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Research on Input-output Efficiency of Urban Science and Technology in Guangdong Province

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Abstract

the article selected the number of R&D personnel, science and technology input and output elements such as R&D spending, a total of ten indicators, the city of Guangdong province science and technology input and output efficiency evaluation index system is established, using the DEA model of CCR model and BCC model, to the other as the comparison sample, 30 provinces of Guangdong province science and technology input and output data from 2013 to 2015 were analyzed, and the order to produce input and output efficiency of science and technology of Guangdong province, science and technology into use fully, input and output structure good conclusion. Some Suggestions are put forward according to the conclusion, such as: the government should formulate more perfect science and technology policies, give reasonable guidance to enterprises and universities, promote the development of enterprises, universities and research institutes, and universities should pay attention to the transformation of scientific and technological achievements into mature technologies.

Keywords

Guangdong province , science and technology , input-output efficiency , DEA model.

1. Introduction

Guangdong became the first big economic province in the past, is through the traditional pattern of export-oriented processing development, however, this era is the era of science and technology, in the country under the guiding ideology of "science and technology is the first productive force", need to have innovative technology, to improve the traditional industry pattern, add or change the driving force of economic development, it is effective in the right direction. According to the new economic growth theory, the increasingly extensive knowledge base and abundant human capital have become the main reasons for the rapid development of the contemporary world economy. Technological force is the main driving force to promote economic development, while investment in science and technology is the source to promote the strengthening of technological force and the development of science and technology, both of which are closely related to economic growth. Science and technology investment as one of the most obvious manifestations of science and technology productivity, its importance is self-evident. However, simply increasing the amount of science and technology input to increase the amount of science and technology output is a waste of precious human resources, financial resources and scientific and technological strength. Therefore, improving the efficiency of science and technology input and output, making full use of various resources, and improving the economic transformation of science and technology has become an important direction for the study of science and technology to promote social and economic development. In order to give full play to the service power of science and technology to the social economy, it is necessary to promote the technological progress of research, development and production and improve the technological innovation

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ability of enterprises. Innovation is the survival foundation of enterprises, which requires enterprises to develop corresponding incentive mechanism in order to stimulate technological innovation. In the operation of enterprises, the six aspects of planning, decision-making, implementation, production, application and maintenance are closely related to science and technology. As the main body bearing science and technology, enterprises inevitably need to invest in science and technology. But the enterprise is not the only subject of science and technology investment, the government only occupied the main position in the government investment in science and technology, although the government's investment in capital and human have far fewer than businesses invest, but the government ACTS as a guide for the enterprise, it ACTS as a barometer, embodies the national policies and priorities. Therefore, it is necessary to establish evaluation index and analyze production efficiency of urban science and technology input-output in Guangdong province. To analyze the efficiency of input and output of science and technology, so as to see the existing problems and advantages, is the inherent requirement of building an innovative city, the need to enhance the utilization efficiency of scientific and technological resources, and also a reference for local government to formulate relevant policies for the development of local science and technology. In addition, it is necessary to actively promote the construction of production, learning and research, so as to make enterprises, research institutes and institutions of higher learning unite. A three-way connection can share resources, share results, and prevent redundant or wasteful investment in science and technology. In addition, according to the different characteristics of each region, the government should improve the innovative development policy and do a good job in criticizing the vane. At the same time, we should strengthen inter-regional ties and cooperation, promote the development of science and technology, and establish a local innovation mechanism with local characteristics. Provincial science and technology input and output efficiency of system is a more complex system of investment, more output, need to take into account the interaction between decision making units, the relative efficiency evaluation of multiple homogeneous decision making units, and can make further evaluation, the results of evaluation is similar to the result is the difference between sex, effectively improve the objectivity and accuracy of evaluation. These requirements and conditions are determined by the environmental background and nature of interprovincial input-output efficiency system. Only by establishing an objective, accurate and comprehensive input-output efficiency system can the results of efficiency analysis be more objective, accurate and practical.

2. Literature Review

2.1. The Research Methods

Bankeretal (1990) used data envelopment analysis to study the input-output efficiency of information technology industry and information technology personnel. We have studied how to allocate resources to achieve the most efficiency in several stages. Suggestions and guidance are provided for the resource allocation of information technology.

Ming Miin Yua and Erwin T.J.L (2008) studied the input-output efficiency of 20 railways in 2002 by using data envelopment analysis. According to the empirical analysis, the efficiency of each railway is obtained, and the reasons for the different efficiency are deeply explored. Sun Shanxia, Fan Chunzeng and Shi Qinghua (2008) used data envelopment analysis to analyze the status of science and technology input and output of three major departments engaged in science and technology research and development in China. According to the actual situation of the three main departments, reduce the input redundancy and improve the output weakness to increase the output.

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Zhao shuxin and zheng linchang (2009) used DEA analysis method to select 13 key universities in Beijing as samples to evaluate the input-output efficiency of science and technology in universities in Beijing. The empirical results show that the input-output efficiency of colleges and universities in Beijing is high and should be maintained.

Wang yimin (2011) investigated the relative effectiveness of science and technology input-output in the development process of jiangsu province from 1996 to 2009 with DEA method. The results show that the input and output of science and technology from 1996 to 2000 and from 2005 to 2009 were in an effective state, while the input and output of science and technology from 2000 to 2005 were ineffective or ineffective. From the dynamic trajectory, from 1996 to 2009, the input-output efficiency of jiangsu province presented a "positive u-shaped" distribution.

Zhao qian, jiao jie and wang yihua (2011) used super-efficiency DEA method to analyze and evaluate the situation of 31 provinces (cities and autonomous regions) in China from two aspects of total and structure of science and technology competitiveness. Experiments show that the efficiency of each province is not evenly distributed, but distributed in a rugby pattern. The obvious influence effect among provinces fully confirms the national policy of "the rich first drives the rich later", which also indicates that there are great differences between provinces, both in terms of the total amount of science and technology and the scale of science and technology activities. Moreover, the province's science and technology competitiveness and its economic capacity is not necessarily positive correlation.

Zhou wei (2013) used data envelopment analysis to evaluate and analyze the input-output efficiency of science and technology in henan, hubei, hunan, anhui, jiangxi and jin in 2011. It shows that: on the one hand, the regional GDP, the number of scientific research institutions, and the salary level of R&D personnel have a great impact on the efficiency of science and technology input and output; On the other hand, attention should be paid to the influence of external factors on the efficiency.

Liu huizhen (2013) adopted DEA evaluation method and selected data from Beijing, tianjin, Shanghai, guangzhou and chongqing from 2005 to 2009 for empirical analysis. The results show that tianjin has the highest efficiency of science and technology, and Shanghai's science and technology investment is saturated.

Li xinyun, shi jihui and tang baoguo (2013) used DEA method to evaluate the input-output efficiency of science and technology in shandong province. The experimental analysis proves that the efficiency difference of science and technology activities is obvious, and the efficiency of the whole industry is low, which needs great improvement. In view of this result, they used regression analysis method to conduct in-depth research and analyzed the important conditions that would affect the efficiency. Suggestions are put forward to improve the investment structure of science and technology, give priority to the development of superior industries, and increase the investment in science and technology for the industries related to people's livelihood.

Ma xiuzhen and ma da (2014) made an empirical analysis on the relative efficiency of science and technology input-output in Qingdao from 2001 to 2011 by using the data enveloping analysis method. It is suggested that the formulation of science and technology policy should seek breakthroughs in the aspects of science and technology investment concept, macro structure, innovation of science and technology investment mode, science and technology investment system, science and technology funds management system reform and so on.

Xu qiaoling (2014) evaluated and analyzed the relative efficiency of science and technology input-output in 30 provinces in China by combining the BCC model of data envelopment analysis with the se-ccr model. The results show that most of China's provinces have ineffective technology or ineffective scale, and diminishing returns to scale. Therefore, it is suggested that in the case of existing investment resources, the main goal should be to improve the technology transformation force and change the efficiency in the non-dea effective state.

Sun jing (2012) used factor analysis method of multivariate statistics to analyze science and technology input and output indicators in 31 regions of China. It is concluded that human input is more effective than financial input to improve scientific and technological output in a short period of time.

Yang wenming, song shuwei, an weijin et al. (2013) used adagio data model and cluster analysis to analyze the data of 20 cities in China from 2005 to 2010. The goal is to identify the characteristics of each city's input and output of science and technology. Data clustering shows that the 20 cities can be divided into six different types. The experimenters believe that the amount of science and technology input, the structure of science and technology activities and the efficiency of resource allocation are the main reasons that affect the city's science and technology activities. According to the different situation of each city, some Suggestions are put forward to help the development of science and technology.

2.2. Research on the Level of Science and Technology in Guangdong Province

Yang can (2008) analyzed the scale and efficiency of science and technology input and output in Guangdong province. The scientific and technological input-output is regarded as a dynamic system and connected with economic development. According to the analysis results, it is suggested that Guangdong should increase the intensity of investment in science and technology.

Xu qiang and fan chunzeng (2010) used the DEA CCR model to analyze the input and output of science and technology in Guangdong province. Based on the analysis of overall efficiency and economies of scale, some Suggestions are put forward to improve the efficiency of technology transformation.

Lv liangwen and he jing (2011) analyzed and evaluated the efficiency of local financial science and technology investment in Guangdong province from 2001 to 2008 by using the se-dea model. The empirical analysis shows that Guangdong should invest more in science and technology in local finance to make it have a positive impact on economy.

Xie huifang and zhang wei (2013) used DEA model to evaluate the input-output efficiency of science and technology in Guangdong province from 2000 to 2012. The empirical results show that the input-output efficiency of science and technology in Guangdong province is high, and the innovation ability is constantly improved. Except for the redundancy of investment in 2000 and 2011, there is no excessive investment in other years. On the one hand, Guangdong province can improve the utilization rate of science and technology resources. On the other hand, if you want to increase the output of science and technology, you need to increase the amount of science and technology investment. The interprovincial science and technology input-output efficiency system is a complex system with multiple inputs and outputs, which needs to take into account the interaction between decision making units. The evaluation results obtained by the data envelopment analysis method are more comprehensive, objective and accurate. Therefore, the data envelopment analysis method is adopted here for analysis and evaluation.

3. Research Methods and Innovations

This article will mainly adopts the following three methods to analyse and evaluate analysis: (1) by the method of literature retrieval method and network literature collection: grasp the study status of DEA method, summarizing the experience and the achievements of predecessors, the study of science and technology input and output efficiency analysis method.

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(2) the combination of normative research and empirical research: to combine theoretical knowledge with the actual situation and find practical methods. (3) qualitative and quantitative combination: qualitative analysis, comprehensive evaluation of the status quo of urban science and technology input and output in Guangdong province, and comparison of inter-city science and technology environment, science and technology input and output; Quantitative analysis, using data envelopment analysis method to calculate the science and technology input-output efficiency of cities in Guangdong province, factor productivity decomposition research. The innovation of this paper mainly include the following: (1) according to the literature survey, at present only a few scholars study of Guangdong province science and technology input and output, and USES DEA method and other economic models, focusing on Guangdong city, the analysis of the input and output efficiency of science and technology, no one has done. (2) by choosing different indicators of science and technology input and output, different indicator systems will be constructed and different analysis results will be obtained. This paper intends to consider as many aspects and angles as possible, select the data of recent years, and strive for a comprehensive selection of science and technology input and output indicators, as far as possible objective and comprehensive results. In addition to the construction of the index system, some data items not included in the index system will be selected to be included in the reference analysis during the analysis, in order to achieve more complete, more accurate, more comprehensive and more multi-angle analysis results. (3) the analysis results and Suggestions of this paper will pay more attention to the perspective of urban individuals. Most of the research focuses on the development status and prospect of the whole province of Guangdong. This paper will be divided into parts to analyze problems and put forward Suggestions based on the status quo of the city itself. (4) according to the research results of other scholars, it is found that their research years are already too early, and the situation of scientific and technological activities is also somewhat different from the current situation. Therefore, this paper will select the data of recent years for analysis, and strive to obtain more accurate, effective and practical data results.

4. Construction of Technology Level System

4.1. Construction of Scientific and Technological Input-output Index System

Principle of systematicness : A system is composed of a number of small subsystems, which have the characteristics of the main system, but also has its own characteristics that the main system does not have. If the regional science and technology system is the main system, its subsystems are the science and technology input system and the science and technology output system. Each subsystem is selected to represent its own characteristics, which is the selection index. The more complete and comprehensive the index coverage is and the closer the correlation is, the more representative the system is. In order to systematically reflect the characteristics of the allocation of regional scientific and technological resources, the selection of the index system is very important, which requires to fully reflect the different aspects of input and output. The principle of systematicness requires the evaluation index system to reflect the overall state of regional resource allocation, and to pay attention to various detailed elements according to the results of systematic analysis of the science and technology system, so as to ensure the comprehensive, objective and accurate evaluation of the efficiency of regional science and technology resource allocation.

Principle of validity : The validity principle requires that the evaluation index system and sample characteristics are consistent, and can reflect the input-output situation of the regional science and technology system truly and accurately. However, there will be some differences between the construction of the evaluation index system and the actual situation. Validity is the degree of validity of a measurement. That is, how accurately the evaluation

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index system can measure the points to be measured. It is usually used to indicate the effectiveness of the evaluation system developed for the unit to be evaluated. The higher the validity is, the higher the correlation is, which indicates that the designed evaluation index system is more in line with the actual and malignant situation of the system. The higher the effectiveness.

Operational principle : It mainly includes three aspects: first, the availability of data, which can be obtained from the national bureau of statistics of China and the websites of regional statistics bureau. The second is to try to use quantifiable indicators, avoid qualitative indicators, empirical indicators, compared with quantifiable indicators can ensure the objectivity, accuracy, effectiveness of the results. Thirdly, the number of evaluation indexes should be simple and precise, so as to reduce the research workload and achieve double results with half the effort.

Principle of comparability : The definition of the index is clearly defined to ensure the unification of the index caliber, so that the horizontal and vertical comparison can be made, which is conducive to the study of the allocation of scientific and technological resources in different regions and time series.

Teleological principle : The purpose of this study is to analyze the influence on economic development, scientific and technological level mainly need to review the input and output efficiency of science and technology, the index system to closely around the goal to design, from the science and technology input and output of the system and it can bring the benefits of these aspects of choosing representative indicators, in the hope of index system of comprehensive, multiple perspectives to reflect the characteristics of the system of science and technology.

Principle of representativeness : Index system choice is for the purpose of the analysis of a regional science and technology level, data is comprehensive but also not the more the better, when designing the index system must pay attention to the index between the interaction, mutual influence, and avoid the strong correlation between indices and repeatability, avoid too much trouble to collect data and operation, reduce the error.

4.2. Data Collection and Collation

The data index is divided into input index (X) and output index (Y), among which the output index is divided into direct output index and indirect output index. Select the following indicators.

R&D activity personnel (x1) : refers to the manpower input of the whole city science and technology system. It can also be understood as the number of personnel engaged in research and development activities during the reporting period. More than 10 percent of the year must be spent on R&D or technology-related work. The number of personnel is the sum of full-time personnel plus part-time personnel.

Internal expenditure of R&D expenditure (x2) : expenditures directly spent on R&D activities within the reporting period only, excluding indirect expenditures such as management fee, construction fee and maintenance fee.

Number of persons engaged in scientific and technological activities (x3) : refers to the number of persons engaged in scientific and technological activities in the survey unit during the reporting period. Non-idle personnel who are required to directly engage in scientific and technological activities or services and whose working time is more than 10% of the annual working time.

Scientists and engineers (x4) : refers to those with at least a bachelor's degree, or intermediate or advanced professional titles.

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Expenditure on scientific and technological activities (x5) : refers to the total expenditure on scientific and technological activities of the survey unit during the reporting period. These include direct expenditures, those directly used for scientific and technological activities; And indirect expenditures for expenses other than scientific and technological activities.

Local finance science and technology appropriation (x6) : refers to the financial support for science and technology input by the government, which is the main source of science and technology funding.

The number of papers collected by foreign main retrieval tools (y1) : the number of papers directly reflects the research achievements of science and technology activity personnel. The main retrieval tools in foreign countries are SCI, EI and CPCI -S.

Number of patent applications accepted (y2) : refers to the number of invention patent applications received by the intellectual property office each year.

Number of contracts concluded in technology market (y3) : the number of contracts concluded in accordance with the recognized standards of technology market. Is one of the most objective factors.

Export of high-tech products (y4) : new, replacement, improved, or innovative products produced with high-tech or new technologies according to national or provincial requirements.

Table 1. data table of science and technology investment index in 2013

Index city	X1	X2	X3	X4	X5	X6
Beijing	242175	11850469	7182	163135	6023924	5317749
Tianjin	100219	4280921	3252	15036	416214	347988
Hebei	89546	2818551	3885	19569	259904	232557
Shanxi	49035	1549799	9750	16512	144749	121974
Neimenggu	37280	1171877	6262	9145	87587	69562
Liaoning	94885	4459322	8698	21343	564612	492777
Jilin	48008	1196882	9108	13216	260995	217801
Heilongjiang	62660	1647838	11283	15242	307980	289856
Shanghai	165755	7767847	8388	45650	1925405	1676936
Jiangsu	466159	14874466	12138	51258	1018787	625051
Zhejiang	311042	8172675	7169	24790	241705	198168
Anhui	119342	3520833	4564	20302	364642	314244
Fujian	122544	3140589	5614	7127	107754	86958
Jiangxi	43512	1354972	8941	12536	122711	113177
Shandong	279331	11758027	18001	23093	397837	348406
Henan	152252	3553246	6365	27179	300012	216012
Hubei	133061	4462043	7138	31149	570923	456873
Hunan	103414	3270253	9531	16824	168305	114242
Guangdong	501718	14434527	12863	26774	447986	309440
Guangxi	40664	1076790	10043	11123	129585	85297
Hainan	6962	148357	2033	5129	32354	30781
Chongqing	52612	1764911	9109	15096	127825	89187
Sichuan	109708	3999702	11883	71642	1679334	1212518

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Index city	X1	X2	X3	X4	X5	X6
Guizhou	23888	471850	3833	5933	62053	36589
Yunnan	28483	798371	6634	10979	190516	152083
Xizang	1203	23033	1292	1292	13284	13178
Shanxi	93494	3427454	6216	60853	1548747	1384390
Gansu	25047	669194	6849	10768	188770	166147
Qinghai	4767	137541	665	1133	16799	14299
Ningxia	8234	209042	858	858	10425	9631
Xinjiang	15822	454598	6376	7277	82251	68409

Table 2. data table of science and technology output index in 2013

Index city	Y1	Y2	Y3	Y4
Beijing	60784	123336	62755	20354
Tianjin	10180	60915	15664	19289
Hebei	5660	27619	4201	2811
Shanxi	2875	18859	817	3228
Neimenggu	1080	6388	631	110
Liaoning	14875	45996	12819	5430
Jilin	9364	10751	3252	386
Heilongjiang	11557	32264	2578	296
Shanghai	28597	86450	25952	88710
Jiangsu	30599	504500	30724	127965
Zhejiang	17540	294014	12074	14276
Anhui	8498	93353	6951	2826
Fujian	5705	53701	5230	15527
Jiangxi	3498	16938	1942	3442
Shandong	14726	155170	14263	17394
Henan	7512	55920	3794	20726
Hubei	16786	50816	14701	5209
Hunan	12679	41336	6548	1660
Guangdong	16057	264265	20169	256431
Guangxi	2297	23251	694	1942
Hainan	473	2359	57	571
Chongqing	7623	49036	4998	24836
Sichuan	13846	82453	12754	19217
Guizhou	803	17405	593	154
Yunnan	3064	11512	3084	2019
Xizang	14	203	0	56
Shanxi	18496	57287	19292	4739
Gansu	4646	10976	3777	242

Index city	Y1	Y2	Y3	Y4
Qinghai	193	1099	747	24
Ningxia	227	3230	597	129
Xinjiang	1109	8224	984	331

Table 3. data table of science and technology investment index in 2014

Index city	X1	X2	X3	X4	X5	X6
Beijing	245384	12687953	7325	168993	6409252	5471283
Tianjin	113335	4646868	3235	16730	385516	311673
Hebei	100946	3130881	3851	20347	303852	275385
Shanxi	48955	1521871	9789	15913	122822	102998
Neimenggu	36435	1221346	6691	8679	64771	54597
Liaoning	99586	4351851	8763	21599	541413	481829
Jilin	49774	1307243	8970	12775	264228	240352
Heilongjiang	62648	1613469	11386	15093	280492	248660
Shanghai	168173	8619549	9538	47890	2322281	2002365
Jiangsu	498801	16528208	13072	53827	1210910	515661
Zhejiang	338398	9078500	7214	27927	271184	212494
Anhui	129319	3936070	4594	20360	472080	355429
Fujian	135866	3550325	5932	7411	129107	105880
Jiangxi	43469	1531114	8843	13379	114192	104712
Shandong	286352	13040695	17477	22605	457737	392350
Henan	161444	4000099	7043	28050	314389	230494
Hubei	140741	5108973	7063	31764	637743	525480
Hunan	107432	3679345	8966	15760	168027	124559
Guangdong	506862	16054458	14051	28408	536420	363043
Guangxi	41208	1119033	10530	11712	127985	97297
Hainan	7514	169151	2106	5165	34131	32457
Chongqing	58354	2018528	8940	10604	86538	70716
Sichuan	119676	4493285	12795	74240	1887479	1575760
Guizhou	23969	554795	4108	6255	67526	43505
Yunnan	30523	859297	6738	10502	173852	139043
Xizang	1262	23519	1230	1230	14581	14581
Shanxi	97138	3667730	6387	62386	1545659	1430022
Gansu	27122	768739	6872	10949	208974	187681
Qinghai	4731	143235	614	1072	21118	18811
Ningxia	9500	238580	844	844	13785	13745
Xinjiang	15662	491587	5543	6392	73736	67631

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Table 4. data table of science and technology output index in 2014

Index city	Y1	Y2	Y3	Y4
Beijing	72672	138111	67284	18750
Tianjin	11893	63422	14947	19942
Hebei	6028	30000	3232	2754
Shanxi	3701	15687	667	3763
Neimenggu	1358	6359	535	345
Liaoning	17256	37860	11173	5122
Jilin	10917	11933	2891	354
Heilongjiang	13162	31856	2131	336
Shanghai	34191	81664	24864	89064
Jiangsu	38340	421907	24094	129364
Zhejiang	20051	261435	11923	15499
Anhui	10635	99160	7092	6117
Fujian	7003	58075	3708	15043
Jiangxi	3901	25594	1429	5253
Shandong	17617	158619	17331	20590
Henan	8214	62434	2942	22156
Hubei	19979	59050	21507	6311
Hunan	14922	44194	4879	2400
Guangdong	19338	278358	18577	231056
Guangxi	2805	32298	2347	2878
Hainan	570	2416	36	332
Chongqing	8089	55298	4016	31084
Sichuan	16711	91167	11932	21046
Guizhou	1129	22467	658	348
Yunnan	3946	13343	2785	1446
Xizang	13	248	0	18
Shanxi	21948	56235	25969	8037
Gansu	5697	12020	3354	248
Qinghai	214	1534	801	14
Ningxia	350	3532	544	415
Xinjiang	1471	10210	704	455

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Table 5. data table of science and technology investment index in 2015

Index city	X1	X2	X3	X4	X5	X6
Beijing	245728	13840231	7494	170563	7027642	6196676
Tianjin	124321	5101839	3177	17088	442132	368098
Hebei	106975	3508708	3964	21605	406037	346804
Shanxi	42873	1325268	9839	16208	154623	128765
Neimenggu	38248	1360617	6919	9002	93504	82226
Liaoning	85366	3633971	8665	21791	602499	551628
Jilin	49276	1414089	8728	12520	290165	275968
Heilongjiang	56598	1576677	11087	14593	257266	223774
Shanghai	171798	9361439	9582	48056	2647025	2384007
Jiangsu	520303	18012271	13287	57002	1303174	685198
Zhejiang	364710	10111792	7363	15775	302803	200857
Anhui	133558	4317511	4599	21373	480534	391900
Fujian	126572	3929298	5984	7469	154848	117673
Jiangxi	46548	1731820	8788	13094	122029	110979
Shandong	297845	14271890	17741	23079	480902	416496
Henan	158858	4350430	6913	31241	331388	229893
Hubei	135481	5617415	6623	32032	644219	492405
Hunan	114869	4126692	8816	14010	196044	132319
Guangdong	501696	17981679	14039	29124	639820	426376
Guangxi	38269	1059124	10797	11986	130616	105871
Hainan	7713	169685	1996	4971	33067	30741
Chongqing	61520	2470012	9753	11422	179589	162802
Sichuan	116842	5028761	12775	77723	2116421	1831484
Guizhou	23537	623196	4276	6417	78854	51514
Yunnan	39535	1093570	7047	11112	225672	192201
Xizang	1130	31242	1272	1272	13956	13951
Shanxi	92618	3931727	6531	63004	1636352	1534823
Gansu	25859	827203	6880	10687	248233	227444
Qinghai	4008	115843	914	1364	23354	20153
Ningxia	9247	254842	855	855	15723	15587
Xinjiang	16949	520010	5464	6383	86377	78319

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Table 6. data table of science and technology output index in 2015

Index city	Y1	Y2	Y3	Y4
Beijing	81896	156312	72306	14036
Tianjin	13103	79963	12456	19716
Hebei	7911	44060	3298	2362
Shanxi	4133	14948	698	3960
Neimenggu	1644	8876	498	334
Liaoning	18595	42153	11878	4564
Jilin	12663	14800	2420	306
Heilongjiang	13701	34611	1857	219
Shanghai	37134	100006	22119	85231
Jiangsu	43846	428337	32508	131110
Zhejiang	22408	307264	11273	16797
Anhui	12349	127709	12488	6691
Fujian	8230	83146	4132	14634
Jiangxi	5106	36936	1137	5126
Shandong	18647	193220	20422	17694
Henan	9572	74373	3482	27663
Hubei	23470	74240	22532	8013
Hunan	16027	54501	3704	3596
Guangdong	24313	355939	17316	232572
Guangxi	3076	43696	1577	3698
Hainan	673	3127	257	292
Chongqing	9724	82791	2638	28120
Sichuan	19421	110746	11228	15151
Guizhou	1244	18295	650	1368
Yunnan	4538	17603	2666	1145
Xizang	30	309	0	4
Shanxi	24683	74904	22508	9916
Gansu	6582	14584	4712	378
Qinghai	250	2590	952	43
Ningxia	345	4394	661	235
Xinjiang	1848	12250	658	322

The above data are obtained from China statistical yearbook of science and technology and the statistical yearbook of each province. Taking the data of science and technology input and output of Guangdong province as the experimental sample data, the data of science and technology input and output of 30 other provinces (cities, autonomous regions and municipalities directly under the central government) except Guangdong, Hong Kong, Macao and Taiwan were selected as the control sample data.

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5. The Principle of DEA Model

5.1. Advantage

DEA model is more applied to efficiency analysis, resource allocation and other problems than other models, because it has more advantages in system analysis with multiple inputs and outputs. (1) the functional relationship between the input and output indicators does not need to be determined in advance, and the interference of the subjective factors of the experimenter and other irrelevant factors can be excluded, so it has a strong objectivity. (2) it can be used to evaluate the technical effectiveness of multiple decision making units of the same type, and the scientific and technological input and output to be studied in this paper are also multi-index, so it is suitable for the systematic analysis of scientific and technological activities with multi-input and multi-output. (3) by using the projection principle, non-DEA effective decision making unit (DMU) can be provided with improved methods to ensure that each index with invalid DEA can reach the DEA's relative effectiveness after improvement. (4) the weight of each indicator can be set as a variable without the experimenter's initiative in advance, so as to achieve the optimal evaluation. (5) at the same time, it is not necessary to give the functional form of "production frontier" in advance, because DEA method can directly form the "production frontier" with effective decision making units, which reduces the influence of statistical errors on experimental results.

5.2. The CCR Model

Suppose there are n comparable DMU(decision making units), DMU1, DUM2, DMU3... DUMn, each decision making unit has p types of input x, and q types of output y. The x of each input represents how much a corresponding decision making unit has invested in a certain resource, and the y of each output represents the result of the corresponding decision making unit after the consumption of the input resource x. As follows:

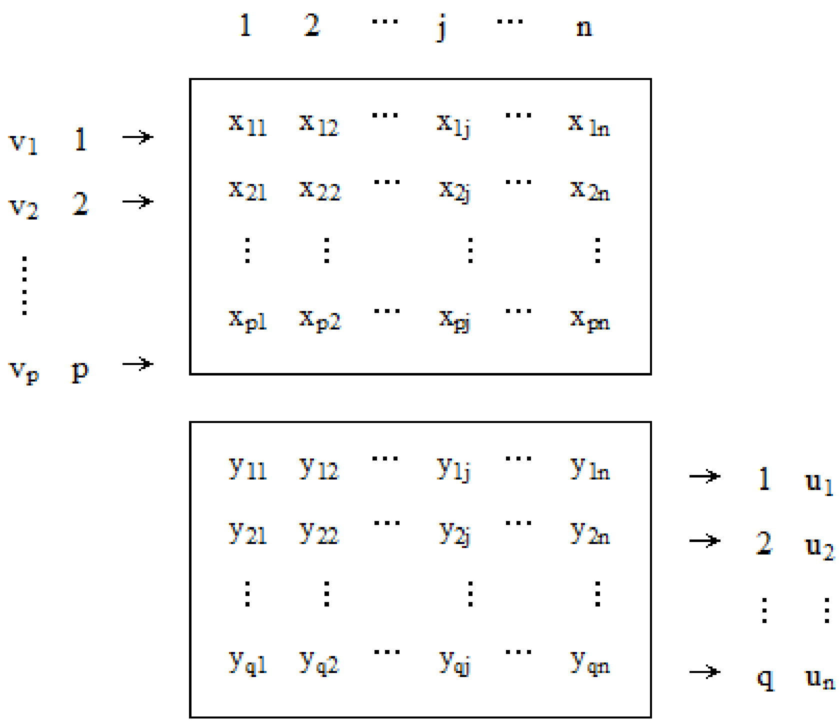

Figure 1. DMU schematic

Where, unit j is denoted as DMU_j, ($1\le j\le n$)

The input quantity of the ith input is expressed as $x_{ij}=DMU_j$, $x_{ij}>0$;

The output of the RTH output is expressed as $y_{rj}=DMU_j$, $y_{rj}>0$;

The input vector $X_j=(x_{1j}, x_{2j}, \ldots, x_{pj})^T$,

The output vector $Y_j=(y_{1j}, y_{2j}, \ldots, x_{qj})^T$,

Amount of input power $v=(v_1, v_2, \ldots, v_n)^T$,

Amount of output power $u=(u_1, u_2, \ldots, u_q)^T$,

The evaluation efficiency index of DMUj is $h_j = \frac{\sum_{r=1}^{q} u_r y_{rj}}{\sum_{i=1}^{p} v_i x_{ij}} = \frac{u^T Y_j}{u^T X_j}$ j=1, 2, 3, …, n, To determine whether the DMU is optimal, we need to calculate the maximum value of hj0 when v and u change. The input of DMUj0 is x0=xj0, y0=yj0, 1≤j0≤n. Then the evaluation efficiency index of DMUj0 is

$$\max h_{j0} = \frac{\sum_{r=1}^{q} u_r y_{rj0}}{\sum_{i=1}^{p} v_i x_{ij0}} = \frac{u^T Y_0}{u^T X_0}$$

The most basic CCR model is

$$C^2R\begin{cases} \max h_{j0} = \dfrac{\sum_{r=1}^{q} u_r y_{rj0}}{\sum_{i=1}^{p} v_i x_{ij0}} \\ s.t. \dfrac{\sum_{r=1}^{q} u_u y_{rj}}{\sum_{i=1}^{p} v_i x_{ij}} \le 1, \quad j = 1,2,\ldots,\mathrm{n} \\ u \ge 0, \ v \ge 0 \end{cases} \tag{1}$$

Among them, $\boldsymbol{t = \frac{1}{\sum_{i=1}^{p} v_i x_{ij0}}}$

The data we can collect are xij and yrj, which are known Numbers, while vi and ur are variables. The meaning of CCR model is to set vi, ur as variables, hj as constraints, constraint objects as all DMU, and hj0 of DMUj0 as the target. To evaluate the productivity effectiveness of a DMU relative to all DMU except this DMU. Use of dual linear programming, and Charnes Cooper - change, the introduction of the concept of the Archimedes infinitesimal, the above formula can be conversion: epsilon than any positive and greater than zero. And it's a non-Archimedes infinitesimally small quantity. Consider the C2R model with a non-archimedean infinitesimal:

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$$max\ h_{j0} = \mu^T Y_0$$
$$s.\ t.\begin{cases} \mu^T Y_j - \omega^T X_j \le 0 \\ \omega^T X_0 = 1 \\ \omega^T \ge \varepsilon \cdot \hat{e}^T \\ \mu^T \ge \varepsilon \cdot e^T \end{cases} \tag{2}$$

Among the : $j = 1,2,\ldots\ldots, n;\ \hat{e}^{T} = (1,1,\ldots,1) \in E_p;\ e = (1,1,\ldots,1) \in E_q$

So :

$$max\ h_{j0} = \mu^T\ Y_0$$
$$D\varepsilon\begin{cases} min[\theta - \varepsilon(\hat{e}^T s^- + s^+)] \\ \sum_{j=1}^{n} x_j\lambda_j + s^- = \theta X_0 \\ \sum_{j=1}^{n} y_j\lambda_j - s^+ = Y_0 \\ \lambda_j \ge 0,\ j = 1,2,\ldots, n \\ s^- \ge 0,\ s^+ \ge 0 \end{cases} \tag{3}$$

S is the vector composed of the slack variables corresponding to the input, and s is the vector composed of the residual variables corresponding to the output. Lambda is the coefficient of linear combination of decision making unit, is the effective value of DMU_{j0} of decision making unit to be evaluated. Set on the type of the optimal solution for λ^0, s^{0-}, s^{0+}, θ^0, has the following conclusions:

(1) if $\theta^0=1$, DMU_{j0} as weak DEA effective.

(2) if $\theta^0=1$, and $s^{0-}=0$, $s^{0+}=0$, DMU_{j0} is DEA valid.

(3) if $\theta^0 < 1$, DMU_{j0} is not valid for weak DEA.

(4) Assuming that $\hat{X}_0 = \theta_0 X_0 - s^{0-}$, $\hat{Y}_0 = Y_0 + s^{0+}$, then $<\widehat{X_0}, \widehat{Y_0}>$ is the projection of <X0,Y0> onto the effective front. And this projection is valid relative to all the DMU's before.

(5) If λj0(j=1,2,3,……p)exists for $\sum_{j=1}^{n} \lambda_j^0 = 1$ to be true. Then DMUj0 is the scale benefit unchanged. If there is noλj0(j=1,2,3,……p) for $\sum_{j=1}^{n} \lambda_j^0 = 1$ to be true. Then $\sum_{j=1}^{n} \lambda_j^0 = 1$, DMUj0 is increasing benefit of scale; DMUj0 represents diminishing returns to scale.

Interpretation of a valid solution : $F(X)=\{f_1(X), f_2(X), \ldots\ldots, f_n(X)\}$

For the maximum (Max) type, the various solutions are defined as follows:

Absolute optimal solution: if for any X, we have $F(X_0) \ge F(X)$;

Effective solution: if there is no X, make $F(X_0) \le F(X)$;

Weak efficient solution: if X does not exist, make $F(X_0) < F(X)$.

The production activity of CCR model is (x_j, y_j), j=1, 2, …, n. One is to describe the production possibility set and the other is to judge the relative effectiveness of production activities. This is also the economic implication of our study on the effectiveness of DEA.

The production possible set is defined as *T={(X,Y)| The output vector Y can be produced by the input vector X}*

So the input quantity is $X=(x_1, x_2, \ldots, x_p)^T$, Output for $Y_j=(y_1, y_2, \ldots, x_q)^T$, Its production potential set can be determined as :

$$T = \{(X,\ Y) | \sum_{j=1}^{n} x_j\lambda_j \le X, \sum_{j=1}^{n} y_j\lambda_j \ge Y,\ \lambda_j \ge 0\} \tag{4}$$

Effectiveness definition: 100% on the efficiency of a decision making units at random means that

(1) if the input x determine the constant, the output y whether any which one cannot increase, unless other output y can be reduced, the output y can increase;

(2) if the output y is determined to be unchanged, the input x can not be reduced no matter which one, unless other input x can be added, the final output y can remain unchanged.

When a decision making unit achieves 100% efficiency, the decision making unit is effective, that is, the effective decision making unit.

Definition of invalidity:

(1)For any $(X,Y)\in T$, and $X \ge X$, All have $(\hat{X}, Y) \in T$.

(2)For any $(X,Y)\in T$, and $\hat{Y} \le Y$, All have $(X, \hat{Y}) \in T$.

That is, there may be redundant input items or insufficient output items.

5.3. The BCC Model

Still assuming :

Decision r unit $j=DMU_j$, ($1\le j\le n$) ;

The input of the ith input $x_{ij}=DMU_j$, $x_{ij}>0$;

The output of the rth output $y_{rj}=DMU_j$, $y_{rj}>0$;

So:

$$(BC^2)\begin{cases} max(\mu^T Y_0 - \mu_0), \\ \omega^T x_j - \mu^T y_j + \mu_0 \ge 0,\ j = 1,2,3,\ldots\ldots, n \\ \omega^T X_0 = 1 \\ \omega \ge 0,\ \mu \ge 0,\ \mu_0 \in E, \end{cases} \tag{5}$$

Linear dual model:

$$D_{BC^2}\begin{cases} min\ \theta, \\ \sum_{j=1}^{n} x_j\lambda_j \le \theta X_0, \\ \sum_{j=1}^{n} y_j\lambda_j \ge Y_0, \\ \sum_{j=1}^{n} \lambda_j = 1, \\ \lambda_j \ge 0,\ j = 1,2,\ldots, n,\ \ \theta \in E, \end{cases} \tag{6}$$

The corresponding production set may be:

$$T_{BC^2} = \{(X,\ Y) | \sum_{j=1}^{n} x_j\lambda_j \le X, \sum_{j=1}^{n} y_j\lambda_j \ge Y, \sum_{j=1}^{n} \lambda_j = 1,\ \lambda_j \ge 0,\ \ j = 1,2,\ldots, n\} \tag{7}$$

At this time ,

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$$D_{BC^2}\begin{cases} min\ \theta, \\ (\theta X_0.Y_0) \in T_{BC^2} \end{cases} \quad (8)$$

In the production possibility set T of linear programming (D), if the input X_0 is reduced by the same proportion (the proportion is), then the output Y_0 is not changed. If X_0 does not decrease according to the optimal value of linear programming, that is, the ratio of shrinking is not theta =1, if there is only one input and one output, then the decision making unit j_0 is technically valid. If X_0 can be reduced according to the optimal value of linear programming, that is, the optimal value is not equal to 1 but less than 1, if there is only one input and one output, then the decision making unit j_0 is not technically valid. That's the economic explanation for linear programming. The reason why the BCC model is different from the CCR model is that the production of the possible set T does not meet the axiomatic assumption of "conicity".

The axiom of conicity assumes that it is arbitrary $(X,Y)\in T$, and $k\geq 0$, then $k(X,Y)=(kX,kY) \in T$.

The axiom is that if you increase the input X by k times to kX, then the input Y might also increase by k times to kY.

The CCR model is essentially the same as the BCC model. The only difference is the premise of the two models. One is the constant return to scale, and the other is the variable return to scale. The production set of the CCR model is a convex cone and the BCC model is a convex polyhedron. If the production fronts of the two models are drawn together, it can be seen that the DEA efficiency point on the CCR model is "absolute DEA efficiency". The production front in the first segment of the BCC model represents increasing returns to scale because its slope is greater than that of the CCR model. In addition, the production front of BCC model consists of three sections.

6. Analysis on the Influence of City Science and Technology Level on Economic Development in Guangdong Province

Software DEAP 2.1 was used to calculate the data in section 2.2, because the CCR model and the BCC model are essentially the same, although their results are slightly different. Therefore, the BCC model will be used to calculate the pure technical efficiency and the scale efficiency. The experimental results are divided into four parts: comprehensive efficiency, pure technical efficiency, scale efficiency and scale revenue. The following analysis will also be based on these four results.

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Table 7. input-output efficiency of science and technology in 2013

City	OE	TE	SE	RS
Beijing	1.000	1.000	1.000	-
Tianjin	1.000	1.000	1.000	-
Hebei	0.634	0.688	0.921	irs
Shanxi	0.433	0.441	0.983	irs
Neimenggu	0.214	0.301	0.708	irs
Liaoning	1.000	1.000	1.000	-
Jilin	1.000	1.000	1.000	-
Heilongjiang	1.000	1.000	1.000	-
Shanghai	1.000	1.000	1.000	-
Jiangsu	1.000	1.000	1.000	-
Zhejiang	1.000	1.000	1.000	-
Anhui	0.861	0.882	0.976	irs
Fujian	1.000	1.000	1.000	-
Jiangxi	0.542	0.574	0.944	irs
Shandong	0.869	0.924	0.941	drs
Henan	0.732	0.756	0.968	irs
Hubei	1.000	1.000	1.000	-
Hunan	1.000	1.000	1.000	-
Guangdong	1.000	1.000	1.000	-
Guangxi	0.667	0.680	0.981	irs
Hainan	0.622	0.791	0.787	irs
Chongqing	1.000	1.000	1.000	-
Sichuan	0.876	0.877	0.998	irs
Guizhou	1.000	1.000	1.000	-
Yunnan	0.781	0.783	0.997	drs
Xizang	0.265	1.000	0.265	irs
Shanxi	1.000	1.000	1.000	-
Gansu	1.000	1.000	1.000	-
Qinghai	1.000	1.000	1.000	-
Ningxia	1.000	1.000	1.000	-
Xinjiang	0.651	0.685	0.951	irs
Average	0.843	0.883	0.949	

Irs: represents increasing economies of scale; DRS: represents diminishing returns to scale; - : indicates that economies of scale remain unchanged.

Table 8. input-output efficiency of science and technology in 2015

City	OE	TE	SE	RS
Beijing	1.000	1.000	1.000	-
Tianjin	1.000	1.000	1.000	-
Hebei	0.609	0.659	0.924	irs
Shanxi	0.518	0.566	0.915	irs
Neimenggu	0.292	0.365	0.800	irs
Liaoning	1.000	1.000	1.000	-
Jilin	1.000	1.000	1.000	-
Heilongjiang	1.000	1.000	1.000	-
Shanghai	1.000	1.000	1.000	-
Jiangsu	1.000	1.000	1.000	-
Zhejiang	1.000	1.000	1.000	-
Anhui	1.000	1.000	1.000	-
Fujian	0.928	0.953	0.973	irs
Jiangxi	0.726	0.763	0.952	irs
Shandong	1.000	1.000	1.000	-
Henan	0.752	0.776	0.969	irs
Hubei	1.000	1.000	1.000	-
Hunan	1.000	1.000	1.000	-
Guangdong	1.000	1.000	1.000	-
Guangxi	1.000	1.000	1.000	-
Hainan	0.649	0.809	0.802	irs
Chongqing	1.000	1.000	1.000	-
Sichuan	0.854	0.923	0.925	drs
Guizhou	0.784	0.846	0.927	irs
Yunnan	0.669	0.669	1.000	-
Xizang	0.257	1.000	0.257	irs
Shanxi	1.000	1.000	1.000	-
Gansu	1.000	1.000	1.000	-
Qinghai	1.000	1.000	1.000	-
Ningxia	1.000	1.000	1.000	-
Xinjiang	0.721	0.755	0.956	irs
Average	0.863	0.906	0.948	

Irs: represents increasing economies of scale; DRS: represents diminishing returns to scale; - : indicates that economies of scale remain unchanged.

6.1. Comprehensive Efficiency Analysis

In 2013, the comprehensive efficiency of 18 provinces was 1. In 2014, the comprehensive efficiency of 18 provinces was 1. In 2015, the comprehensive efficiency of 19 provinces was 1. When the comprehensive efficiency is equal to 1, it indicates that the input and output of science and technology have reached the optimal value, that is, DEA is effective. When the comprehensive efficiency is less than 1 and greater than 0.9, the weak DEA is effective; otherwise, the DEA is invalid. The DEA value of Guangdong province is effective, and the input and output of science and technology are optimized. According to the data, the provinces whose comprehensive efficiency can reach 1 can be divided into two categories. There are still a few underdeveloped areas such as Gansu and Qinghai, which can achieve the optimal efficiency with less investment, which shows that their investment has been fully utilized, and the way of technology transformation is scientific, effective, and in line with their own reality, which is worthy of learning in Guangdong, which belongs to the mode of high input and high yield.

The expenditure of Guangdong province is the second in the country, R&D personnel are the first in the country, and enterprises are the first in the country. The pearl river delta, an economically developed region, occupies the right place at the right time. The expenditure input, especially the R&D expenditure of service enterprises, accounts for 3/4 of the total amount of the whole province, and the R&D expenditure of all industries accounts for 94% of the whole province, making it an important region for the input and output of Guangdong. In 2015, the number of new product projects developed by industrial enterprises in Guangdong increased by 9.5% over the previous year, and the output value of new products increased by 14.6% over the previous year. All these have brought huge economic and social benefits to Guangdong.

6.2. Pure Technical Efficiency Analysis

In 2013, there were 19 provinces with technical efficiency of 1, in 2014, there were 20 provinces with technical efficiency of 1, in 2015, there were 19 provinces with technical efficiency of 1. Technical efficiency indicates the utilization degree of technology investment, and the higher the efficiency value is, the more fully it is put into use. The technical efficiency of Guangdong province is 1 for three consecutive years, which is far higher than the national average and most of the provinces. This shows that Guangdong province has found a way to make full use of the input resources, achieve the maximum output benefit and achieve the optimal transformation of scientific and technological input and output.

In terms of research, research institutions and universities in Guangdong province attach great importance to experimental research, which can make full use of invested resources and turn it into scientific and technological achievements more than basic research and applied research. In terms of economy, Guangdong province, with its double advantages of talents and technology, can make full use of the input factors for output. In some industries, for example, the input-output ratio of the computer and office equipment manufacturing industry can reach 1:41.8, that of the electronic and communication equipment manufacturing industry can reach 1:10.8, and that of the lower pharmaceutical manufacturing industry can reach 1:9.3. All these can prove that Guangdong province science and technology investment conversion efficiency is high. It can be seen from the data that the technical efficiency is relatively easy to achieve, and Guangdong province should continue to maintain this state.

6.3. Scale Efficiency Analysis

In 2013, the technical efficiency of 18 provinces was 1. In 2014, the technical efficiency of 18 provinces was 1. In 2015, the technical efficiency of 20 provinces was 1. The scale efficiency was 1 in 14 provinces for 3 consecutive years, and 1 province for 1 consecutive year and 1 province for 2 consecutive years. The scale efficiency of Guangdong province is better than that of most provinces. The efficiency of science and technology input and output technology is effective and the scale remains unchanged, which means that under this input, the output of science and technology of Guangdong province has reached the maximum scale and can make full and effective use of the input of science and technology for production. The higher the scale efficiency, the better the utilization of the existing scale. The data shows that the current scale of Guangdong province is suitable for its current state of scientific and technological activities.

By 2015, there were 143 universities in Guangdong province, ranking the third in China. There are 189 research and development institutions. Traditional technology cities like Guangzhou and innovative technology cities like Shenzhen have formed a large-scale industrial enterprise cluster area in Guangdong. There are 42,113 enterprises in the industrial enterprise cluster area, among which 5,002 have R&D institutions and 8,113 have R&D activities, ranking the second in China. In addition, Guangdong province has a strong R&D expenditure, and ranks the fifth in the proportion of total GDP. With the advantages of universities, enterprises and industry, Guangdong province is striving to develop emerging industries with high technology content and large investment in R&D. Government funds are an important source of scientific research funds in Guangdong province. The government's investment is oriented, and the government looks at the problem from a strategic perspective of the overall situation. As a result, the investment in science and technology in Guangdong province is seldom redundant, wasteful, or in the wrong direction. With the adjustment of innovation-oriented industrial structure, high-tech industry develops rapidly. With the increase of personnel and capital demand, the scale of investment is also expanding. But the efficient technology conversion rate makes the high investment obtains the high output.

7. Conclusion and Countermeasures

(1) according to the data, the comprehensive efficiency, pure technical efficiency and scale efficiency are all equal to 1 for three consecutive years, so it is difficult to see the deeper problems in the science and technology input-output system of Guangdong province. If more years are selected for comparison, the line graph of input-output efficiency of science and technology can be drawn for dynamic analysis, which can guide the monitoring of input-output of science and technology activities of science and technology department in the future according to its historical track.

(2) the science and technology input of Guangdong province is large, and the output is also large. This is because Guangdong province has more universities, more high-tech enterprises, developed economy, so the investment is also large, high conversion efficiency. And the good economic foundation, the loose economic environment, the transformation of industrial upgrading, all led to the increase of science and technology investment. Increase investment in science and technology and expand the scale. The scale efficiency of Guangdong province is equal to 1, which means it is difficult to increase output unless input is increased. Therefore, on the premise of ensuring technical efficiency, the input of science and technology should be moderately increased to improve the output scale.

(3) Guangdong province and Beijing are also high-input, high-yield and high-efficiency models, so we can refer to the input-output model of science and technology in Beijing, and target industries with high added value and profits. We can make full use of the developed pearl river delta region and Shenzhen, a special economic zone, which is close to Hong Kong, Macao and southeast Asia. An effective system ensures the high efficiency of science and technology activities in Beijing, and Guangdong province can follow suit and strengthen the formulation, implementation and promotion of its own science and technology policies and regulations. On the basis of standardized management, Guangdong should give play to the initiative and guiding role of the government, not only to clarify the key points of Guangdong's financial investment in science and technology, but also to guide the technological innovation of enterprises.

(4) on the one hand, the government should provide guidance and guarantee, optimize the allocation of science and technology resources, adjust the structure of science and technology investment, so that those regions with high efficiency of science and technology have better science and technology resources, so as not to waste science and technology resources, can

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obtain more scientific and technological output. On the other hand, when investing in science and technology, cities in Guangdong can start from the following three aspects: the amount of investment in science and technology, the structure of investment in science and technology, and the efficiency of resource allocation. Only when combined from top to bottom can Guangdong's economy, science and technology develop faster and better.

(5) from the past development experience, the research team is an important factor to enhance the scientific and technological strength of Guangdong province. In the future development of Guangdong province must focus on strengthening the strength of scientific research team, improve the scientific research and innovation ability of scientific and technological personnel, which needs to attract talents. Economic, political and cultural environment are the main factors influencing the recruitment of talents. High-quality talents can stimulate the innovation spirit of the research team, enhance the team's vitality, and improve the overall quality and knowledge level. However, we cannot just recruit talents without a plan. In light of the actual situation of Guangdong province, we should replenish personnel in regions and institutions that lack research talents, improve the quality of personnel in key industries and research, and pay attention to the balance between regions and industries.

(6) as the largest economic province in China, Guangdong province has been standing at the forefront of the national economy for many years with its economy based on traditional technology, and has accumulated abundant capital for itself. However, in the adjustment of the industrial structure, problems arise. In the past, relying on economic strength to attract talents, purchase scientific and technological achievements, add scientific research equipment, and stimulate enterprises and industries to increase investment in science and technology, this has led to the lack of scientific and technological innovation ability, and the low input and output of basic research and applied research.

(7) enhancing scientific and technological exchanges. Scientific and technological exchanges can be divided into two aspects: internal exchanges and external exchanges. Internal communication refers to the exchanges and cooperation between industries and regions. External exchanges refer to exchanges and cooperation across industries and regions. Nowadays, the world is becoming more and more integrated, and the union between industries and regions has become a necessary trend of development. Nothing can be done behind closed doors. Learning advanced technology, ideas and ideas, uphold the principle of "I give priority to, I use", to their own learning progress plays a great role. In addition, enhanced communication can promote the formation and optimization of a line of r & d - production - application, which is of great benefit to improving the economic benefits and practicability of research results, expanding the scale of enterprises and exploring new markets.

(8) at present, there is a problem in the scientific and technological activities in Guangdong province, that is, the scientific and technological research achievements of universities and small and medium-sized enterprises can not achieve economic benefits, while the large enterprises with strong economic strength and the ability to invest funds are skeptical of the domestic scientific and technological achievements, and prefer to buy foreign technology. After spending a lot of manpower, financial resources and material resources to research achievements, it is difficult for universities and small and medium-sized enterprises to continue in-depth research or conduct new research without financial support. Large enterprises may not be able to meet their own expectations if they spend a lot of money, and foreign technologies may not be in line with the actual situation of domestic enterprises. This not only results in a two-way waste of scientific and technological research results and funds, but also goes against the development of both sides. This requires the government to guide and organize intermediary organizations to build a bridge between universities and enterprises, so as to achieve a win-win situation.

(9) universities and enterprises have different values on scientific and technological achievements. Universities pay more attention to the awards, number of papers and quality of research results, while enterprises pay more attention to the economic benefits, risks and safety of research results. This results in some deviation between the research results of universities and the actual needs of enterprises. In addition, there is no "after-sale guarantee" after universities turn to molding technology for research results, which is one of the reasons why enterprises prefer to buy mature technology directly.

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