Analysis on the effectiveness of inland port and regional economic linkage development based on DEA-- Taking Xi'an inland port as an example

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Abstract: The close linkage relationship between inland port and regional economic development causes the construction boom of domestic inland port, inland port's large capital investment and low operation efficiency can't match with regional economic development. The paper uses DEA data model to make a quantitative analysis of input - output effectiveness between regional economy and inland port, and takes comprehensive efficiency value to evaluate the effectiveness of each decision making unit (DMU) input and output, and finally takes the non effective decision making units -Xi'an inland port as an example, under the output unchanged to modify the redundancy of input. To a certain extent, this research is helpful to the construction of inland port and the coordinated development of regional economy.

Introduction

China's inland areas have been experiencing some problems about long-term high logistics cost, low efficiency, low level of foreign trade for a long time in carrying out foreign trade, because of the constraint of the system, regional and imperfect of international logistics function.But with "The Belt and Road" implementation and urgent need of Midwest export-oriented economy, inland port , to a certain extent, solves the bottleneck problems of China's export-oriented economy in inland areas. Inland port's powerful function of ports and logistics, international container transport functions contributes to linking inland and international, accelerating the integration process of economic and trade cooperation between the eastern and western ,it also helps inland cities to be true port city by improving the city's opening level , and drives the development of inland areas.[1]

Inland port is also known as "dry port", it refers to the establishment in the inland without water, and it also has convenient transportation channel of goods distribution, transit, storage, customs clearance, multi-transport, information services, circulation processing, product display and other functions as harbor.The functions of inland ports are almost the same as harbors except loading and unloading ship,therefore it is regarded as the extension of coastal ports functions,.

The relationship between inland port and regional economic

As the main distribution center for comprehensive transportation hub and the import and export of goods, Inland port is conductive for inland areas to attracting foreign investment, promoting logistics and related services, and the industrial transfer. Its comprehensive port functions simplifies

procedures and saves time for the owner[2]. By collaboration with the harbor, it also achieves the maximum return of container volume, efficiency transport improving and transportation costs reducing. Conversely, the regional economic development level, foreign trade, industrial structure and other factors on the inland port are also playing an important influence on the scale and development potential of region economic.Regional transport channel, namely traffic hub property, multi-transport ability and related government policy directly affect the function of inland port.

Research Summary

At present, the research of inland port and regional economy can be summarized as the following two aspects: one is the qualitative analysis of the linkage relation, this kind of research thoroughly discusses the mutual influence between the two to a certain extent, but lack of rigorous quantitative analysis[3]; Secondly by the two aspects of quantitative relation analysis, this kind of research, mainly through the introduction of various types of analysis models, selects the relevant indicators and the specific operational data to a quantitative analysis of linkage of regional economic and inland port development, and the solution plays an important role in blind government investment to inland port, but this kind of research has not given specific measures on non effective units [4].

Model Construction and its effectiveness evaluation of the linkage between regional economy and inland port

Construction of validity model of the inland port and the regional economic development Based on the data envelopment analysis (DEA)[5]

Introduction to data envelopment analysis model(DEA)：DEA is a new effective system analysis method proposed by Charnes, who was a well-known operational research experts. Not considering each index dimension and the relationship between input and output and its simple evaluation process, so the model is widely used in economic, medical, education and other fields.

Index selection

There are many factors that affect the effectiveness of the regional economy and inland port development. This paper finally determines the following evaluation indexes based on the full consideration of the coverage:

① Evaluation index of inland port

Input index: warehouse area(X11), yard area(X12), amount of investment(X13);

Output index: container handling capacity(Y11).

② Evaluation index of the regional economic:

Input index: fixed asset investment(X21), the number of employees(X22);

Output index: total retail sales of social consumer goods(Y21), total industrial output value(Y22).

③ Effectiveness evaluation index of the linkage between regional economy and inland port：

Regional economy to promoting the development of inland port：Investment index: fixed assets investment(X31), number of employees(X32), output index: container handling capacity(Y31);

Inland port on promoting regional economy：Input index: container handling capacity(X41); Output index: total retail sales of social consumer goods(Y41), total industrial output value(Y42);

Determination of decision making units(DMU) and data sources

According to the principles of input and output index of a total of not more than 2 times the number of decision unit in DEA analysis model, and data availability and accuracy of decision unit

evaluation, this paper determines the number of decision making units for 8, including 1-Xi'an, 2-Beijing, 3-Shijiazhuang, 4-Ningxia,5-Baotou, 6-Yiwu, 7-Linyi and 8-Zhengzhou.all kinds of statistical data from all over the city and the inland operating units in 2015, covering government statistics, statistical yearbook, the official company website and relevant statistics etc., Yiwu and Huinong are district level unit ,these two cities are picking related index data of Jinhua and Shizuishan as decision making unit. See in Table 1.

Table1 evaluation index of inland port and regional economic

inland port/city	Input			Output	Input		Output	
	X11	X12	X13	Y11	X21	X22	Y21	Y22
1	165000	1572000	6.8	110000	5165.98	535	3405.38	1417.61
2	17088	32000	3.4	150000	7990.9	1002.8	10338	17408.2
3	19900	39820	2.68	80000	5689.9	275.6	2680.9	2117.3
4	15922	80000	1.17	46300	498.95	19	96.06	225.5
5	6658	30000	3	50000	2582.91	79.9	1276.6	3142.2
6	349000	123395	16	47736	1836.16	373.6	1783.10	4927.5
7	49000	13000	12	49700	3219.2	235	2235	1687.1
8	18840	60000	3	200000	6288	559.6	3294.7	3625.5

Analysis of the effectiveness evaluation of regional economy and inland port based on DEA

This paper used cross section data from inland port and its regional economy as table 1. DEAP2.1 as a specific analysis of DEA software,which has the advantages of simple operation, fast operation, clear objective, was used to calculate the effective value of inland port, regional economy and the two linkage relationship,see table 2.

（1） value efficiency analysis of inland port and regional economic

As seen from table 2, effective inland port are 2-Beijing, 8-Zhengzhou ; regional economic effective areas are 2-Beijing, 5-Baotou and 6-Jinhua. For other regions, they are double void.

Table 2 the effectiveness value of inland port and regional economy

DMU	Inland port efficiency		Regional economic efficiency	
	Comprehensive efficiency θn	Validity	Comprehensive efficiency θq	Validity
1	0.243	void↑	0.595	void↑
2	1.000	effective-	1.000	effective-
3	0.536	void↑	0.734	void↓
4	0.594	void↑	0.351	void↑
5	0.707	void↑	1.000	effective-
6	0.083	void↑	1.000	effective-
7	0.816	void↑	0.817	void↑
8	1.000	effective-	0.532	void↑

①To inland port, all eight ports comprehensive efficiency are differences. The comprehensive efficiency value$q_n = 1$ of Beijing, Zhengzhou means the two inland's input getting the maximum output,and they are effective DEA.The other six cities are not effective in DEA, which indicates these 6 ports lag behind the development of regional economy. The comprehensive efficiency value of,Baotou, Shijiazhuang, and Linyi is $0.5 < q_n < 1$, Which indicates the four city inland port has entered a good stage of development ;but the comprehensive efficiency value of Jinhua and Xi'an are too low, which is only 0.083 and 0.243 indicating that the two areas of inland port are small scale and backward mode of operation.

②On the regional economy, Beijing, Baotou and Jinhua are DEA effectively because their comprehensive efficiency value is equal to 1 , which mean the three regional investment to get the maximum output and thus achieved the optimal; the other five regional economic development is DEA invalid,which indicated the five city regional economic output was not the best but the momentum of regional economic development in the five regions is in the phase of growth because of its comprehensive efficiency value $0.5 < q_q < 1$.

③ Effectiveness and result analysis of the linkage between inland port and regional economy

We choose Inland port index for Input and the regional economic output index for output, to determine the effective value of the inland port in promoting regional economic development, as shown in table 3.

Table 3: efficiency value of inland port - regional economic

relationship	inland port - regional economic			regional economic- inland port		
efficiency value	crste	vrste	scale	crste	vrste	scale
1	0.817	0.0817	1.000	0.229	0.561	0.409
2	1.000	1.000	1.000	0.202	0.551	0.367
3	1.000	1.000	1.000	0.152	0.499	0.304
4	0.152	1.000	0.152	1.000	1.000	1.000
5	0.726	0.976	0.744	0.257	0.401	0.641
6	1.000	1.000	1.000	0.280	0.301	0.930
7	1.000	1.000	1.000	0.166	0.195	0.854
8	0.517	0.520	0.995	0.343	0.854	0.343

As table 3 shows, for the inland port promoting regional economic development, DEA is effective in the area of Beijing, Shijiazhuang, Yiwu and Linyi, because their regional technical efficiency and scale efficiency are optimal, the regional economy and inland port are double effective. Xi'an, Baotou and Zhengzhou are second, it shows that their inland port excessive investment, but because of their comprehensive efficiency value is between 0.5-1, it indicates that inland port on regional economic role in a good growth stage; Huinong is the worst because its scale efficiency value is too low. On the other hand, in regional economy promoting to the inland port, Ningxia Huinong is the best, its technical efficiency and scale efficiency achieved a good effect,which illustrated the good interaction of inland port construction and regional economic development. In other areas, the comprehensive efficiency value is generally low, which indicates that the regional economy has not realized two-way effective coordinated development in promoting the development of the port and port.

Efficiency improvement of the linkage between Xi'an inland port and regional economy based on the projection theory

As table 3 shows, Xi'an inland port and regional economy did not achieve good coordination development, according to the projection theorem, we analyzed the non effective units of input redundancy and output deficiency of Xi'an inland port and regional, and adjusted the corresponding indicators, to realize output unchanged in condition of minimum investment. according to the results in tables 4 and 5, the technical efficiency value of Xi'an inland port on promoting regional economic development is 0.817 while scale efficiency value is 1, it indicated that Xi'an inland port efficiency has reached the optimal scale and its development trend is increasing returns to scale,

according to the effectiveness of input and output, in the existing inland investment and infrastructure the optimum container handling capacity of Xi'an international inland port is 89817.788TEU, but actual processing capacity has far exceeded the maximum load of inland port, so the technical efficiency Value is only 0.817, so it should reduce the handling capacity of the container 20182.212 in order to achieve the double effect of Xi'an port on regional economic development.

Table 4:effectiveness improvement of Xi'an inland port and regional economy

Results for firm: 1
Technical efficiency = 0.817
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	5165.980	0.000	0.000	5165.980
output	2	535.000	0.000	0.000	535.000
input	1	110000.000	-20182.212	0.000	89817.788

As the technical efficiency and scale efficiency values of regional economy to Xi'an inland port were 0.561 and 0.409 as Table 5, which shows that the two are not optimal in both technology and scale. From investment point of view, the two indexes were redundant respectively 2267.795 and 291.952, namely keeping the current level of output Xi'an should reduce the amount of investment in fixed assets and personnel input and the correct input level should be 2898.185 and 243.048.

Table 5: effectiveness of regional economy to Xi'an inland port

Results for firm: 1
Technical efficiency = 0.561
Scale efficiency = 0.409 (drs)
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	110000.000	0.000	0.000	110000.000
input	1	5165.980	-2267.795	0.000	2898.185
input	2	535.000	-234.858	-57.094	243.048

Conclusion

This paper uses DEA to analysis the effectiveness of inland port,regional economy and the linkage with regional economic and inland port, according the analysis result :Beijing belongs to the double effective city, Zhengzhou port is inland port effective and regional economic invalid; Jinhua and Baotou are regional economic effective and inland port ineffective . Based on the DEA projection theory, this paper finally makes a correction to the non effective urban Xi'an land port and its regional economic input redundancy and output deficiency.

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