An Empirical Study on the Contribution of Information Technology to Liaoning Economy based on Econometric Model: Taking the Internet Industry as an Example

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Abstract: Information technology is regarded as the fourth industrial revolution. Information technologies such as big data, Internet and artificial intelligence have become important driving forces to promote economic development. Taking Liaoning Province as the research object, this paper uses a variety of econometric analysis methods to study its development level of Internet industry and its contribution to the economy. This paper constructs the evaluation index system of Internet industry, and uses entropy method to make a quantitative analysis. Multiple regression analysis was used to study the impact of Internet technology on economy. The research shows that the level of information technology such as Internet in Liaoning Province is increasing year by year, and has significantly promoted the economic development of Liaoning Province. On this basis, this paper puts forward countermeasures and suggestions to speed up the development of information technology industry in Liaoning Province: we should take information technology as a key development industry, cultivate and introduce relevant enterprises, and speed up the training of information technology talents.

1 INTRODUCTION

In 2019, Liaoning Province achieved the GDP of 2490.95 billion yuan, an increase of 5.5% over the previous year, ranking 15th among all provinces and cities in China. Since 2000, the overall economic and industrial development of Liaoning Province has encountered great difficulties. The economic growth has been slowing down, especially in 2016. So far, the total GDP of Liaoning Province has not recovered to the level of 2015. Liaoning is an old industrial base in China, the proportion of traditional industries is high, the development of emerging industries is relatively late, and the problem of unreasonable industrial structure is serious. As an emerging industry, Internet has the prominent advantages of high industrial relevance and strong driving ability. In recent years, the rapid economic development of China's southeast coastal provinces has also proved the important role of the Internet economy in the national economy. Compared with southern

provinces in China, Liaoning Province's Internet economy started relatively late. There is a big gap between Liaoning Province and the other provinces in terms of industrial output scale and the number of industry leading enterprises. This gap is also one of the important reasons for the imbalance of industrial structure and the continuous decline of economic ranking in Liaoning Province.

Nordhaus (Nordhaus, 2021) believes that long-term economic growth faces many difficulties, such as environmental constraints and unreasonable economic structure, and information technology is an effective way to solve these problems and an important driving force to promote regional economic development. Especially since the outbreak of COVID-19, the global economy is facing greater difficulties. The economy and trade between countries have been greatly restricted, and many countries and regions have experienced negative economic growth. Sharma et al . (Sharma, et al, 2021) reviewed the relevant and published literature that has been obtained, it is found that after the covid-19 pandemic, the use of digitization, information and technology, the Internet of things and other related technologies is being emphasized, and the mode of

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economic growth shows a great change from traditional methods to modern methods. Therefore, it is necessary to study the role of Internet industry in Liaoning economy from the perspective of Internet industry, and put forward how to realize the transformation and upgrading of Liaoning economy through the development of Internet economy.

As an emerging thing, the research on the impact of the Internet on the economy and industry is still in its infancy, but in the limited research, we have basically reached a consensus that the development of the Internet industry has a positive role in promoting the economy. For example, Yincheng Xie et al. (Xie, et al, 2015) took the tertiary industry as an example to study the impact of the Internet industry on economic development. The study found that the Internet has a positive impact on the added value of many sectors in the tertiary industry, and proposed that the development of the Internet industry should be accelerated. Qiping Jiang (Jiang, 2015) proposed that the Internet would greatly promote China's economy, and analyzed the positive impact of Internet plus on the three industries from the perspective of agriculture, manufacturing and service industries. Debao Dai et al. (Dai, et al, 2016) put forward the Internet business model to accelerate China's economic transformation and development, and Internet technology supports the transformation of Internet business model. From the above literature, we can see that most of the studies from the perspective of national macro-economy have studied the role of the Internet industry in promoting the economy. These studies have laid a solid foundation for this study, but from the provincial level, especially in Liaoning Province as the research object is still relatively rare.

2 MODEL BUILDING

2.1 Internet Development Index Model

Measuring the development level of the Internet requires comparative analysis from multiple dimensions, of which the Internet infrastructure construction and Internet application are the two most important aspects. Combined with the research results of other scholars at home and abroad, this paper constructs the Internet development index model of the two provinces from these Liaoning aspects, as shown in the table below.

Table 1: Index System of Internet development in Liaoning Province.

First level index	Second level index
Internet infrastructure	Realm name
	Internet broadband access port
	Length of optical cable line
Internet applications	Number of websites
	Number of web pages
	Internet broadband access users
	Internet penetration rate

In the index system of Internet development of Liaoning Province, the first level index Internet infrastructure includes three second level indexes, namely domain name, Internet broadband access port and optical cable line length km. The first level indicator Internet application includes four second level indicators, which are the number of websites, the number of web pages, Internet broadband access users and Internet penetration rate.

How to effectively evaluate the development level of the Internet has always been a hot topic in academic circles. The methods used include factor analysis, expert scoring and so on. Although these methods can solve the problem of multi index evaluation to a certain extent, they are too subjective in determining the weight, and the evaluation results are difficult to convince everyone. In order to overcome this problem, this paper uses entropy method to evaluate the Internet development level of Liaoning Province, which can eliminate the impact of subjective scoring on the evaluation results. Entropy method is a mathematical method used to judge the degree of dispersion of an index. The greater the degree of dispersion, the greater the impact of the index on the comprehensive evaluation. The calculation formula is as follows:

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^{m} y_{ij} \ln_{ij} \quad (1)$$
$$(i=1..n; j=1..m)$$

$$d_j = 1 - e_j \quad (2)$$

Among them, e_j is the entropy of the j-th index, M is the number of samples, y_{ij} is the proportion of the i-th year under the j-th index, and d_j is the redundancy of entropy. After obtaining the entropy and redundancy of the index, the weight of the index can be further determined.

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j} \quad (3)$$

After determining the weight of the indicator, the final comprehensive score can be obtained by combining the specific data of the indicator. The calculation formula is as follows:

$$s_i = \sum_{j=1}^{m} w_j \cdot p_{ij} \qquad (4)$$

Among them, s_j is the comprehensive score, w_j is the weight of the index, pij is the actual value of the index.

2.2 Multiple Regression Model

After obtaining the Internet development index of Liaoning Province, this paper further analyzes the impact of Internet industry development on the economy of Liaoning Province. In the traditional theory of economics, capital investment and human investment are important forces to promote economic growth and industrial development. In addition, scientific and technological progress is another important factor. In this paper, we take the development level of the Internet as an indicator to reflect the progress of science and technology. Therefore, we build a model of influencing factors of economic and industrial development in Liaoning Province.

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon \qquad (5)$$

Among them, x1 is capital input, x2 is human input, x3 is Internet development index, and Y is GDP of Liaoning Province. Collect the relevant data of Liaoning Province from 2011 to 2019, and combine with the Internet development index of Liaoning Province obtained from the previous analysis to conduct multiple regression analysis of time series, using Eviews software.

3 DATA COLLECTION AND ARRANGEMENT

The data analysis of this paper is divided into two parts. The first part is to build the Internet development index model of Liaoning Province, collect and sort out the data required by the indicators in the model, and calculate the development and change of Internet Index in Liaoning Province during the research period. The second part is the analysis of the influencing factors of the economic development of Liaoning Province, which creatively takes the Internet Index as an important influencing factor to find out its relationship with the economy of Liaoning Province and the influence intensity. All the data are

from *China Statistical Yearbook* and *Liaoning statistical yearbook*. The research period is from 2011 to 2019.

4 EMPIRICAL ANALYSIS OF INTERNET DEVELOPMENT LEVEL

4.1 Descriptive Statistics

Before empirical analysis, descriptive statistical analysis of each index data is carried out. As can be seen from the table, the overall indicators of Internet industry in Liaoning Province are increasing year by year.

Table 2: Basic data of Internet industry in Liaoning Province.

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Realm name	0.14	0.23	0.22	0.30	0.48	0.59	0.48	0.65	0.96
Internet broadband access port	9.81	12.7	16.3	20.8	27.1	32.4	31.2	32.4	32.7
Length of optical cable line	4010	4422	5228	6346	7707	10353	11744	13547	14998
Number of websites	4.8	6.4	8.6	9.7	11.1	11.8	12.3	11.4	12.2
Number of web pages	972	1822	2282	2409	1841	1711	2100	1772	2199
Internet broadband access users	6.5	7.1	7.3	7.7	8.6	9.7	10.6	11.4	12.3
Internet penetration rate (%)	47.7	50.1	55.9	58.8	62.3	62.6	64.2	66.5	71.8

Note: million

It can be seen from table 2 that from 2011 to 2019, the data of various indicators of Internet industry in Liaoning Province have increased significantly, especially the growth rate of realm name and internet broadband access port has exceeded 300%, and the growth rate of length of optical cable line and number of websites has also exceeded 100%. At the same time, the Internet penetration rate has also increased from less than 50% to 71.8%, exceeding the national average. It can be seen that the development quality of Internet industry in Liaoning Province has improved significantly.

4.2 Internet Index Analysis

Based on the index system constructed above, the entropy method is used to calculate the Internet industry development index of Liaoning Province.
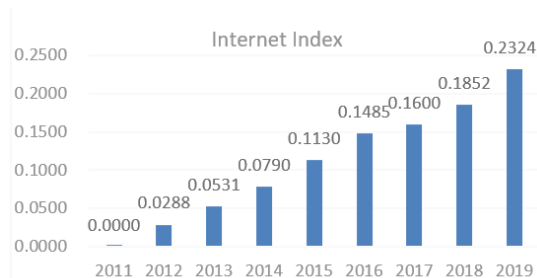

Figure 1: Internet development index of Liaoning Province.

As can be seen from Figure 1, the Internet development index of Liaoning Province has an obvious upward trend, reaching 0.2324 in 2019, which has almost doubled in five years.

5 RESEARCH ON INTERNET CONTRIBUTION

Before multiple regression analysis of time series data, it is necessary to test the stationarity of each index data. The method used in this paper is unit root test. First, after the data is standardized, the unit root test is performed on the data.

Table 3: Results of the first unit root test.

	GDP	Invest	Labor	Internet
ADF-test	-2.1442	-1.4409	-1.9112	0.4968
Prob	0.2358	0.5017	0.3099	0.9724
Conclusion	NO	NO	NO	NO

It can be seen from the table that these variables have not passed the unit root test, so there is no way to do further cointegration analysis. According to the usual practice, these variables need to be logarithmically processed, and then the second unit root test is carried out. The test results are as follows:

Table 4: Results of the second unit root test.

	GDP	Invest	Labor	Internet
ADF-test	-2.2843	-2.389	-12.119	-43.4941
Prob	0.0297	0.0269	0.0003	0.0001
Conclusion	YES	YES	YES	YES

It can be seen from table 4 that all variables have passed the unit root test, shows that these variables are of the same order, so regression analysis can be carried out. The results of regression analysis are as follows:

Table 5: Regression analysis results.

	Model 1	Model 2
C	-2.3729*	-3.1212**
	(1.0637)	(2.0206)
β_1	2.2137*	5.9395**
	(1.0777)	(2.0010)
β_2	-1.0042	
	(0.3614)	
β_3	1.3522	4.5338***
	(0.2342)	(4.0040)
Adjusted R^2	0.2010	0.8072
F	1.6708	17.7481

Note: the standard deviation in brackets, ***, **, * indicate the significance level of 1%, 5%, and 10% respectively.

From table 5, we can see that when model 1 is adopted, both human investment and Internet development index fail to pass the test. At the same time, the value of goodness of fit is 0.201, indicating that the interpretation ability of the model is weak. According to the economic development experience of European and American countries, the contribution of labor force to the economy is becoming weaker and weaker, while the role of capital and information technology is becoming more and more prominent year by year. Therefore, in the second regression analysis, we remove the variable labor input, so we get model 2. In model 2, all variables pass the test, the coefficient of capital investment is 5.9395, and the coefficient of Internet development index is 4.5338. The coefficients of the two variables are positive, indicating that capital investment and Internet development index have a positive impact on the economic development of Liaoning Province. Therefore, we should speed up the development of the Internet industry, so as to drive the high-quality economic development of Liaoning Province, as well as the transformation and upgrading of the industry.

6 CONCLUSIONS AND RECOMMENDATIONS

This paper constructs the evaluation index system of Internet industry development level, calculates it by entropy method, and obtains the Internet development index of Liaoning Province from 2011

to 2019. On this basis, taking it as an important influencing factor, we use the regression analysis model to analyze its contribution to the economy of Liaoning Province.

(1) The index data of Internet industry in Liaoning Province show an upward trend, and its comprehensive evaluation index also shows the same trend.

(2) The Internet industry has a positive impact on the economic development of Liaoning Province. The high-quality development of the Internet industry can promote the transformation and upgrading of Liaoning economy.

Therefore, in order to accelerate the development of Internet industry in Liaoning Province, the following countermeasures and suggestions are put forward.

(1) The government should formulate the Internet development plan. The development of Internet industry is inseparable from the scientific guidance and support of government departments. Internet is different from the traditional industry, is a technology and innovation intensive industry, compared with southern China, Liaoning enterprises' innovation consciousness has a certain gap. Therefore, the government should strengthen the top-level design, formulate the Internet industry development plan, set up the Internet industry guidance fund, formulate the white list of industrial development, give priority to the development of the Internet industry, and accelerate and drive the transformation and upgrading of traditional industries.

(2) We should cultivate and introduce Internet leading enterprises. From the development experience of Internet industry in southern provinces of China, leading enterprises are the key factors to achieve high-quality development of Internet industry. Such as Alibaba and pinduoduo in Zhejiang Province. Tencent and other enterprises in Guangdong Province, through their strong influence, help enterprises form a complete Internet industry ecological chain, which not only directly contributes considerable economic benefits to the local economy, but also drives the high-quality development of other local industries. Therefore, Liaoning Province should speed up the introduction and training of Internet leading enterprises, formulate fiscal and tax preferential policies, and give full support to some Internet Unicorn enterprises.

We should speed up the training of Internet talents. Talent is the core competitiveness of industrial development. The Internet industry is different from the traditional industry, which has high

requirements for the professional knowledge of talents. In order to speed up the development of the Internet industry, we should start from the perspective of personnel training, and quickly form a group of influential talents in the industry. We should give full play to the advantages of Liaoning Province, set up Internet industry related majors in Dalian University of technology, Northeast University and other universities, and carry out extensive training activities within Internet enterprises. Implement the work of Internet talent identification, and provide high-quality services in the fields of personal medical care and children's education. Attract Internet talents from other regions to work in Liaoning Province.

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