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Research on the Determinants of Electronic Information Manufacturing Industry Development

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Abstract: ***The electronic information industry has an important influence on the industrial upgrading, industrial structure adjustment, and transformation of economic development mode, which is treated as an important driving force to our country economic development. Based on the relevant literatures, this paper establishes the determinants of electronic information manufacturing industry development, and does an empirical study by the method of grey correlation analysis. The results show that the level of economic development, the labor input, the input of research and development (R&D), the industrial competition and industrial demand are themaindeterminants of electronic information manufacturing industry development. However, the capital factor, the industrial policy and the opening-up level don't have a significant impact onthe current development of electronic information manufacturing industry. In addition, the paper puts forward someproposals to accelerate the development of China's electronic informationmanufacturing industry.***

Keywords: Electronic Information Manufacturing Industry; Determinants; Grey correlation analysis.

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1. Introduction

Since the 1990s, with the development of information technology in the world, the electronic information industry has become a new booming strategicindustry. In recent years, China's electronic information industrygrows rapidly for many years, and the output reached154166 billion yuan in 2015, of whichthe manufacturing industry accounted for 72% and the software industry accounted for 28%.Obviously, the manufacturing industry was the most important part of the electronic information industry. Recently, with the adjustment and transformation of the world economy, the electronic information manufacturing industry will facefierce competition and restructuring of the industrial landscape in world.Thus, exploring the main factors affecting the development of China's electronic information industry has vital significance to industrial cultivation anddevelopment.

2. Literature Review

The electronic information industry is an important driving force, and has widespread influence on the industrial upgrading, industrial structure adjustment, and the transformation of economic development mode etc. It caused a great deal of attention from academic and practical departments for a long time. Related research about the determinants of electronic information industry development mainly includes:

Firstly, based on the Cobb-Douglas(C-D) production function, some factors are introduced and empirical analysisis carried out. Du Xiaoming (2010) applies layered grey relational analysis and comes to a conclusion that the main influencing factors of China's information industry development are R&D input, capital input, technological innovation capability and human resources [1]. The conclusion of Zhang Xirong's study shows that demand, resource supply and international trade and international investment are basic factors to electronic information industrial upgrading inShanghai,while innovation and technologyInnovation are the core factor to promote industrialupgrading[2]. The result of Chen Kaixiao's study indicates that labor, capital, human resources, trade, and marketization are all havesignificant influence on the development of electronic information industry of Fujian Province, among which, the marketization level's influence is the biggest, and the technology's influence is the least[3].Shen Chenchen (2015) arrives at the result that foreign direct investment (FDI), sales rate and labor input have a significant impact on the promotion of electronic information industry of Tianjin[4]. Zhu Xiujuan (2017) concludes that the capital investment, R&Dinputand the expansion of economies all promote the development of electronic information industry [5].

Secondly, based on the Michael Porter diamond Model, Some industrial development factors have been tested. From the Perspective of diamond model, Chen Lufu, Shao Yunfei(2017) take the new generation information industry

as an example, and choose the multiple regression model to analyze, the conclusion shows that factors ofproduction, demand diversity, related industry and governmenthave more significant effects on the innovation performance of new generation of information industry, but market scale, support industry and competitive fail to haven't pass the significance test [6].

Thirdly, some core factors, such as technological innovation, government procurement have been verified. Zheng Yue's study (2017) shows the R&D investment and the number of regional authorized patents both enhance the development of software industry with the regression analysis [7]. Ji Shunyu (2014) reaches the conclusion that government procurement has a significant impact on China's electronic information industry with the regression analysis [8]. Xing Lebin, Li Jun (2014) analyze with the questionnaire survey and come to the conclusion that human resources, R&D service, intellectual property and patent protection, condition of enterprises, and policy support are the five major variables of promoting locating in inland of R&D institutions[9].

Besides, some other related works about high-tech industry and Internet industry as follows: Jiang Wenxiu (2012) obtains that R&D investment has a greater impact on the output value of China's high-tech in the long run by using the VAR model [10]. Mai Junhong's study (2014) shows that the level of economic development, R&D investment and human capital has a positive role in promoting the development of high-tech industry with the regression analysis [11]. KeJianfei (2014) concludes that the development of high-tech industry of Ningbo is mainly affected by FDI, human resources, technology investment with the grey correlation analysis[12]. He Juxiang (2015) reaches the result that the continued growth of Internet industry is guaranteed by the level of economic development by using the production function [13]. Gao Yanchao (2017) and Li Jing (2017) both establish the regression model on the basis of the principal component analysis, the similar result of their study shows that the development of high-tech industry is mainly affected by the level of economic development and market factor from the perspective of demand, and it is mainly affected by the labor input and technology input from the perspective of supply [14, 15].

In summary, on the basis of the C-D Production function and Porter's diamond model,some empirical studies are carried out by the methods of the regression analysis and the gray correlation analysis, and so on. For the industrial development which not only due to the labor input and capital input, but also the results of thedemand, supplyand competition,industrial policy, technological innovation and other factors. Therefore, this paper combines the thoughts ofC-D production function and the diamond model,combines the characteristics of electronic information manufacturing industry, buildsthe model about determinants of electronic information manufacturing industry development, thendoes an empirical analysis and identifies the key driving factors of industrial development. Based on the results,some corresponding countermeasures and suggestions are put forward to promote the development of China's electronic information manufacturing industry.

3. Empirical Analysis

3.1 Indicator and Data Sources

As for the indicators ofthe developmentof electronic information manufacturing industry, different scholars choose diverse indicators because of different research methods and perspectives. From the aspects of industrial scale and profitability, it chooses the main business revenue and profit of the electronic information manufacturing industry as the indicators of industrial development in this paper.

Based on the C-D production function and the diamond model,combined with the characteristics of electronic information manufacturing industry and the availability of data, it chooses the factors to the development of electronic information manufacturing industry. It includes these:capital factor, labor factor, industrial demand, industrial competition, industrial policy, economic development level, technological innovation, Industrial supporting, marketization degree and opening-up level etc. Among them, technological innovation includes the input of technological innovation and the output of technological innovation, the input of technological innovation is measured by the R&D input, and the output of technological is measured by the number of authorized patents.Industrial supporting means the supporting situation of upstream and downstream related industries which have internal economic connection with each other. Industrial supporting is measured by influence coefficient and sensitivity coefficient. The specific indicators of different factors are shown in Table.1.

In order to analyze the recent situation, the annual data from 2006 to 2015 is chosen to be used for the empirical study in the paper. Most of the data is from *China electronics information industry Statistical Yearbook*, some of the data is from *China Statistical Yearbook*, and the other data is from the State Intellectual Property Office and the Ministry of Science and Technology of China. The original data of each indicator is shown in Table.2.

Table 1: Industrial Development Indicators and Influencing Indicators

Category	Sequence	Indicator (unit)
Industrial development	Y1	Main business revenue of the manufacturing industry (billion yuan)
	Y2	Total profit of the manufacturing industry (billion yuan)
Capital factor	X1	Fixed asset investment (billion yuan)
Labor factor	X2	Average employed person of each year (ten thousand)

	X3	R&D staff full-time equivalent (man-year)
Industrial demand	X4	Growth ratio of industrial sales value (%)
	X5	Export value of electronic information products (billion dollars)
Industrial competition	X6	Number of enterprises
	X7	Number of large and medium enterprises
Industrial policy	X8	Proportion of government fund in the R&D input (%)
	X9	Proportion of state budget fund in the fixed asset investment (%)
Economic development level	X10	Per capita GDP (yuan)
	X11	Per capita disposable income of urban residents (yuan)
Technological innovation	X12	R&D input (billion yuan)
	X13	Number of authorized patents
Industrial supporting	X14	Influence coefficient
	X15	Sensitivity coefficient
Marketization degree And Opening-up level	X16	Proportion of non-state economy in the main business revenue (%)
	X17	Proportion of foreign capital in the fixed asset investment (%)

Table 2: Original Data of Different Indicators

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Y1	38827	45425	51253	51305	63945	74909	84619	93202	102988	111318
Y2	1384	1663	1703	1791	2825	3300	3506	4152	5052	5602
X1	2068	2646	3528	4147	5993	9077	9592	10828	12065	13775
X2	505.07	587.92	677.31	663.64	772.75	819.48	840.00	874.00	906.63	909.26
X3	122066	170923	201456	241402	278583	318018	380497	390977	411861	426583
X4	23.08%	18.65%	12.00%	2.41%	26.28%	19.01%	12.72%	10.40%	10.66%	9.04%
X5	3640	4595	5217	4572	5912	6612	6980	7807	7897	7811
X6	16958	14298	16511	19892	20983	15054	16587	17966	18727	19905
X7	3150	3029	3476	3842	3918	4538	5548	5985	6157	6253
X8	24.71%	24.62%	23.59%	23.41%	24.02%	21.68%	21.57%	21.11%	20.25%	21.26%
X9	0.60%	0.60%	1.00%	0.50%	0.80%	0.40%	0.90%	0.40%	0.56%	0.30%
X10	16500	20169	23708	25608	29992	36403	40007	43852	47203	50251
X11	11759	13786	15781	17175	19109	21810	24565	26467	28844	31195
X12	348.4	404.1	480.9	549.6	686.3	941.1	1064.8	1252.5	1392.5	1611.7
X13	12717	15887	24552	34201	35825	41267	50565	51391	47007	42375
X14	1.3954	1.4075	1.4075	1.4075	1.4075	1.4075	1.6084	1.6084	1.6084	1.6084
X15	1.9131	1.7749	1.7749	1.7749	1.7749	1.7749	0.9991	0.9991	0.9991	0.9991
X16	96.80%	96.10%	97.50%	97.20%	98.00%	97.90%	97.80%	97.60%	98.50%	98.50%
X17	30.70%	31.70%	21.90%	14.90%	9.60%	8.40%	6.80%	4.90%	4.50%	4.90%

3.2 Model of Grey Correlation Analysis

3.2.1 Method

At present, the regression analysis and the gray correlation analysis are the two common methods. However, the multi-collinearity among the different factors is easily present when the regression analysis is used for time series data [7, 15]. Furthermore, the large amount and obvious distribution of data are required for the regression analysis. Thus, it is difficult to use the regression analysis if the time series data is not complete. In contrast, the distribution of data is not highly required for the gray correlation analysis which is easy to grasp and comprehend [16]. Therefore, in this paper, the gray correlation analysis is used for analyzing the determinants of electronic information manufacturing industry development.

The gray correlation analysis, as a method of the gray system theory, was put forward in 1982 by Professor Deng Julong, a scholar of China. Whether the relation between two time series is close or not should be determined by the similarity of curve figure of time series. The closer the curves are, the greater the relational degree between time series is, otherwise, the smaller. The correlation degree is regarded as the main criteria to measure the relationship between system elements. Calculating the correlation degree between system elements is the core step of the gray correlation analysis.

3.2.2 Calculation of Grey Correlation Degree

First step, the reference sequence reflecting the behavior characteristics of the system and the comparison sequence affecting the behavior of the system should be determined firstly. Two reference sequences are identified in the paper, the main business income and the total profit. And some comparison sequences are also identified. Both the reference sequences and the comparison sequences are shown in Table.1. The reference sequences and the comparison sequences can be respectively defined as follows:

$$Y_i = \{Y_i(t), t = 1,2,\cdots,k, i = 1,2\cdots,n\}$$

Where k is the time span of the reference sequences, and n is the number of the reference sequences.

$$X_j = \{X_j(t), t = 1,2,\cdots,k, = 1,2,\cdots,m\}$$

Where k is the time span of the comparison sequences, and m is the number of the comparison sequences.

Second step, the data processing is supposed to be done. In order to compare the similarity of curve figure of different sequences, the original data of each sequence should be handled with dimensionless methods. Initialization, standardization and mean value treatment are the common dimensionless methods. In this paper, the original data is handled with initialization, in which the similarity of the original data can be improved [17]. The initialization is that all the data should be divided by the first data in the same sequence. In this way, the new reference sequences and comparison sequences can be given as follows:

$$Y_i = \left\{\frac{Y_i(t)}{Y_i(1)}, t = 1,2,\cdots,k,\ i = 1,2,\cdots,n\right\};$$

$$X_j = \left\{\frac{X_j(t)}{X_j(1)}, t = 1,2,\cdots,k,\ j = 1,2,\cdots,m\right\}.$$

Third step, the absolute difference should be calculated. The absolute difference between the comparison sequence X_j and the reference sequence Y_i can be calculated as follows:

$$\Delta_{ij}(t) = \left|Y_i(t) - X_j(t)\right|,\ t = 1,2,\cdots,k$$

For the comparison sequence X_j, the minimal absolute difference can be written as $min\left|Y_i(t) - X_j(t)\right|$, the maximal absolute difference can be written as $max\left|Y_i(t) - Xjt\right.$. For the whole comparison sequences, the minimal absolute difference can be written as $minmin\left|Y_i(t) - X_j(t)\right|$, the maximal absolute difference can be written as $maxmax\left|Y_i(t) - X_j(t)\right|$.

Then, the grey correlation coefficient should be calculated.The grey correlation coefficient between the comparison sequence X_j and the reference sequence Y_i can be calculated as follows:

$$\eta_{ij}(t) = \frac{minmin\left|Y_i(t) - X_j(t)\right| + \rho * maxmax\left|Y_i(t) - X_j(t)\right|}{\left|Y_i(t) - X_j(t)\right| + \rho * maxmax\left|Y_i(t) - X_j(t)\right|}$$

Where ρ is the distinguishing coefficient, the meaning of which is to weaken the distortion caused by the maximal absolute difference and increase the significance between the grey correlation coefficient. And$\rho \in (0,1)$, it is widely accepted that $\rho = 0.5$ generally.

Last, the grey correlation degree should be calculated. The grey correlation degree between the comparison sequence X_j and the reference sequence Y_i can be calculated as:

$$R_{ij} = \frac{1}{k} * \sum_{t=1}^{k} \eta_{ij}(t),$$

$$i = 1,2,\cdots,n,\ j = 1,2,\cdots,m$$

In general, when $R_{ij} > 0.5$, the relation between the comparison sequence X_j and the reference sequence Y_i is much closer.

3.2.3 Results Analysis

The five steps of the calculation are performed in Excel2010, and the empirical results are obtained and shown in Table.3. In general, the grey correlation degrees between the 17 influencing factors and two indicators of industrial development are all greater than 0.5. Therefore, it can be concluded that all thefactors are closely related to the development of electronic information manufacturing industry.

For theindustrial development indicatorof the main business revenue, per capita disposable income of urban residents and per capita GDPhave the highest correlation with it, according to the grey correlation degrees which is 0.9554 and 0.9178respectively. It means thatthe economic developmentlevel has great impact on the development of electronic information manufacturing industry and it is the vital foundation and core driving force of the development of electronic information manufacturing industry.Economy sustainable development is the effective way to promote the development of electronic information manufacturing industry. The export value of electronic information products ranks third, which shows that theforeign consumption demand is an important pulling force for the electronic information manufacturing industrydevelopment. Average employed person of each year and R&D staff full-time equivalent rank 4th and 6th respectively, which stands forthat human resource is also the crucial factor of the development of manufacturing industry at present. Number of large and medium enterprises and number of enterprises rank 5th and 9th respectively, which indicates that the industrial competition accelerates the development of manufacturing industry. R&D input ranks 7th, which implies that R&D input has an important role in promoting the development of manufacturing industry. Electronic information manufacturing industry is a technology-intensive industry, higher R&D input often means more technological innovation, and which in turn promotes the new productionresearch and the transformation of technological achievements preferably.Then itspeeds up the industrial technology progress and development.The other factors rank latter, which means that others are the secondary factors affecting the development of manufacturing industry.

As for the total profit of manufacturing industry, according to the ranking of the grey correlation degrees of 17 indicators, R&D expenditure ranks first, which further proves thatscience and technology is the primary productive force. In all, technological reform and innovation is avital factor to promote industrial development and to increase profitability. Per capita GDP and per capita disposable income of urban residents rank second and 4th respectively, R&D staff full-time equivalent and average employed person of each year rank third and 6th respectively, the export value of electronic information products ranks 5th,

number of enterprises and number of large and medium enterprises rank 8th and 10th respectively. The total profit is mainly affected by the above factors, which are basically consistent with the significant factors affecting the main business income. It can be concluded again that the level of economic development, human resource, R&D investment, industrial competition and industrial demand are the core determinants of electronic information manufacturing industry development and profit. The difference is that number of authorized patents ranks 7th among the 17 indicators affecting the total profit, which indicates that intellectual capital and technological innovation also has an important role in promoting the development of manufacturing industry.

In addition, the capital factor ranks last among the 17 affecting indicators to the main business revenue, and it ranks 14th among the 17 indicators affecting the total profit. Thus, it can be concluded thatcurrent development of electronic information manufacturing industry is little dependent on the capital, but more dependent on human resource and technology innovation.

Table 3: Empirical Results

Category	Indicator	Sequence	Main business revenue		Total profit	
			Correlation degree	Ranking	Correlation degree	Ranking
Capital factor	Fixed asset investment	X1	0.6093	17	0.6526	14
Labor factor	Average employed person of each year	X2	0.8639	4	0.7699	6
	R&D staff full-time equivalent	X3	0.7821	6	0.8586	3
Industrial demand	Growth ratio of industrial sales value	X4	0.6502	15	0.6076	16
	Export value of electronic information products	X5	0.9078	3	0.7980	5
Industrial competition	Number of enterprises	X6	0.7371	9	0.6834	10
	Number of large and medium enterprises	X7	0.8392	5	0.7548	8
Industrial policy	Proportion of government fund in the R&D input	X8	0.7109	12	0.6638	13
	Proportion of state budget fund in the fixed asset investment	X9	0.7245	11	0.6674	12
Economic Developmentlevel	Per capita GDP	X10	0.9178	2	0.8758	2
	Per capita disposable income of urban residents	X11	0.9554	1	0.8199	4
Technological innovation	R&D input	X12	0.7812	7	0.8778	1
	Number of authorized patents	X13	0.7004	13	0.7634	7
Industry supporting	Influence coefficient	X14	0.7396	8	0.6855	9
	Sensitivity coefficient	X15	0.6878	14	0.6461	15
Marketizationdegree	Proportion of non-state economy in the main business revenue	X16	0.7292	10	0.6780	11
Opening-up level	Proportion of foreign capital in the fixed asset investment	X17	0.6299	16	0.5978	17

4. Proposal

Empirical study results show that the level of economic development, human resource, R&D investment, industrial competition and industrial demand are the core determinants of electronic information manufacturing industry development. On the basis of results, some proposals are given to promote the development of China's electronic information manufacturing industry vigorously.

Firstly, it’s very important toincrease R&D investment and protect the intellectual property. According to the conclusions, R&D investment and intellectual capital have a positive influence on the development and profits of enterprises. Electronicinformation is a technological innovation industry, which has most intensive R&D investment, most active innovation, most wide application, and most radiation and driving function to other industries. IncreasingR&D investment, accelerating core-technology creation, and breaking through some frontier technologies, such as5G technology,big data and cloud computing ,et.

Secondly,government administrators and enterprisesneed pay attention to industrial talent training. Both the industrial employees and R&D personnel have a higher impact on the development of China's electronic information manufacturing industry. Talent is one of core competences of industrial development. In order to cultivate professional talent with high comprehensive qualities, enterprises are suggested to cooperate with universities in the pattern of “learning in universities-practicing in enterprises”. In addition, the enterprises are also supposed to take effective measures to attract, retain, and bring in talents.

Thirdly, we should encourage the economic development rapidly and improve economic developmentlevel. Development is the premise. The level of economic development is the most important determinant of China's electronic information manufacturing industry development. Higher level of economic development provides a good foundation for industrial development.It’s time to develop the information service industry and other emerging industries, and promote the integration of traditional industries and electronic information industry, which in turn stimulating the further growth of manufacturing industrial demand, promotingbetter development of China's electronic information manufacturing industry.

Then,we should make efforts tostandardize the industrial market and promote fair competition. The increase of the number of enterprises, especially the number of large and medium enterprises, intensifies the competition between enterprises. Highly competitive market always promotes enterprises to improve their technology, in order toenhance their competitiveness;what's more, it is also beneficial to rational flow of national capitaland effective allocation of national resources. Governmentdepartments need to regulate industrial market, and actively encouragemore enterprises to engage in the electronic information industry, pulling the industrial developmentin fair competition.

Finally, it's time to enhance the international competitiveness of electronic information products, and expand the exports of products. Asexport is a carriage to pull the national economy, the exports of electronic information products also stimulate the development of electronic information manufacturing industry greatly. We need to focus on both domestic and foreign markets, and exploring the international market actively, paying attention to excavate the potential export of new products. Besides, we should supportleading enterprises to build international marketing network and develop the international market. More enterprises should seize the opportunities of"action plan on the China-proposed Belt and Road Initiati ve"and try their best to"go out" to expand their product exports andincrease their international market share.

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