A Study on the Efficiency and Influencing Factors of Scientific Research in Regional Universities Under "Double First-Class" Project—Based on Super-Efficiency DEA-Tobit Model

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Abstract. With the construction of "Double First-Class" as the background, it is of great significance to study the efficiency of scientific research in regional universities from the perspective of improving the output of scientific research achievements, promoting the transfer of scientific research results, and serving the development of local economy and industry. The DEA model is used to conduct empirical research on the scientific research efficiency of 34 undergraduate universities in Shandong Province from 2015 to 2017, and then the Tobit model is applied to analyze the main factors affecting the scientific research efficiency of the sample universities. The research results show that: the overall research efficiency of the sample universities is not high, and it is slowly declining; technical efficiency and pure technical efficiency are positively correlated; input redundancy and insufficient output are common. Research and analysis demonstrate that regional policy environment and research human capital have no significant impact on scientific research efficiency, while scientific and technological subject research and industry-university-research cooperation have an outstanding impact on scientific research efficiency; in the future, we mainly suggest to create a good regional policy environment to improve the number and quality of scientific and technological projects, optimize the investment capital structure and scale, improve the quality and transfer of scientific research achievements and other measures to improve the efficiency of scientific research in universities.

Keywords: Regional Universities · Data Envelopment Analysis · DEA · Scientific Research Efficiency · Tobit

1 Introduction

"Double First-Class" university project is a major strategic decision made by the CPC Central Committee and the State Council, which is a major initiative to improve the

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comprehensive strength and international competitiveness of China's higher education. In October 2015, the State Council issued the Overall Program of the World-class Universities and the World-class Disciplines Construction; in January 2017, the Ministry of Education, the Ministry of Finance and National Development and Reform Commission issued Implementing Measures of Coordinating the Construction of the World-class Universities and the World-class Disciplines (Trial), and published the list of "Double First-Class" universities and disciplines in September.

In the Overall Program, the state will encourage and support different types of high-level universities and disciplines differentiated development, the main body of China's higher education accounting for more than 90% undergraduate institutions in the country, giving them more opportunities and more important historical mission [14]. In the same time, the task of "Double First-Class" construction in improving the level of scientific research also puts forward a new demand for scientific research of regional universities. In the context of "Double First-Class", local governments have increased funds in regional higher education, strengthening the introduction of human resources. However, under the evaluation mechanism of "highlighting performance-oriented", scientific research input productivity of regional universities, the utilization of technological innovation resources depending on geographical merits and how to properly allocate resources to improve funds efficiency have become a hot spot concerned by the general public and academic circle [5, 20].

Combing previous literature, we find that the current results of research efficiency in universities are mainly from three perspectives: First, from research methods, we mainly adopt methods such as production function method and Data Envelopment Analysis (DEA) method. For instance, some scholars like Chen Litai [3] have drawn a conclusion that the overall efficiency of scientific research in China's inter-provincial universities is low and is declining every year by means of production function method; Li Jiazhe [6] and Zhang Yali [21] believe that DEA is the mainstream in the evaluation method of scientific research and production efficiency in universities, and they are constantly making new attempts to improve the model. Second, from the analysis of research objects, it is mainly the scientific research efficiency of universities directly subordinate to the Ministry of Education or inter-provincial universities. For example, Lu Genshu [11], Luo Hang [12] and Chen Jingyi [2] used DEA model to conduct comprehensive evaluation of scientific research efficiency in universities directly subordinate to the Ministry of Education. It is believed that there is a significant inconsistency between the ranking of scientific research efficiency and the ranking of scientific research input and output. Li Qunxia [7], Shen Lihong [15], Liu Tianzuo [10] used the DEA model to analyze the scientific research efficiency of universities in 31 provinces and cities in the country and found that there is no necessary connection between the scientific research efficiency of universities and the regional economy. Third, from the perspective of research content, it is mainly focused on the research on whether the scientific research efficiency of universities is effective and the influencing factors. Li Yanhua [8] and Cheng Zhaoji [4] used the DEA model to conclude that the sample universities have higher scientific research efficiency, but there is a gap between them. Those universities without efficient DEA model have redundant scientific research input yet insufficient output.

A further review of the literature reveals that in the research on the efficiency of scientific research in universities: there are many research methods and improvement models, and inter-provincial universities at the macro-level or universities subordinate to the Ministry of Education at the micro-level are the main ones. In the empirical research, there are few researches on universities in a certain region, and the current research focuses on the effectiveness of scientific research efficiency in universities, while there are not many studies on influencing factors, especially the description of scientific research in regional universities after the implementation of "Double First-Class" project.

Therefore, this article is under the background of "Double First-Class" project, based on the efficiency evaluation theory, taking the scientific research efficiency of Shandong provincial universities as the research object, and carrying out empirical research on the scientific research efficiency of Shandong provincial universities by the super-efficiency DEA-Tobit two-stage methods. First, we use the super-efficiency DEA model to analyze the scientific research efficiency of universities in Shandong province; Secondly, through the establishment of a Tobit regression model, we further empirically analyze the influencing factors of the scientific research efficiency of universities in Shandong province; Finally, we propose enlightenment and suggestions by addressing the problems existing in the scientific research efficiency of universities in Shandong province and combining its influencing factors. We strive to provide valuable references for higher education authorities to scientifically formulate scientific research policies, optimize disciplines layout, and allocate scientific research resources.

2 Research Design

2.1 Model Method Selection

Compared with other comprehensive evaluation methods, the DEA model can handle multi-input and multi-output variables without the need to dimensionalize input and output variables; the model does not require a preset production function, and it can effectively avoid the effect from subjective factors. These advantages [19] have become the mainstream method to effectively solve the multi-input, multi-output and multi-objective decision-making comprehensive evaluation in the scientific research efficiency evaluation.

In 1978, famous American operation researchers Charnes, Cooper and Rhodes proposed the DEA method and created a CCR model based on Constant Returns to Scale (CRS). Subsequently, Banker, Chames, and Cooper put forward a BCC model based on Variable Return to Scale (VRS), so that the production scale of the projection point is at the same level as the production scale of the Decision Making Units (DMU) being evaluated. That can calculate the efficiency under variable returns to scale. If multiple units are on the leading edge, then the efficiency values of these effective units are all 1, and can no longer be compared [22]. Andersen and Petersen proposed the Super-efficiency DEA (SE-DEA) model [1]. The basic principle is to remove the evaluated decision-making unit from the reference set when evaluating the efficiency of the decision-making unit. The effective frontier of production of effective decision-making units moves backwards, while the effective frontier of production of invalid decision-making units does not change. This will make the efficiency value of effective decision-making units greater than 1, while the efficiency value of invalid decision-making units remains unchanged, further distinguishing the efficiency value of effective decision-making units [18].

The Super-efficiency DEA model is shown in Formula (1):

$$min\ \theta$$
$$s.t.\left\{\begin{array}{l}\sum_{\substack{j=1\\j\neq k}}^{n}\lambda_j X_{ij}\leq\theta X_{ik}\\\sum_{\substack{j=1\\j\neq k}}^{n}\lambda_j Y_{rj}\geq Y_{rk}\\\sum_{\substack{j=1\\j\neq k}}^{n}\lambda_j=1\\\lambda_j\geq 0\\j=1,2,3,\cdots,n(j\neq k)\\i=1,2\ldots m\\r=1,2\ldots s\end{array}\right\} \tag{1}$$

In Formula (1), there is n decision-making unit (DMU), θ is the efficiency value, λ_j is the linear combination coefficient, and DMU_j in the model represents the j DMU in DMU unit. $X_{ij}(i = 1, 2 \ldots m)$ and $Y_{rj}(r = 1, 2 \ldots s)$ are the input variables and output variables respectively in DMU_j, where, m, s are the number of input variables and output variables respectively. Technical efficiency (TE) under variable returns to scale = pure technical efficiency (PTE) *scale efficiency (SE), and its calculation formula is $TE = PTE \times SE$.

2.2 Tobit Regression Model

Super-efficiency DEA can calculate the efficiency of scientific research in universities smoothly, but it cannot analyze the influencing factors and the magnitude of the ineffectiveness of DMU. In order to better analyze the factors affecting the efficiency of scientific research in universities, the Tobit regression model is introduced. The Tobit model is $Y_i^* = X_i\beta_i + \varepsilon_i$, where Y_i^* is the dependent variable vector, X_i is the explanatory variable vector, β_i is the explanatory variable coefficient, ε_i is the disturbance term, and obeys the normal distribution [13].

2.3 Index System and Data Sources

The evaluation index of scientific research efficiency in universities is mainly considered from two aspects of input and output of university scientific research [10]. University scientific research input mainly refers to the various input elements involved in scientific research activities, mainly including the input of scientific research personnel and scientific research funds; output refers to the scientific research results produced by scientific research activities, mainly including papers, monographs, patents, awards and commercialization of scientific and research findings, etc. Combining previous research results, considering factors such as the applicability, simplicity, comparative analysis, accessibility, and ease of calculation of input and output indicators [9], we mainly select the input indicators as “Teaching and Research Objects (X1)”, “Science and Technology Expenditures (X2)”, and the output indicators as “Thesis (Y1)”, “Monograph (Y2)”, “Award (Y3)”, “Income of Technology Transfer in the Year (Y4)” in face of the reality of higher education in Shandong Province.

When selecting the sample, considering that the main body of scientific research in regional universities is public under-graduate universities, private universities, independent universities, art and sports universities, and special types of universities are excluded from the sample; considering the completeness and easy access of data, representativeness and Double First-Class project, finally 34 undergraduate universities were selected as the research samples. The data comes from the Compilation of Statistics on Science and Technology of Higher Education Institutions from 2015 to 2017.

3 Analysis of Empirical Results

From the theory of Data Envelopment Analysis (DEA) model, technical efficiency is the product of pure technical efficiency and scale efficiency. Technical efficiency refers to the comprehensive measurement and evaluation of the resource allocation ability and resource utilization efficiency of the decision-making unit (DMU). Here it is mainly used to measure the allocation ability and utilization efficiency of scientific research input elements, and its value is to 1, which demonstrates that the technical efficiency is more effective. Pure technical efficiency refers to the efficiency brought about by the improvement of the system and management level. Here it mainly reflects the excellent degree of the scientific research mechanism and management level of universities. The closer its value is to 1, the more effective the pure technical efficiency is.

Scale efficiency refers to the difference between the existing scale and the optimal scale under the premise of a certain level of system and management. Here it mainly reflects whether the input elements of scientific research resources in universities reach the optimal scale. When the closer the value is to 1, it indicates the scale efficiency is more effective [10, 17, 22]. This article operates MAXDEA Ultra 8.0 DEA analysis software and uses the scientific research statistics of 34 sample universities between 2015 and 2017.

3.1 Analysis from Scientific Research Efficiency

Analysis from the perspective of technical efficiency: The three-year average value of technical efficiency is 0.715, and the overall level of technical efficiency of universities is not high; from 2015 to 2017, the scientific research efficiency of 34 universities in Shandong Province has shown a slowly downward trend, with an overall decrease of 3.3% in the range, and the decline is not obvious. It can be explained that the “Double First-Class” construction is in the initial stage, and universities are strengthening their own disciplines and professional construction according to the “Double First-Class” project, optimizing the structure of disciplines and majors, and the potential for connotation construction

Table 1. Scientific Research Efficiency Value of Universities in Shandong Province

DMU	2015				2016				2017				MEAN		
	TE	PTE	SE	RTS	TE	PTE	SE	RTS	TE	PTE	SE	RTS	TE	PTE	SE
SDU	0.862	1.000	0.862	Drs	1.000	1.000	1.000	-	0.722	1.000	0.722	Drs	0.862	1.000	0.862
OUC	1.000	1.000	1.000	-	0.977	1.000	0.977	Drs	1.000	1.000	1.000	-	0.992	1.000	0.992
UPC	0.497	0.502	0.990	Irs	0.555	0.561	0.989	Drs	0.834	1.000	0.834	Drs	0.629	0.688	0.938
SDNU	0.725	0.743	0.977	Irs	0.450	0.473	0.951	Drs	0.832	0.835	0.996	Irs	0.669	0.684	0.974
UJN	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000
SDUFE	0.219	0.431	0.508	Irs	0.113	0.411	0.276	Irs	0.258	0.413	0.625	Irs	0.197	0.418	0.470
QLUT	0.763	0.799	0.956	Irs	0.864	0.896	0.964	Irs	1.000	1.000	1.000	-	0.876	0.898	0.973
SDUTCM	1.000	1.000	1.000	-	0.910	1.000	0.910	Drs	1.000	1.000	1.000	-	0.970	1.000	0.970
SDJZU	0.972	0.975	0.998	Irs	0.863	0.886	0.974	Drs	1.000	1.000	1.000	-	0.945	0.953	0.991
SDUST	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000
QU	0.795	0.983	0.808	Drs	0.764	0.811	0.943	Drs	0.976	1.000	0.976	Drs	0.845	0.931	0.909
QUST	0.841	0.902	0.933	Irs	0.591	0.631	0.938	Irs	0.745	0.774	0.963	Irs	0.726	0.769	0.944
QUT	0.443	0.514	0.863	Irs	0.482	0.525	0.919	Irs	0.605	0.607	0.996	Drs	0.510	0.549	0.926
QAU	0.684	0.692	0.988	Irs	1.000	1.000	1.000	-	0.916	0.930	0.985	Irs	0.867	0.874	0.991
YTU	0.328	0.346	0.951	Irs	0.326	0.356	0.918	Irs	0.361	0.378	0.955	Irs	0.339	0.360	0.941
LDU	0.739	0.755	0.978	Irs	0.590	0.594	0.994	Irs	0.522	0.527	0.992	Drs	0.617	0.625	0.988
QFNU	0.586	0.642	0.913	Irs	0.625	0.684	0.914	Irs	0.544	0.620	0.877	Irs	0.585	0.649	0.901
SDUT	0.469	0.476	0.985	Irs	0.720	0.721	0.999	Drs	0.301	0.331	0.910	Irs	0.496	0.509	0.965
SDAU	1.000	1.000	1.000	-	1.000	1.000	1.000	-	0.973	0.985	0.988	Irs	0.991	0.995	0.996
LCU	0.828	0.845	0.980	Drs	0.803	0.805	0.997	Irs	0.813	0.821	0.991	Irs	0.815	0.824	0.989
LYU	0.771	0.771	1.000	Irs	0.997	1.000	0.997	Drs	0.753	0.757	0.994	Irs	0.840	0.843	0.997
SDFMU	1.000	1.000	1.000	-	0.442	0.443	0.997	Irs	0.488	0.501	0.974	Irs	0.643	0.648	0.990
BZU	0.811	0.840	0.965	Irs	0.826	0.868	0.952	Irs	0.776	0.818	0.948	Drs	0.804	0.842	0.955
BMU	0.452	0.484	0.936	Irs	0.364	0.371	0.982	Irs	0.334	0.550	0.607	Drs	0.384	0.468	0.842
DZU	0.598	0.626	0.955	Irs	0.336	0.391	0.858	Irs	0.286	0.297	0.963	Irs	0.407	0.438	0.925
HZU	1.000	1.000	1.000	-	1.000	1.000	1.000	-	0.476	0.490	0.971	Irs	0.825	0.830	0.990
JNU	0.551	0.830	0.664	Irs	0.516	0.659	0.783	Irs	0.399	0.552	0.722	Irs	0.489	0.680	0.723
JMU	0.526	0.661	0.796	Drs	0.376	0.575	0.654	Drs	0.407	0.462	0.881	Drs	0.437	0.566	0.777
SDTBU	0.841	1.000	0.841	Irs	1.000	1.000	1.000	-	1.000	1.000	1.000	-	0.947	1.000	0.947
SDJTU	0.610	0.619	0.986	Irs	0.456	1.000	0.456	Drs	0.272	0.273	0.997	Irs	0.446	0.631	0.813
TSU	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000
WFU	0.244	0.382	0.640	Irs	0.320	0.372	0.860	Irs	0.299	0.346	0.864	Irs	0.288	0.367	0.788
WFMU	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000	-	1.000	1.000	1.000
UZZ	0.564	0.738	0.764	Irs	1.000	1.000	1.000	-	1.000	1.000	1.000	-	0.855	0.913	0.921
MEAN	0.727	0.781	0.919		0.714	0.766	0.918		0.703	0.743	0.933		0.715	0.763	0.923

has not been fully realized. From the perspective of 3-year technical efficiency, in 2015, 2016, and 2017, there were 9, 10, and 10 technically effective universities, accounting for 26.5%, 29.4%, and 29.4% of higher education institutions respectively; The 3-year average technical efficiency of the 4 universities: UJN, SDUST, TSU, WFMU, is effective, accounting for 11.8% of all universities. From the analysis of technical efficiency, although the 4 universities are not the ones with the most personnel and funding, they are the most technically efficient, indicating that they have made full use of resources under the existing conditions and achieved maximum output and benefit. They have played a very good demonstration effect for other universities.

Analysis from the perspective of pure technical efficiency: The overall pure technical efficiency of the sample universities is relatively low, at 0.763. From 2015 to 2017, the technical efficiency of 34 universities in Shandong Province showed a slowly downward trend, with an overall decline of 4.9% in the range, and the decline was not significant. It can be analyzed from Table 1 that there is a positive correlation between the technical efficiency of the sample universities and the pure technical efficiency. In 2015, 2016 and 2017, there were 11, 14 and 13 universities whose pure technical efficiency was effective, accounting for 32.4%, 41.2% and 38.2% respectively. In terms of the average value of the pure technical efficiency in the three years, there are 7 pure technical efficiency effective, accounting for 20.6%. It can be seen that the overall scientific research management level of universities in Shandong Province needs to be further improved, and the connotation construction needs to be further strengthened.

Analysis from the perspective of scale efficiency: The average scale efficiency of the overall universities is 0.923, which is quite high. From 2015 to 2017, it is on an upward trend, with an interval growth rate of 1.5%, and the growth rate is relatively slow. In 2015, 2016 and 2017, there were 10 universities with effective scale and efficiency, accounting for 29.4%. After the launch of the "Double First-Class" project, the personnel and funding input of the sample universities has increased year by year, but the technical efficiency and pure technical efficiency are declining. This shows to a greater extent that the high input drives the output of scientific research results at this stage. Pure technical efficiency has become the main factor affecting the efficiency of scientific research. In other words, with the advancement of the Double First-Class project, the optimization of scientific research management systems and mechanisms has lagging behind, resulting in a decline in scientific research efficiency.

3.2 From the Perspective of Input and Output

We further take the super-efficiency calculation of the scientific research efficiency of universities in 2017 as a sample, and analyze the improvement of its indicators from the perspective of input and output:

In terms of investment indicators, in 2017, there were redundancy in the input of teaching and research personnel in 27 sample universities and the investment in science and technology of 28 universities, and vice versa, the investment was insufficient. Among them, 24 universities have large investment redundancy in both indicators at the same time, and it is necessary to increase the utilization rate of scientific research input resources of universities and reduce the scale of inefficient investment. For universities with insufficient investment, it is critical to further increase the investment in personnel and funds appropriately. In addition, there are reverse changes in personnel and funding inputs in 5 universities, indicating that the input index structure is unreasonable and the structure of input factors needs to be optimized and adjusted (Table 2).

Table 2. The improvement value of input and output of Shandong regional universities

NO	DMU	SE	Input Index(X1)	Input Index(X2)	Output Index(Y1)	Output Index(Y2)	Output Index(Y3)	Output Index(Y4)
1	SDU	0.722	−2216.02	−31611.40	4.88	146.61	0.00	0.00
2	OUC	1.233	536.12	−17067.73	0.00	564.87	2903.25	0.00
3	UPC	0.834	−471.17	−7209.29	0.00	0.00	887.46	1.90
4	SDNU	0.832	−160.57	−1627.43	0.00	0.00	194.75	1.40
5	UJN	3.051	2742.25	31150.91	9.55	2536.03	0.00	6.58
6	SDUFE	0.258	−276.71	−1432.15	0.00	0.00	1.03	0.09
7	QLUT	1.175	125.75	953.27	0.00	74.26	436.21	0.00
8	SDUTCM	1.838	−112.92	3912.55	1.50	0.00	25.20	0.00
9	SDJZU	1.684	639.02	−1341.31	0.00	0.00	58.14	5.22
10	SDUST	1.623	1153.09	6159.31	0.00	1721.74	0.00	0.00
11	QU	0.976	−40.04	−218.06	0.00	0.00	224.08	0.82
12	QUST	0.745	−308.49	−4895.04	1.11	0.00	189.05	0.00
13	QUT	0.605	−448.65	−3481.03	0.00	0.00	0.00	0.73
14	QAU	0.916	−98.12	−1343.98	0.00	0.00	804.71	1.49
15	YTU	0.361	−721.00	−2119.18	0.45	0.00	0.37	0.00
16	LDU	0.522	−364.97	−1934.77	0.00	0.00	3.43	1.33
17	QFNU	0.544	−324.12	−3620.71	0.00	0.00	411.71	0.27
18	SDUT	0.301	−997.87	−11389.88	0.00	0.00	268.01	0.03
19	SDAU	0.973	−38.03	−6256.26	0.00	505.68	0.00	0.00
20	LCU	0.813	−197.68	−1115.12	0.00	0.00	158.27	1.84
21	LYU	0.753	−207.41	−1762.89	0.00	0.00	178.44	3.58
22	SDFMU	0.488	−914.40	−3929.36	0.00	0.00	18.94	0.00
23	BZU	0.776	−107.02	−326.50	0.00	0.00	1.39	0.52
24	BMU	0.334	−1045.11	−2009.72	0.00	0.00	0.00	0.00
25	DZU	0.286	−408.67	−847.42	0.19	0.00	0.00	0.38
26	HZU	0.476	−224.86	−433.20	0.22	0.00	0.00	0.44
27	JNU	0.399	−167.78	−451.68	0.17	0.00	0.00	0.35
28	JMU	0.407	−1422.27	−2052.22	0.64	0.00	0.00	1.28
29	SDTBU	1.769	76.66	247.95	0.00	0.00	3.81	0.33
30	*SDJTU*	0.272	−559.59	−1380.13	0.00	0.00	0.17	0.28
31	TSU	1.348	−155.88	370.81	0.00	137.34	0.00	0.59
32	WFU	0.299	−399.44	−1989.64	0.00	0.00	34.50	0.29
33	WFMU	1.028	38.21	134.97	2.11	0.00	159.89	4.11
34	UZZ	1.777	−158.00	211.45	1.50	0.00	0.00	0.00

In terms of output indicators, all universities except BMU have different degrees of output deficiencies, which are mainly manifested in the two indicators of scientific and technological achievements transfer income and scientific research awards. According to the data analysis of various universities, the two indicators of each ones are quite different. Many universities have not yet got income from scientific and technological achievements; the scientific research awards of some universities also reflect that the quality of scientific research results of universities is not high. Universities with insufficient income from the commercialization of scientific and technological achievements need to further improve the ability to transfer application results, and universities with insufficient scientific research awards need to further enhance the quality and level of scientific research results. From the perspective of output indicators, the main reason for the insufficient output and the difference in scientific research efficiency is not the papers and monographs that universities pay more attention to, but the ability to transfer scientific and technological achievements and scientific research awards.

3.3 Tobit Regression Analysis

When using the Tobit model to analyze influencing factors, this article selects Regional Policy Environment (X1), Industry-university-research Cooperation (X2), Research Human Resources (X3), Scientific and Technological Subject Research (X4) as explanatory variables, and the technical efficiency of each university as the explained variable. The model is established as shown in Formula (2), and regression analysis is carried out through Stata software.

$$TechEff = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon \tag{2}$$

In order to deeply explore the factors that affect the efficiency of scientific research input and output of universities in Shandong province, the collected data is uploaded into Stata software, and the regression results after analysis and calculation are shown in Table 4.

1) A good regional policy environment will help improve the efficiency of scientific research in universities. It can be seen from Table 4 that there is a positive correlation between the regional policy environment and the scientific research efficiency of universities, but it is not significant. This shows that government investment in scientific research in universities is an important source of scientific research funding for universities, and good government policies have a guiding role in improving the efficiency of scientific research in universities. At the same time, the improvement of scientific research efficiency in universities cannot be got rid of the support of the government. Government departments should optimize scientific research policies, increase funding, encourage universities to produce more scientific research results, promote the effective transfer and utilization of scientific research results, and improve the efficiency of scientific research in universities.

2) There is no obvious positive correlation between industry-university-research cooperation and university scientific research efficiency. It can be seen from Table 4 that industry-university-research cooperation has a certain negative correlation with the scientific research efficiency in universities, and is significantly correlated at the 5% level of significance, which shows that the investment of enterprises and institutions has a significant negative effect on the scientific research efficiency of universities. The

Table 3. Influencing Factors of the Efficiency of Scientific Research in Regional Universities

Influencing Factors	Index	Basic Assumptions
Regional Policy Environment (X1)	Government Investment in Science and Technology Funds	The more the government invests, the higher the efficiency of scientific research is.
Industry-university-research Cooperation (X2)	Entrusted Investment Funds by Enterprises and Institutions	The more funds entrusted by enterprises and institutions provide, the higher the efficiency of scientific research is.
Research Human Resources (X3)	Full-time Equivalent Personnel	The more researchers engaged in scientific research, the higher the efficiency of scientific research is.
Scientific and Technological Subject Research (X4)	The Number of Scientific and Technological Projects	The more the number of projects are, the higher the efficiency of scientific research is.

reason is that enterprises and public institutions pay more attention to solving practical problems faced by enterprises and institutions and the practical application of scientific research results in the scientific research investment and scientific research needs of universities and institutions. At present, scientific research in universities is more to carry out theoretical research and basic research. At the same time, it also shows that when evaluating the scientific research efficiency of the funds entrusted by enterprises and institutions, the evaluation indicators must "break five obsolete conceptions", and the papers and works cannot be simply used as indicators. The indicators must be optimized to improve the efficiency of scientific research (Table 3).

3) There is no positive correlation between research human resources and scientific research efficiency of universities. It can be seen from Table 4 that there is a certain negative correlation between research human resources and scientific research efficiency of universities, but it is not significant. This shows that the total number of people engaged in scientific research cannot determine the efficiency of scientific research activities in universities. The previous concept of focusing on the absolute number of scientific research output should be changed to focus on relative output indicators. Investing too many researchers will bring about the phenomenon of input crowding, which will otherwise lead to a decline in scientific research efficiency. Therefore, improving the efficiency of scientific research in universities is not blindly adding researchers, but the "capital" investment represented by personnel should be rationally distributed within a certain range.

4) There is a positive correlation between the research on scientific and technological projects and the efficiency of scientific research in universities. It can be seen from Table 4

Table 4. Analysis of Influencing Factors of Scientific Research Performance of Regional Universities

Explanatory Variable	Correlation Coefficient	Standard Error	P Value
Regional Policy Environment (X1)	0.0048066	0.004253	0.261
Industry-university-research Cooperation (X2)	−0.0195407**	0.0090491	0.033
Research Human Resources (X3)	−0.000106	0.0000992	0.288
Scientific and Technological Subject Research (X4)	0.0003014**	0.0001484	0.045

Note: *, **, *** indicate significant value at the 1%, 5%, and 10% levels respectively

that scientific and technological projects research is significantly correlated with the scientific research performance of universities at the 5% significance level, indicating that the establishment of scientific and technological projects is an effective way to improve the efficiency of scientific research in universities. Science and technological projects are the carrier of scientific research funds and the basis for scientific researchers to transfer their innovative ideas into scientific and technological achievements [16]. The more scientific and technological projects establish, the more scientific research results are brought about, and the higher the efficiency of scientific research in universities is.

4 Conclusion and Enlightenment

This article uses the DEA method under the background of "Double First-Class" project, and takes 34 universities in Shandong province as a sample to conduct an empirical study on the efficiency of scientific research input and output of regional universities, and then uses the Tobit model to explore the influencing factors that affect the efficiency of scientific research in regional universities. All these have given rise to a certain extent of reference significance to study the efficiency of scientific research in regional universities. Through research, the following conclusions are obtained:

Between 2015 and 2017, the overall efficiency of scientific research of universities in Shandong Province was not high, and during the period, the efficiency of scientific research was slowly declining, and the efficiency of scientific research was still in the stage of relying on high input driving; university technical efficiency and pure technical efficiency were positively correlated. Since the implementation of the "Double First-Class" project, universities have increased significantly in terms of personnel, funds and other scientific research input elements. However, the scientific research management system and mechanism of regional universities are in the process of transformation and upgrading, lagging behind the growth rate of scientific research element input. Its own potential has not yet been realized. Although the scale efficiency remains high, the pure technical efficiency is relatively low. As a result, it restricts the improvement of technical efficiency. It can be seen from the input indicators that only emphasizing too much scientific research element input will result in crowded input elements and abuse of scientific research resources, which will affect the technical efficiency of universities. From the output indicators, it can be seen that the transfer ability and quality of scientific and technological achievements is a shortcoming, and the level of universities serving local economic development and the quality of scientific research results need to be further improved. Therefore, strengthening the improvement of the internal scientific research management system of universities and improving the efficiency of resource operation, while appropriately transferring scientific research resources to avoid excessive redundancy of input resources and improving the transfer ability of scientific and technological achievements are the keys to improving the scientific research efficiency of regional universities.

In view of the above analysis and research, this article can get the following two enlightenments and suggestions:

First, strengthening industry-university-research cooperation and increasing research and development human resources investment are not effective measures to improve the efficiency of scientific research in regional universities. With the help of industry-university-research cooperation, enterprises and institutions are pursuing the ability to solve practical problems and transfer scientific research achievements. It is necessary to further strengthen the "breaking five obsolete concepts" and improve the performance-oriented multi-dimensional evaluation index system; at the same time, an excessive increase of human capital or low-efficiency investment has caused redundancy of resources and reduced scientific research efficiency. It is wise to appropriately adjust the scale of input capital, increase the utilization rate of human capital, and optimize the structure of input factors so as to improve the efficiency of scientific research in regional universities.

Second, the good scientific research policies adopted by the government and the establishment of high-quality scientific research projects are conducive to improving the efficiency of scientific research in universities. We suggest to increase government support for scientific research policies in universities, improve scientific research policies, and facing the reality of regional economic development, increase the pertinence of scientific and technological projects, strengthen the quality of scientific research, and focus on the transfer of scientific research achievements to serve the local economy and industry development, thereby promoting the efficiency of scientific research input and output in regional universities.

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