10
0.013652	1.02619E-10
0.012755	3.77513E-11
0.012768	1.38879E-11
0.011339	5.10909E-12
0.012271	1.87953E-12
0.011796	6.9144E-13
0.01083	2.54367E-13
0.011125	9.35762E-14
0.009707	3.44248E-14
0.009635	1.26642E-14
0.00978	4.65889E-15
0.009628	1.71391E-15
0.008856	6.30512E-16
0.008647	2.31952E-16
0.008069	8.53305E-17
0.007698	3.13913E-17

In order to make the better results, considered that the first several group of data has more volatility, we did not include these data.

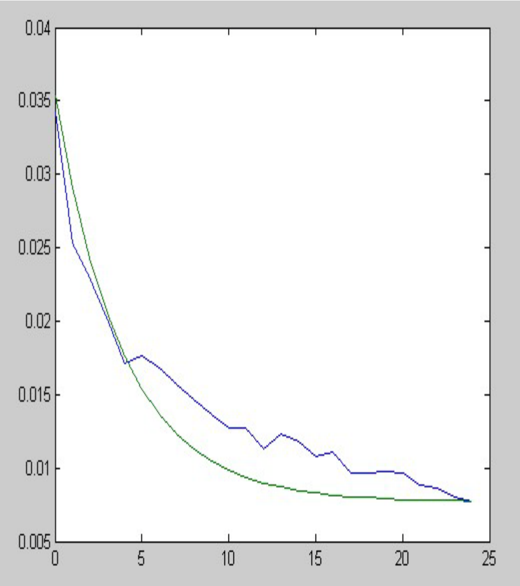

Fig 3: Fitting figure from Matlab

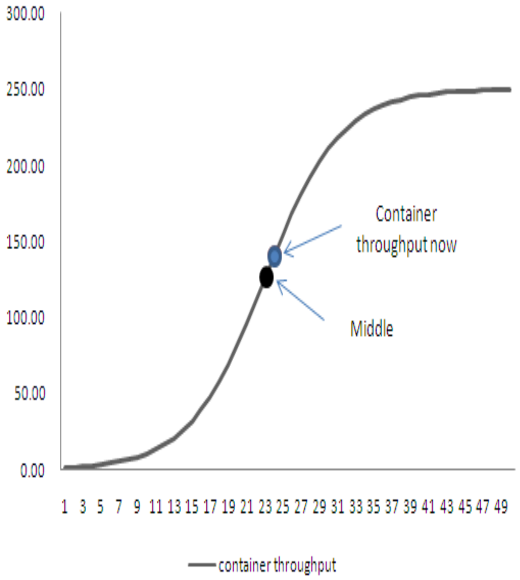

Fig 4: the logistic curve of container throughput of Tianjin port

The error is in the allowable range, so the result of simulation is also accpectable. In the fig 4, the blcak dot represents the inflection point of Growth curve and the other dot represents present situation. The results show that the superior limit of container throughput of Tianjin port is 250, and now its throughput has beyond the inflection point of Growth curve. In the next years, the throughput of Tianjin port will still maintain high speed to develop, but its speed will slow down. It is also said that the container throughput of Tianjin port will reach the superior limit in 10 years. The way to increase the future throughput is to change current circumstances such as deepening the channel, speeding up the construction of inland transportation and so on.

3 Competitive analysis of ports based on neural network

3.1 Competitive relationships between ports

In general port competition ability is high or low not only depends on its own management ability but also the quantity and quality of its competitors. We can find out strengths and weaknesses of Tianjin port after analyzing main competitors' management level, business efficiency, operating risk, earning capacity, inland transportation construction and natural conditions.

3.2 Data analysis

Samples are from 15 Chinese port enterprises which are going public. The data comes from Enterprise's Financial Statements of 2010 and some statistical yearbooks. This article targets 7 indexes as input indexes which are administration expense, Assets Liabilities Ratio, current ratio, net profit, city's GDP, highway mileage of province and channel depth. And the output index is container throughput. The differences between indexes are very big, in order to make caculation more accurate we do some change to original data. The samples are normalized and then the normalized samples are used to train neural network.

This article takes 12 sets of data to train and 8 of sets to test, Set up a BP neural network which has 10 input nodes, 15 hidden nodes and 1 output node and target error is 1e-10.

Table 2: Normalized data (first four indexes)

NO.	net profit	administration expense	Assets Liabilities Ratio	current ratio
A	0.133	0.052	0.112	0.029
B	0.007	0.000	1.000	0.055
C	0.017	0.041	0.122	0.060
D	0.049	0.034	0.105	0.041
E	0.011	0.047	0.212	0.046
F	0.043	0.063	0.206	0.015
G	0.000	0.005	0.107	0.052
H	0.005	0.008	0.105	0.000
I	0.079	0.025	0.133	0.031
J	1.000	1.000	0.116	0.047
K	0.061	0.101	0.122	0.130
L	0.073	0.011	0.000	1.000
M	0.096	0.075	0.142	0.050
N	0.018	0.089	0.123	0.025

Table 2: Normalized data (second four indexes)

NO.	city's GDP	highway mileage	channel depth	container throughput
A	0.628	1.000	0.362	0.209
B	0.000	0.329	0.557	0.114
C	0.084	0.375	0.698	0.194
D	0.035	0.561	0.631	0.020
E	0.517	0.304	0.000	0.010
F	0.042	0.561	0.497	0.093
G	0.049	0.523	0.295	0.000
H	0.260	0.809	0.396	0.042
I	0.044	0.864	0.329	0.031
J	1.000	0.000	0.758	1.000
K	0.269	0.870	0.349	0.004
L	0.628	1.000	0.732	0.121
M	0.328	0.561	0.362	0.174
N	0.052	0.809	0.698	0.134

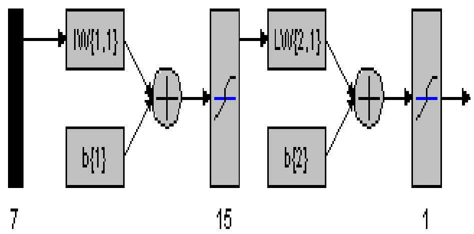

Fig 5: the structure of network

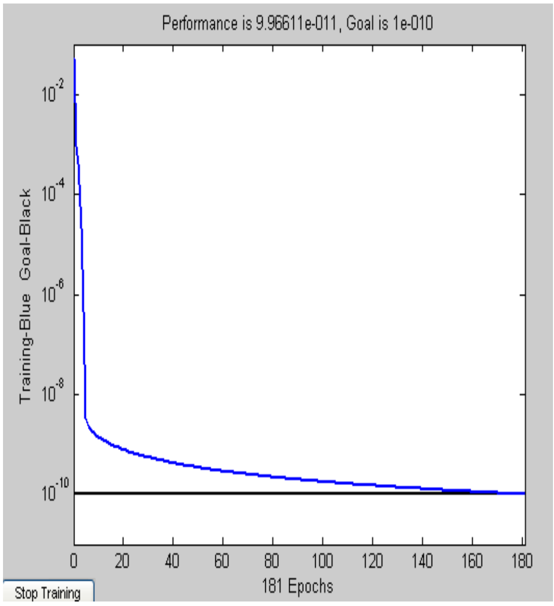

Fig 6: The training of network

From Fig 6 we can see that the result of training and simulation is acceptable.

Table 3: Train results

	A	B	C
Expected output	0.2091	0.1145	0.1936
Training results	0.2090	0.1141	0.1942
Error percentage	-0.06%	-0.31%	0.30%
	G	H	I
Expected output	0.0000	0.0425	0.0309
Training results	0.0000	0.0420	0.0310
Error percentage	0.20%	-1.17%	0.42%
	D	E	F
Expected output	0.0196	0.0105	0.0928
Training results	0.0199	0.0100	0.0930
Error percentage	1.74%	-4.83%	0.24%
	J	K	L
Expected output	1.0000	0.0039	0.1211
Training results	0.9999	0.0040	0.1210
Error percentage	-0.01%	2.56%	-0.10%

Table 4: Test results

	M	N
Expected output	0.174	0.134
Training results	0.17372	0.13431
Error percentage	0.06%	0.60%

From the results we can get that the biggest error percentage between training results and expected output is 4.83%. This is also to say the training of BP neural network is successful.

Then we put corresponding data of Tianjin port into this model and the final output is 0.19563. The actual container throughput data which is normalized is 0.1733. The error percentage is 12.92% which is a little big.

3.3 The results and analysis

The result shows that there should be more container throughput for Tianjin port under the existing conditions. Such difference tells that Tianjin port didn't do well in resource utilization and operation. We applied Radar Chart to find out Tianjin port's advantages and disadvantages.

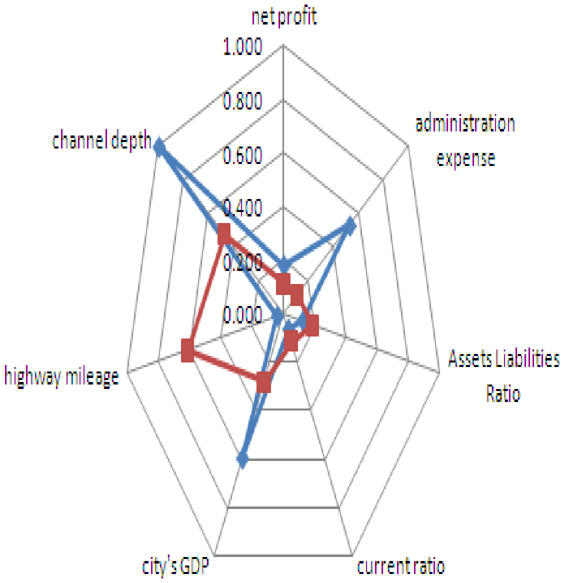

Fig 7: Radar Chart

The blue line represents the data of tianjin port and the red line represents the average data of other ports. We can discover some differences between this comparsion. From this figure we can get high administration cost and the lag of inland transportation construction are two major factors which constrain Tianjin Port's development. The problem of administration expense need to do some deep work to sovle it such as research on financial report, make questionares and many other things. It belongs to internal problem, here we foucus on the external problem. Inland transportation construction is the biggest problem and we will find their relationship between inland transportation and container throughput.

4 The coexistence relationship of port and inland transportation

4.1 The relationship between port and inland transportation construction

A port cannot develops without inland transportation and the traffic demand from port will also make transport system develops faster. There are obvious coexistence relationships between them. But such relationship is not strong. If the development of inland transport system is unable to keep pace of the speed of port's expansion, it will inhibit port's growth. Otherwise, both of them will develop fast.

This article use container throughput to represent the scale of Tianjin port and use the city's highway mileage to represent the level of inland transport system.

4.2 Model Establishment

The model this article used is:

$$\begin{cases} \frac{dN_1}{dt} = -\frac{r_1}{K_1}N_1^2 + \frac{\mu r_1}{K_2}N_1N_2 + \varepsilon r_1 N_1 \\ \frac{dN_2}{dt} = -\frac{r_2}{K_2}N_2^2 + \frac{\nu r_2}{K_2}N_1N_2 + \eta r_2 N_2 \end{cases} \quad (3)$$

Ordinary, inland transport system plays a more important role, so the influence which the transport system has on port is much greater. So here we suppose $\mu > \nu$. To make this difference much clearer, we suppose $0 < \nu < 1$ and whether μ is more than 1 or less than 1 depends on their relationships. ε and η are referred to other factors which can affect this model. N_1 means container throughput and N_2 means highway mileage. N_1^* means the optimal container throughput and so does N_2^*. r_2 means container throughput's fastest growth rate, r_2 means highway mileage's fastest growth rate, K_1 , K_2 means the superior limit of throughput and highway mileage.

Ecah of container throughput and highway mileage will be affected by other factors. And it is also ture that other factors really play important role which can not be ignored. So we suppose $2 < \varepsilon < \eta$.

Here suppose: $r_1 > 0$, $r_2 > 0$, $2 < \varepsilon < \eta$, $0 < \nu < 1$. $\begin{cases} \mu > 1, N_2^* \geq lN_1^* \\ \mu < 1, N_2^* < lN_1^* \end{cases}$. l is just a constant, and we also suppose that if $N_2^* \geq lN_1^*$, then $0 < \nu < 1,\ \ 2 < \varepsilon < \eta < \mu + 1$.

4.3 Model analysis

From the model we can get that the key of solving this problem is how to keep $\mu > 1$. When $\frac{dN_1}{dt} = 0, \frac{dN_2}{dt} = 0$, this model achieves balanced status.

$$\begin{cases} \frac{dN_1}{dt} = 0 \\ \frac{dN_2}{dt} = 0 \end{cases} \Rightarrow$$

$$\begin{cases} -\frac{r_1}{K_1}N_1^2 + \frac{\mu r_1}{K_2}N_1N_2 + \varepsilon r_1 N_1 = 0 \\ -\frac{r_2}{K_2}N_2^2 + \frac{\nu r_2}{K_2}N_1N_2 + \eta r_2 N_2 = 0 \end{cases} \quad (4)$$

we can get four balance points after solving system of equations:

$$E_1 = (0,0), E_2 = (0,\ \ K_2\eta), E_3 = (K_1\varepsilon, 0),$$
$$E_4 = (\frac{\mu\eta + \varepsilon}{1 - \mu\nu}K_1, \frac{\beta\varepsilon + \eta}{1 - \mu\nu}K_2) \quad (5)$$

The first three points are lack of possibility of equilibrium, so we just consider about the equilibrium condition of the forth point which is

$$\begin{cases} \mu\nu < 1 \\ \mu > \frac{-\varepsilon}{\eta} \\ \nu > \frac{-\eta}{\varepsilon} \end{cases} \text{ or } \begin{cases} \mu\nu > 1 \\ \mu < \frac{-\varepsilon}{\eta} \\ \nu < \frac{-\eta}{\varepsilon} \end{cases} \quad (6)$$

We have already supposed that $0 < \nu < 1,\ \ 2 < \varepsilon < \eta < \mu + 1$. So the equilibrium condition of E_4 is $\mu\nu < 1$. But E_4 should also meet the condition of $N_2^* \geq lN_1^*$, so another equilibrium condition of E_4 is :

$$(\mu\eta + \varepsilon)lK_1 \leq (\nu\varepsilon + \eta)K_2 \quad (7)$$

From the analysis we can find that $N_1^* > K_1$ and $N_2^* > K_2$. That is also to say, when $N_2^* \geq lN_1^*$, both container throughput and highway mileage develops fast and their optimal value exceed the limits, their relationship can called mutualism.

4.3 stability analysis

If a balance point has good stability, we can consider that the state at this point is the final stable state, so we need to judge the stability of E_4. If all of the characteristic value of Jacobian matrix are negative, we call such point has good stability.

The Jacobian matrix of E_4 is :

$$\begin{pmatrix} -\frac{2r_1}{K_1}N_1^* + \frac{\mu r_1}{K_2}N_2^* + \varepsilon r_1, & \frac{\mu r_1}{K_2}N_1^* \\ \frac{\nu r_2}{K_1}N_2^*, & -\frac{2r_2}{K_2}N_2^* + \frac{\nu r_1}{K_1}N_1^* + \eta r_2 \end{pmatrix} \quad (8)$$

Its characteristic equation is:

$$\lambda^2 - (A+D)\lambda + AD - BC = 0 \quad (9)$$

Here: $A = -\frac{2r_1}{K_1}N_1^* + \frac{\mu r_1}{K_2}N_2^* + \varepsilon r_1$,

$B = \frac{\mu r_1}{K_2}N_1^*, C = \frac{\nu r_2}{K_1}N_2^*$,

$D = -\frac{2r_2}{K_2}N_2^* + \frac{\beta r_1}{K_1}N_1^* + \eta r_2$

Obviously, if $A + D < 0, AD - BC > 0$ then all of characteristic value are negative.

Because $(\mu\eta + \varepsilon)lK_1 \le (\nu\varepsilon + \eta)K_2$, we can get:

$$\begin{aligned} -(A+D) &= \frac{(\varepsilon + \mu\eta)r_1 + (\eta + \nu\varepsilon)r_2}{1-\mu\nu} \\ &\ge (\frac{lK_1}{K_2}r_2 + r_1)\frac{(\mu\eta+\varepsilon)}{1-\mu\nu} \\ &= (\frac{lK_1}{K_2}r_2 + r_1)\frac{N_1^*}{K_1} > 0 \end{aligned} \quad (10)$$

So we can make sure that $A + D < 0$.

Here meets the first balance condition. Then we consider the second condition, if the second condition is also meted. We can say E_4 is stable. In the process of judging its stability, we may also get something very useful.

$$\begin{cases} (\mu\eta+\varepsilon)lK_1 \le (\nu\varepsilon+\eta)K_2 \\ 2 < \varepsilon < \eta \end{cases} \Rightarrow$$

$$\mu \le \frac{K_2}{lK_1}(1 + \frac{\varepsilon}{\eta}\nu) - \frac{\varepsilon}{\eta} \Rightarrow$$

$$\mu < \frac{K_2}{lK_1}(1+\nu) \quad (11)$$

After analysis of $A + D$, we will analyze whether $AD - BC$ is more than 0 or not.

$$\begin{aligned} &AD - BC \\ &= \frac{\nu\varepsilon^2(1-\mu\nu) + \varepsilon\eta(1-\mu^2\nu^2) +}{(1-\mu\nu)^2} \\ &= \frac{\mu[(\eta-1)^2 + (\eta-1) - 3 - 4(\eta-1)\nu]}{(1-\mu\nu)^2} \\ &\quad - \frac{(\eta + (\eta-1)^2)\mu\nu}{(1-\mu\nu)^2} \end{aligned} \quad (12)$$

Because $\eta < \mu + 1, \mu\nu < 1$,

$$AD - BC > \frac{\nu\varepsilon^2(1-\mu\nu) + \varepsilon\eta(1-\mu^2\nu^2) - 8\mu}{(1-\mu\nu)^2} \quad (13)$$

We apply $\mu < \frac{K_2}{lK_1}(1+\nu)$ to $AD - BC$, then we get:

$$\begin{aligned} &(1-\mu\nu)^2(AD-BC) \\ &> -\frac{K_2^2}{l^2K_1^2}\varepsilon\eta\nu^4 \\ &- \left[\frac{2K_2^2}{l^2K_1^2}\varepsilon\eta + \frac{K_2}{lK_1}\eta^2\right]\nu^3 \\ &- \left[\frac{K_2}{lK_1}\varepsilon^2 + \frac{K_2^2}{l^2K_1^2}\varepsilon\eta\right]\nu^2 \\ &+ \left[\varepsilon^2 - \frac{8K_2}{lK_1}\right]\nu \\ &+ \varepsilon\eta - \frac{8K_2}{lK_1} \end{aligned} \quad (14)$$

Here we use some new symbols to make formula simple.

So $x = \frac{K_2}{lK_1}, y = \varepsilon, z = \eta, 2 < y < z, 0 < \nu < 1$.

Here we also create a new fuction called f to replace (14), then $(1-\mu\nu)^2(AD-BC) > f$,

$$\begin{aligned} f &= -x^2yz\nu^4 - (xy^2 + 2x^2yz)\nu^3 - \\ &\quad (xy^2 + x^2yz)\nu^2 + (y^2 - 8x)\nu + yz - 8x \end{aligned} \quad (15)$$

If we can make sure f>0 when v is in (0, 1), then we can also make sure that $AD-BC>0$. f>0 is the sufficient condition for $AD-BC>0$.
Again we use some new symbols to make formula simple.

So

$a=-x^2yz$, $b=-(xy^2+2x^2yz)$, $c=-(xy^2+x^2yz)$, $d=y^2-8x$, $e=yz-8x$

$$f=av^4+bv^3+cv^2+dv+e \tag{16}$$

And $a<0$, $b<0$, $c<0$, $d>0$, $e>0$.

$$f^{'}=4av^3+3bv^2+2cv+d \tag{17}$$

we cannot judge whether this equation is greater or less than 0. Then we solve its Second derivation function.

$$f^{''}=12av^2+6bv+2c<0 \tag{18}$$

We can find that f is a convex function. So we can make sure f>0 in (0, 1) as long as f(0)>0 and f(1)>0.

So :

$$\begin{cases} f_0=yz-8x\geq 0 \\ f_1=(1-4x^2)yz+(1-2x)y^2-16x\geq 0 \end{cases} \tag{19}$$

Here we have three possible conditions:

$$\begin{cases} 1\text{-}4x^2>0 \\ 1-4x^2=0 \\ 1-4x^2<0 \end{cases} \tag{20}$$

The different condition will lead to different value of x.

When $1\text{-}4x^2>0$, then $1-2x>0$, $x<0.5$. The fuction becomes an increasing fuction. And $2<y<z$.

So :

$$\begin{aligned} f_1 &= (1-4x^2)yz+(1-2x)y^2-16x \\ &> (1-4x^2)4+(1-2x)4-16x \end{aligned} \tag{21}$$

If $(1-4x^2)4+(1-2x)4-16x\geq 0$, we cn make sure that $f_1\geq 0$. And the range of x is $(0,0.281]$.

After considering the other two possible conditions, we find that the value of x is not situable.

Finally, we get $l\geq 3.56\frac{K_2}{K_1}$.

When $N_2^*\geq 3.56\frac{K_2}{K_1}N_1^*$ which means the highway mileage must be $3.56\frac{K_2}{K_1}$ times the container throughput, both container throughput and highway mileage develops fast and their optimal value exceed the limits.

In the consideration of the influence of time delay, if in a period the ratio between highway mileage and container throughput descends, it will affect the container throughput in next periods not the same period.

This article takes corresponding data from 2001 to 2009 to do some analysis.

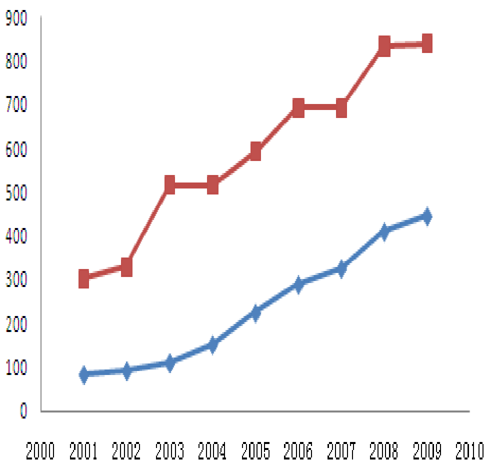

Fig 8: Comparison of growth of container throughput and highway mileage

The blue line represents the growth of container throughput, the red line represents the growth of highway.

From fig 8, we can get that the shape of container throughput and highway is still very similar, but we cannot get their relationship clearly. We should analyze it from other aspects.

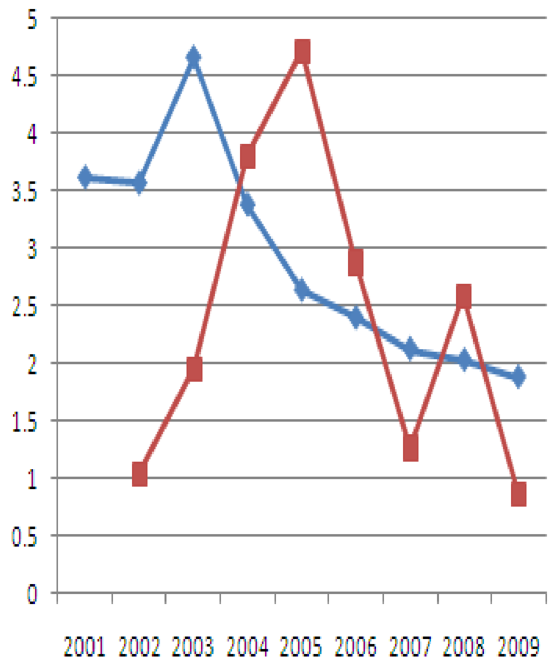

Fig 9: Comparison

The blue line represents the ratio between highway mileage and container throughput and the red line represents 10 times of the growth rate of container throughput. Because it will make compare more clear by using 10 times of cintainer throughput's growth rate.

From figure 8 we can get:①Due to the influence of time delay, we can see the two peaks of wave are not in the same period. The influences of some external factor make the emerging of second peak of growth rate of container throughput. But the trend of these two curves is very similar, and we can conclude that there must be certain relationship between them. ② When the ratio is greater than 3.5 which is very close to the critical rate, the growth rate of container throughput increases; when the ratio is lower than 3.5, the growth rate slows down. ③From 2005, the growth container throughput keeps descending with the ratio between highway mileage and container throughput descending. That is to say the inland transport system constrains the development of Tianjin port; some measures should be done to improve the transport system, and otherwise Tianjin port will fall into a passive state of low increasing.

5 Conclusion

Tianjin port will still keep high speed of growth just in several years without improvement of its circumstance. Due to the analysis of logistic growth model, we know that it will take not long time to meet Tianjin port's bottleneck in development. The answers of how to solve this problem rely on the improvement of its circumstance which includes external factors and internal factors. Compared with other ports which are also listed companies, the major factors which constrain the development of Tianjin port are High administration cost and the lag of inland transportation construction. High administration is a problem which is common in many state-owned enterprises. Tianjin port's reform in management has to follow the indication of government and other state-owned enterprises' attempt. And inland transportation construction is most serious. Take highway mileage and container throughput as example, they must reach a reasonable proportion which can maintain the growth of container throughput. The matched speeds of port and inland transport system are emphasized to ensure their relationship of mutualism.

References:

[1] Q. Gao, J. H. Ma. Research on Co-opetition Strategy Between Container Terminals. *Journal of Xidian University(Social Science Edition)*, Vol.19,No.3,2009,pp.77-80.

[2] W. Z. Yang, P. Dong, D. Guo. Model of competition and mutualism among ports based on nonlinearity dynamic system. *Journal of Shanghai Maritime University*, Vol.27,No.3, 2006, pp. 5-9.

[3] T. T. Chen, Y. Y. Chen. Port Cargo Throughput Forecast Based on BP Neural Network. *Computer and Modernization*, No.170,2009, pp. 4-5,9.

[4] L. X. Liao, Y. Wu. The application of genetic algorithms in the Container terminal integrated dispatching. *Containerization*, Vol.19,No.7, 2008, pp.18-21.

[5] B. Yang, J. X. Yu, Q. Wang. The Application of the Logistics Model in the Middle/Long Term Container Prediction. *Ocean Technology*, Vol.25,No.4,2006,pp.88-93.

[6] M. Gyllenberg, P. Yan, Y. Wang. Limit cycles for competitor-competitor-mutualist Lotka-Volterra systems. *Physica D*. Vol.221, No.2, 2006, pp. 135-145.

[7] X. Z. Lian, Z. Y. Lu, Y. Luo. Automatic search for multiple limit cycles in three-dimensional Lotka–Volterra competitive systems with classes 30 and 31 in Zeeman's classification. *Journal of Mathematical Analysis and Applications*. No.348,2008, pp. 34–37.

[8] Y. C. Juanh, R. Michael. A Study on Success Factors of Development Strategies for Intermodal

Freight Transport Systems. *Journal of the Eastern Asia Society for Transportation Studies*, Vol. 8, 2010, pp. 722-732.

[9] R. H. Xu, Application of logistics. *Journal of Shanxi Finance And Economics University*. Vol. 32, No.2, 2010, pp. 311-312.

[10] Y. Zhou, C. H. Tian, Q. G. Zhang. Complex population dynamic and its experimental verification based on logistic growth model. *Bulletin of Biology*. Vol.45, N0.7, 2010,pp. 21-23.