Article

The Evaluation of Comprehensive Teaching and Research Efficiency and Its Key Influencing Factors Analysis of “Double First-Class” Universities in China

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Abstract: An evaluation index system is established in order to evaluate the comprehensive teaching and research efficiency of “Double First-Class” universities in China, using the Joint Data Envelopment Analysis method. The influence of the parameters in the model is analyzed and the algorithmic steps are given. The key factors of the system are identified by the Grey Correlation Analysis method. The comprehensive teaching and research efficiency of “Double First-Class” Universities in China in 2019 has thereby been calculated as an empirical study. The results show that: (1) It is effective and feasible to construct an evaluation method based on joint DEA, for the evaluation of comprehensive teaching and research efficiency of “Double First-Class” Universities in China. (2) The key factors are the number of cited papers, the annual budget, and the salaries of graduates. Based on those factors, suggestions have been put forward to improve their efficiency. (3) The comprehensive teaching and research efficiency of China’s “Double First-Class” Universities are high, and the comparison between research efficiency and teaching efficiency shows that 69.2% of the “Double First-Class” Universities have higher research efficiency than teaching efficiency. Most of those universities allocate a higher proportion of shared input to research.

Keywords: “Double First-Class” universities; comprehensive teaching and research efficiency; data envelopment analysis; Grey Correlation Analysis

1. Introduction

Nowadays, the growth of the national economy and the improvement of international competitiveness depend on the talents of people, and universities are essential places where talents are developed. To this end, in 2015, China formulated the Overall Plan for Promoting the Construction of “Double First-Class” Universities (i.e., Construction Overall Plan). In 2017, 42 universities in China were selected as “Double First-Class” Universities (i.e., DFCUs) as a prelude to the construction of DFCUs. Guiding Opinions on Accelerating the Construction of DFCUs (i.e., Construction Guidance) were promulgated in 2018, and The Measures for Evaluating the Effectiveness of DFCUs Construction (for Trial Implementation) were formulated in 2021. These policies have formed the guiding documents for the development of DFCUs in China and constituted the guiding ideology to evaluate their performance. However, they present neither a concrete appraisal standard nor a method for the evaluation of the performance of DFCUs.

Furthermore, the improvement of scientific research on DFCUs was also stressed by Construction Guidance in 2018. The National Conference on Education Work in China proposed that the key principles for higher education should be the “undergraduate foremost” and the promotion of the “four returns”, which is “return to common sense, return to duty, return to original intention and return to dream”. National Education Minister Baosheng Chen
pointed out that one of the main purposes of educational reform and development should be more attention to performance management. It is concluded that the core purpose of DFCUs in China is to teach and conduct scientific research. Therefore, there is an urgent need not only for building more DFCUs but also for the methods to evaluate comprehensive teaching and research efficiency (referred to as CTRE) and strategies for its promotion.

In order to evaluate the CTREs of DFCUs scientifically, the structure of this paper is as follows, the second part summarizes the literature concerning the index system and the methods of evaluating the efficiency of international universities and DFCUs. The third part establishes the evaluation index system of comprehensive teaching and research efficiency of DFCUs in China. The fourth part constructs the joint DEA model of CTRE evaluation. The fifth part evaluates the CTREs of 26 DFCUs in China. The sixth part analyzes the influencing factors of the comprehensive efficiency of DFCUs by the Grey Correlation Analysis method. The seventh part presents a strategy for the improvement of efficiency. The eighth part conducts the conclusion and prospects for future research.

2. Literature Review

2.1. Research on the Evaluation Index System of Input-Output Efficiency of Universities

The current evaluation index system of the input-output efficiency of universities contains basic input indicators such as faculties, daily funding inputs, and equipment funding; the number of graduated students and the number of published academic papers are recognized as output indicators. There are scholars who have constructed evaluation index systems with various focuses. In terms of input indicators, cost, such as faculty salaries, was selected as an input indicator [1]. Faculty members were divided into academic and non-academic staff and recognized as input indicators [2]. Scholars also chose the quality of the college students’ enrollment and graduates’ quality as input indicators [3]. In terms of output indicators, graduates and scientific research achievements were used as output indicators to evaluate the efficiency of universities [4]. Allocated research funding was selected as an output indicator to evaluate the efficiency of 72 German universities [5].

2.2. Evaluation of the Construction of DFCUs

The evaluation of DFCUs has been developed from the university rankings, which evaluated the performance of “World-class” or “First-class” Universities. The comparison scope of DFCUs was mainly at the national and the world level [6]. V. John, executive vice president of the Association of American Universities, defined a world-class university as a university with a broad range of disciplines, top-quality education, and world recognition [7]. Since the 1980s, after the first university evaluation and ranking systems were introduced in the United States, scholars in developed countries have set up different evaluation index systems to evaluate universities. For example, the UK Higher Education Funding Council developed the Research Excellence Framework which classified the submissions of participating universities into four levels based on the quality of research in three areas: research outputs, research impact and research environment [8]; the US National Academy of Sciences created the United States National Research Council (NRC) to evaluate the quality and standard of colleges within research universities, using three main indicators: university characteristics, doctoral program characteristics, and program participants [9]; the UK QS World College and University Rankings were published by Times Higher Education, a British publication [10]. These methods used weighted factors and summation for the evaluation of the efficiency of universities; they were mainly based on the Data Envelopment Analysis (DEA) method.

2.3. Research on the Evaluation Method of Input-Output Efficiency of Universities

The following studies all implement the measurement of the efficiency of universities or educational organizations with the help of DEA. The efficiency of higher education systems in emerging economies was assessed, which were represented by Chilean universities [11]. The efficiency of universities in Mexico was analyzed by a DEA-integrated multi-
dimensional statistical analysis method; the result showed that the scale benefit model highlighted the importance of data by multivariate statistical analysis [12]. Dobrota et al. [13] examined the Quacquarelli Symonds (QS) World University Ranking methodology, pointed to a drawback of using subjective, possibly biased, weightings to build a composite indicator (QS scores) and proposed an alternative approach to creating QS scores, which is referred to as the composite I-distance indicator (CIDI) methodology. The efficiency scores of more than 4800 universities and other research institutions around the world were calculated and found that Harvard University was the best-performing institution for many years, while other institutions from North America and Europe were the second-best, and institutions from the Pacific region had the highest efficiency on average [14]. The efficiency of 27 DFUCs was calculated using a two-stage DEA, and the key influencing factors were explored using grey correlation [15]. Glass et al. [16] investigates whether best-practice efficiency measurement based on DEA provides empirical support for the current policy goals in UK higher education. The efficiency of 40 Mexican Public Higher Education Institutions (P–HEI) from the year 2008 to 2016 was computed by an official database called ExECUM [17].

Since Construction Overall Plan was published in 2015, some Chinese scholars have been discussing the evaluation of DFUCs. Huang et al. [18] put forward the principle of establishing an evaluation index system of DFUCs after studying the common characteristics of scientific research evaluation in developed countries. Problems in the social construction mechanism of the diversified university evaluation system in China were analyzed and ideas were brought up to improve the evaluation of DFUCs [19]. The international research collaboration led by China’s world-class universities and its impact during the first construction cycle of the DFUCs initiative (2016–2020) was explored [20]. The total factor productivity (TFP) of 32 DFUCs from 2015 to 2018 was calculated by using an output-oriented weight-constrained BCC-DEA window model and found that the TFP of the sample universities in the east, middle, west, and northeast had a trend of “central collapse” [21]. Based on the characteristics of different disciplines in universities, an evaluation index system for the scientific research performance of universities from the four dimensions was set up, which contained: scientific research funds, social evaluation, scientific research efficiency, and learning growth, the weights of which were calculated, respectively [22]. Sun et al. [23] used fsQCA and discussed the various resource conditions and talent construction paths that affect the introduction of high-level talents in DFUCs.

The research mentioned above comprehensively studied the evaluation theories and the methods of input and output efficiency of colleges and universities, providing a reliable reference for the research of this paper. However, only a few scholars in the present study have discussed the CTREs of universities. Kuah et al. [24] took staff salaries and equipment costs as shared input indicators. Qiao [25] set up an evaluation model to evaluate CTRE based on a DEA model, and the funds allocated by the government and the number of full-time teachers were selected as shared input indicators. Kuah took the linear combination of teaching efficiency and scientific research efficiency as CTRE and added the relative importance of the indicators as the constraint condition, which made the model solution more complicated than the non-linear model. By contrast, Qiao directly recognized the sum of teaching efficiency and scientific research efficiency as a measure to evaluate CTRE. However, this model indicated that up to 2/3 of universities had the same scientific research efficiency figure, i.e., 1, and nearly 1/3 of universities were also given the optimal teaching efficiency figure. Thus, the results of this model lacked effective differentiation and it needs to be improved. In addition, the two research results did not involve a deeper analysis of the influence of the parameter value on the solution of the model and its algorithmic steps. This issue must be resolved if we are to do further research on this model as a way to evaluate the CTRE of DFUCs in China.

To address the above problems, this paper highlights the high-level and forward-looking development of DFUCs, with the number of professors and annual budget fundings as shared input indicators, national teaching achievement awards and student employment
rates as teaching outputs, and national science and technology achievement awards and
the number of highly cited papers as research output indicators. The evaluation index
system of teaching-research comprehensive efficiency of DFCUs is, therefore, constructed
and the virtual decision unit is constructed using collected data to form the evaluation
model of teaching-research comprehensive efficiency of DFCUs based on the joint DEA
model. The key factors influencing the comprehensive efficiency of teaching research in
DFCUs are identified using the gray correlation analysis method; the data of the evaluation
indexes of teaching research of some DFCUs in China in 2018 are collected as the basis for
the evaluation of the efficiency of teaching-research. An empirical study is conducted on
the evaluation indexes of teaching-research efficiency of some DFCUs in China in 2018
as an example, so as to propose strategies to improve the teaching-research efficiency of
DFCUs in China.

3. Establishment of the Evaluation Index System for CTRE of DFCUs

3.1. Selection of Indicator System

The establishment of a scientific and reasonable index system for the evaluation of
efficiency is the basis for the CTREs of DFCUs. In accordance with the relevant require-
ments of the Construction Guidance, the evaluation index system for the CTRE of DFCUs is
developed to fully reflect the input and output of teaching and scientific research during
the process of evaluation of DFCUs. High-level teaching and research achievements are
selected as the output index of DFCUs in China to reflect the connection of its goal with
world-class universities and to realize the availability of the index, as shown in Table 1.

Table 1. Evaluation index system of CTRE of DFCUs in China.

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>Indicator Name</th>
<th>Code</th>
<th>Index Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of professors</td>
<td>I₁</td>
<td>Shared input</td>
</tr>
<tr>
<td>2</td>
<td>Annual budget</td>
<td>I₂</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Quality of enrolled students</td>
<td>I₃</td>
<td>Teaching input</td>
</tr>
<tr>
<td>4</td>
<td>National Teaching Achievement Award</td>
<td>O₁</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Prize in the student innovation competition</td>
<td>O₂</td>
<td>Teaching output</td>
</tr>
<tr>
<td>6</td>
<td>Salary of graduates</td>
<td>O₃</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>National Science and Technology Achievement Award</td>
<td>O₄</td>
<td>Scientific output</td>
</tr>
<tr>
<td>8</td>
<td>Number of subjects in the top 1% of ESI</td>
<td>O₅</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Number of citations per article</td>
<td>O₆</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Number of highly cited papers</td>
<td>O₇</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Equivalent number of granted invention patents</td>
<td>O₈</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Number of words in published monographs</td>
<td>O₉</td>
<td></td>
</tr>
</tbody>
</table>

3.2. The Measurement of Indicators

The evaluation indicators of CTRE of DFCUs in China are calculated as follows:

(1) Number of professors. The number of professors, associate professors, teachers,
and other personnel are adopted from the collection of scientific and technological statistics
of higher education institutions. The number of professors is treated as the criterion, while
other personnel are converted into the equivalent number of professors according to the
coefficients of 0.75, 0.5, and 0.1, respectively (Shao) [26].

(2) Annual budget. The annual budget is used as the financial input of DFCUs, and
the amount is obtained from the home page of each university, the unit of which is billions
of yuan.

(3) Quality of enrolled students. This indicator is measured by the college entrance
examination scores for enrolled students. The index and its calculation method are obtained
from the website of Best Chinese Universities Ranking.

(4) National Teaching Achievement Award. According to the results of the eighth
National Teaching Achievement Awards, two special awards, 50 first-place awards, and
400 s-place awards were given out. Referring to the relevant documents of the National Science and Technology Prizes in China, each special award, first prize, and second prize is assigned 15 points, 3 points, and 1.5 points, respectively, in order to distinguish the importance of awards with different levels. The total score of this index for each DFCU is calculated according to the first finished university of National Teaching Achievement Awards score.

(5) Prize in the student innovation competition. These prizes are awarded as part of the Chinese university student entrepreneurs’ competition (or “The Challenge Cup”) and the “Internet Plus” competition, held by the Ministry of Education of China. They are selected here to calculate this index. The number of special awards, gold, silver, and bronze awards of each DFCU are counted according to their competition results (Yuan, et al.) [27]. The scores of the special-class award, the gold prize, the silver prize, and the bronze prize are given 30, 2, 1.5, and 1 point, respectively, to reflect the importance of different prizes.

(6) Salary of graduates. This is collected from the quality of the undergraduate education report of each DFCU, the unit of which is 1000 yuan per month.

(7) National Scientific and Technological Achievements Awards. The indicator included the following awards: National Science and Technology Prizes, National Natural Science Awards, National Technological Invention Awards, and National Scientific and Technological Progress Awards. The first university that obtained each of those awards is recorded, and for the special prize, the first prize, and the second prize, 15, 3, and 1.5 points are given, respectively, to reflect the importance of different prizes.

(8) Number of subjects in the top 1% of ESI. This indicator is the number of subjects in the top 1% of ESI of DFCUs.

(9) Number of citations per article. According to the ESI database, the number of citations per article is calculated as the number of citations of academic papers published by universities divided by the number of papers published. The data were obtained from the top 100 overall rankings of universities in China.

(10) Number of highly cited papers. According to the ESI database, highly cited papers are the papers that rank in the top 1% of cited papers in the recent ten years. The number of highly cited papers by the first author was selected using the data of the ESI ranking of highly cited papers of DFCUs.

(11) Equivalent number of granted invention patents. Patents for inventions, utility models, and designs are given weights of 1, 0.5, and 0.2, respectively, in order to uniformly transform the number of all kinds of patents into a figure equivalent to the number of invention patents. The data of the patents for inventions, utility models, and designs were obtained from the Compilation of Statistics on Science and Technology of Institutions of Higher Learning.

(12) Number of words in published monographs. This was selected as the output index to scientifically reflect the workload of monographs. The data were obtained from the Compilation of Statistics on Science and Technology of Institutions of Higher Learning, the unit of which are thousands of words.

4. The Evaluation Model of the Comprehensive Teaching and Research Efficiency of DFCUs in China Based on a Joint DEA Model

4.1. The Selection and Modeling Idea of the Joint DEA Model

Data Envelopment Analysis (DEA) was developed by Charnes et al. in 1978 [28]. The DEA method is used to evaluate the relative efficiency of departments of the same type and could effectively manage the complicated problem of multi-inputs and multi-outputs (Sun, et al.) [29]. Because of its advantages, plenty of scholars have studied this model and explored its application. As a result, the DEA method has been developed into an analytical and research tool and is commonly used in several fields, such as business management, agriculture management and systematic engineering, etc. (Banker, et al.) [30]. Furthermore, it has been used to analyze the efficiency of scientific research in universities, so it is also suitable to use the DEA model to evaluate the CTREs of DFCUs.
Most DEA models evaluate the efficiency of the input and output of the same kind of decision-making unit (DMU), but in the process of DFCU evaluation, the efficiency of scientific research of each university should be considered, and the efficiency of teaching activities should be considered as well. Therefore, according to the research results of Kuah et al. and Qiao, a joint DEA model is developed to evaluate the CTRE of universities. Its index structure is shown in Figure 1.

![Figure 1](image)

Figure 1. The evaluation structure of comprehensive teaching and research efficiency of DFCUs.

The performance of DFCUs in China is evaluated by their comprehensive teaching and research efficiency. The optimal ratio of the shared input index is calculated, and it is allocated to both teaching and research phases.

In order to enhance the differentiation among the results, the optimal standard, the average standard, and the worst standard are developed from the data collected from the comprehensive efficiency evaluation index of teaching and research of DFCUs in China (Li et al.) [31]. The value of the input index of the optimal standard is each minimum value of the input index of DFCUs, and the output index of the optimal standard is each maximum value of the output index of DFCUs. The input index and output index of the average standard are the average values and represent the general level. The input index of the worst standard is the maximum value of the input index of DFCUs, and the output index is the minimum value of the output index of DFCUs. That is, the worst standard is the one with the most input and the least output, thus its efficiency is the lowest.

### 4.2. The Steps of the Joint DEA Model

Combining the research results of Kuah et al. (2011) and Qiao (2015), a comprehensive teaching and research efficiency evaluation model of DFCUs is constructed based on a joint DEA model. The constructive steps are as follows:

1. Construct the evaluation index system of comprehensive teaching and research efficiency of DFCUs. The index includes the shared input index $CI_a (a = 1, 2, \ldots, A)$, the input index $TI_b (b = 1, 2, \ldots, B)$ in the teaching stage, the input index $RI_c (c = 1, 2, \ldots, C)$ in the research stage, the output index $TO_d (d = 1, 2, \ldots, D)$, and the output index $RO_e (e = 1, 2, \ldots, E)$ in the research stage. The DFCUs to be evaluated are $U_{p0} (p0 = 1, 2, \ldots, n)$. Then, the optimal standard, the average standard, and the worst standard are developed. The number of universities is $n + 3$. Let, $n = n + 3$ be the number of DFCUs to be evaluated. Table 2 shows the structure of the data.

<table>
<thead>
<tr>
<th>DFCUs</th>
<th>Input Indicator</th>
<th>Output Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$CI_1$</td>
<td>$CI_2$</td>
</tr>
<tr>
<td>$U_1$</td>
<td>$x_{11}$</td>
<td>$x_{12}$</td>
</tr>
<tr>
<td></td>
<td>$\ldots$</td>
<td>$\ldots$</td>
</tr>
<tr>
<td>$U_{n}$</td>
<td>$x_{n1}$</td>
<td>$x_{n2}$</td>
</tr>
<tr>
<td></td>
<td>$\ldots$</td>
<td>$\ldots$</td>
</tr>
</tbody>
</table>
(2) Draw on Beasley’s study with the following equation [32]. Firstly, set the teaching efficiency level \( ET_{p_0} \). This is the weighted sum of the indicators of teaching output divided by the weighted sum of the indicator values of teaching input for \( U_{p_0} \), namely:

\[
ET_{p_0} = \left( \sum_{i=1}^{D} u_i y_ip_0 \right) \left/ \left( \sum_{j=1}^{A} v_j q_j x_j p_0 + \sum_{j=A+1}^{A+B+C} v_j x_j p_0 \right) \right. , \quad p_0 = 1, \ldots, n
\]  

(1)

Secondly, set the research efficiency \( ER_{p_0} \). This ratio is the weighted sum of the index value of the scientific research output divided by the weighted sum of the index value of the scientific research input for \( U_{p_0} \):

\[
ER_{p_0} = \left( \sum_{i=D+1}^{D+E} u_i y_ip_0 \right) \left/ \left( \sum_{j=1}^{A} v_j (1-q_j) x_j p_0 + \sum_{j=A+B+1}^{A+B+C} v_j x_j p_0 \right) \right. , \quad p_0 = 1, \ldots, n
\]  

(2)

Shared input indicators are used between the two efficiencies, \( q_j \) and \( 1-q_j \), to represent the ratio of each \( j \) shared input allocated to the teaching and research phases. According to the idea of DEA modeling, let:

\[
0 \leq ET_{p_0} \leq 1
\]  

(3)

\[
0 \leq ER_{p_0} \leq 1
\]  

(4)

where \( p_0 = 1, \ldots, n \).

Thirdly, calculate CTRE \( (ETR_{p_0}) \). This ratio is the weighted sum of the output indicators of the teaching and research stage divided by the weighted sum of the input indicators of the teaching and research stage for \( U_{p_0} \):

\[
ETR_{p_0} = \left( \sum_{i=1}^{D+E} u_i y_ip_0 \right) \left/ \left( \sum_{j=1}^{A+B+C} v_j x_j p_0 \right) \right. , \quad p_0 = 1, \ldots, n
\]  

(5)

According to the DEA model, let:

\[
0 \leq ETR_{p_0} \leq 1, \quad p_0 = 1, \ldots, n
\]  

(6)

\[
\max ETR_{p_0} = \left( \sum_{i=1}^{D+E} u_i y_ip_0 \right) \left/ \left( \sum_{j=1}^{A+B+C} v_j x_j p_0 \right) \right. 
\]  

s.t.

\[
\begin{align*}
0 & \leq ETR_p \leq 1, \quad p = 1, \ldots, n \\
0 & \leq ET_p \leq 1, \quad p = 1, \ldots, n \\
0 & \leq ER_p \leq 1, \quad p = 1, \ldots, n \\
0 & \leq ET_{p_0} \leq 1, \quad p_0 = 1, \ldots, n \\
0 & \leq ER_{p_0} \leq 1, \quad p_0 = 1, \ldots, n \\
u_i & \geq \epsilon, i = 1, 2, \ldots, D + E \\
v_j & \geq \epsilon, j = 1, 2, \ldots, A + B + C \\
\xi & \leq q_j \leq 1 - \xi, \quad j = 1, 2, \ldots, A
\end{align*}
\]  

(7)

By solving Model (7), CTRE \( ETR_{p_0}, u_i, v_j, q_j \), and its various weight coefficients are obtained. According to Formulas (1) and (2), the teaching efficiency \( ET_{p_0} \) and research efficiency \( ER_{p_0} \) of DFCUs \( U_{p_0} \) are calculated.

4.3. The Computer Algorithm for Solving the Joint DEA Model

The joint DEA Model (7) is a fractional programming model. Once \( q_j (j = 1, 2, \ldots, A) \) is fixed, it is transformed into a linear constraint form by multiplying both sides of the equation by the denominator. The solution of Model (7) could be solved by MATLAB language programming, and the specific algorithm steps are as follows:

(1) Standardize the data. In addition to Model (7), the input-output index in separate forms is included for the teaching stage and the scientific research stage. When considering
the teaching stage, all the input-output indices for the scientific research stage are assigned a value of 0. When considering the scientific research stage, the input-output index for the teaching stage is assigned a value of 0.

(2) After the step size of $q_j (j = 1, 2, \ldots, A)$ is developed, the values of the specific shared input indicators are allocated to the teaching and research phase, the output index of which is, therefore, calculated.

(3) The second and third kinds of constraints in Model (7) are added to the original DEA model after they are transformed into linear constraints.

(4) The Linprog function in MATLAB is used to solve the optimal solution under the specified value of $q_j$.

(5) The efficiency value $ETR_{p_0}$ of DFCUs $U_{p_0}$ will be evaluated once different values of $q_j$ are obtained. $q_j$ is screened out to maximize the efficiency value $ETR_{p_0}$. The efficiency value $ETR_{p_0}$ is the approximate efficiency value of DFCUs $U_{p_0}$.

Considering the characteristics of the linear programming model, it is reasonable to use the approximate solution to replace the exact solution. Further, reduce the step size and recalculate the solution to obtain more accurate results.

5. An Empirical Study on the Evaluation of the Comprehensive Teaching and Research Efficiency of DFCUs in China

5.1. Collection of Evaluation Data

Among the 42 DFCUs, if any index is missing for a university, the university would be excluded from the calculation. Thus, 26 DFCUs are selected as research objects, including Peking University, Tsinghua University, and the other 24 DFCUs.

The data were obtained from online resources, such as Aizhushen China Alumni network and the Best University website, as well as statistical yearbooks, the national teaching achievement awards, the national college students, the “Chinese university student entrepreneurs’ competition” and the “Challenge Cup competition”. Since the National Teaching Achievement Awards are awarded every four years, the currently available data are from 2018. To make sure of the data year consistency, the data from 2018 were used in this study. Considering that it takes four years for freshmen to graduate, the data on the quality of enrolled students used in the study are from 2014. The evaluation index of the comprehensive teaching and research efficiency of DFCUs is calculated, and the description and statistical analyses are shown in Table 3.

Table 3. Descriptive statistical analysis of the evaluation index of 28 DFCUs.

<table>
<thead>
<tr>
<th>Index</th>
<th>Maximum Value</th>
<th>Minimum Value</th>
<th>Average Value</th>
<th>Standard Deviation</th>
<th>Range</th>
<th>Coefficient of Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_1$</td>
<td>4544.25</td>
<td>1343.75</td>
<td>2686.44</td>
<td>990.57</td>
<td>3200.50</td>
<td>0.369</td>
</tr>
<tr>
<td>$I_2$</td>
<td>269.50</td>
<td>35.80</td>
<td>88.54</td>
<td>50.45</td>
<td>233.70</td>
<td>0.570</td>
</tr>
<tr>
<td>$I_3$</td>
<td>100.00</td>
<td>60.60</td>
<td>78.72</td>
<td>9.48</td>
<td>69.24</td>
<td>0.120</td>
</tr>
<tr>
<td>$O_1$</td>
<td>55.50</td>
<td>1.50</td>
<td>9.00</td>
<td>11.21</td>
<td>54.00</td>
<td>1.246</td>
</tr>
<tr>
<td>$O_2$</td>
<td>80.00</td>
<td>1.00</td>
<td>15.83</td>
<td>16.01</td>
<td>79.00</td>
<td>1.011</td>
</tr>
<tr>
<td>$O_3$</td>
<td>11.71</td>
<td>5.10</td>
<td>7.52</td>
<td>1.62</td>
<td>6.61</td>
<td>0.215</td>
</tr>
<tr>
<td>$O_4$</td>
<td>21.00</td>
<td>1.50</td>
<td>9.63</td>
<td>5.39</td>
<td>19.50</td>
<td>0.560</td>
</tr>
<tr>
<td>$O_5$</td>
<td>21.00</td>
<td>7.00</td>
<td>13.54</td>
<td>4.34</td>
<td>14.00</td>
<td>0.321</td>
</tr>
<tr>
<td>$O_6$</td>
<td>16.24</td>
<td>7.54</td>
<td>11.83</td>
<td>2.23</td>
<td>8.70</td>
<td>0.189</td>
</tr>
<tr>
<td>$O_7$</td>
<td>1547.00</td>
<td>103.00</td>
<td>545.69</td>
<td>349.91</td>
<td>1444.00</td>
<td>0.641</td>
</tr>
<tr>
<td>$O_8$</td>
<td>1325.20</td>
<td>73.30</td>
<td>490.00</td>
<td>344.85</td>
<td>1251.90</td>
<td>0.704</td>
</tr>
<tr>
<td>$O_9$</td>
<td>22,446.00</td>
<td>1613.00</td>
<td>8371.42</td>
<td>5090.58</td>
<td>20,833.00</td>
<td>0.608</td>
</tr>
</tbody>
</table>

According to Table 3, the absolute value ranges of $I_1$, $O_7$, and $O_8$ have a large range, and the coefficient of variation of $O_1$ and $O_2$ are the two largest. It indicates that the
evaluation index data of comprehensive teaching research efficiency of DFCUs in China have a wide range.

5.2. Efficiency Evaluation and Analysis

The CTRE, teaching efficiency, and research efficiency of DFCUs and 3 standards are obtained, and the ratio of shared input indicators used in the teaching phase is obtained by Model (7), solved by MATLAB programming, as shown in Table 4.

<table>
<thead>
<tr>
<th>Name of University</th>
<th>CTRE Value</th>
<th>Rank</th>
<th>Teaching Efficiency Value</th>
<th>Rank</th>
<th>Research Efficiency Value</th>
<th>Rank</th>
<th>Ratio Used in Teaching Phase</th>
<th>Number of Professors</th>
<th>Annual Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>0.996</td>
<td>1</td>
<td>0.945</td>
<td>4</td>
<td>1.000</td>
<td>1</td>
<td>0.55</td>
<td>0.67</td>
<td>U2</td>
</tr>
<tr>
<td>U2</td>
<td>0.987</td>
<td>2</td>
<td>0.183</td>
<td>15</td>
<td>1.000</td>
<td>1</td>
<td>0.30</td>
<td>0.50</td>
<td>U3</td>
</tr>
<tr>
<td>U3</td>
<td>0.984</td>
<td>3</td>
<td>0.154</td>
<td>18</td>
<td>1.000</td>
<td>1</td>
<td>0.36</td>
<td>0.38</td>
<td>U4</td>
</tr>
<tr>
<td>U4</td>
<td>0.981</td>
<td>4</td>
<td>0.132</td>
<td>22</td>
<td>1.000</td>
<td>1</td>
<td>0.33</td>
<td>0.32</td>
<td>U5</td>
</tr>
<tr>
<td>U5</td>
<td>0.958</td>
<td>5</td>
<td>0.196</td>
<td>14</td>
<td>0.969</td>
<td>5</td>
<td>0.67</td>
<td>0.60</td>
<td>U6</td>
</tr>
<tr>
<td>U6</td>
<td>0.943</td>
<td>6</td>
<td>1.000</td>
<td>1</td>
<td>0.702</td>
<td>12</td>
<td>0.44</td>
<td>0.33</td>
<td>U7</td>
</tr>
<tr>
<td>U7</td>
<td>0.932</td>
<td>7</td>
<td>1.000</td>
<td>1</td>
<td>0.831</td>
<td>8</td>
<td>0.45</td>
<td>0.43</td>
<td>U8</td>
</tr>
<tr>
<td>U8</td>
<td>0.904</td>
<td>8</td>
<td>0.171</td>
<td>16</td>
<td>0.915</td>
<td>6</td>
<td>0.48</td>
<td>0.55</td>
<td>U9</td>
</tr>
<tr>
<td>U9</td>
<td>0.902</td>
<td>9</td>
<td>0.859</td>
<td>5</td>
<td>0.905</td>
<td>7</td>
<td>0.35</td>
<td>0.48</td>
<td>U10</td>
</tr>
<tr>
<td>U10</td>
<td>0.879</td>
<td>10</td>
<td>1.000</td>
<td>1</td>
<td>0.461</td>
<td>22</td>
<td>0.56</td>
<td>0.68</td>
<td>U11</td>
</tr>
<tr>
<td>U11</td>
<td>0.736</td>
<td>11</td>
<td>0.618</td>
<td>10</td>
<td>0.743</td>
<td>9</td>
<td>0.32</td>
<td>0.65</td>
<td>U12</td>
</tr>
<tr>
<td>U12</td>
<td>0.729</td>
<td>12</td>
<td>0.158</td>
<td>17</td>
<td>0.737</td>
<td>10</td>
<td>0.40</td>
<td>0.69</td>
<td>U13</td>
</tr>
<tr>
<td>U13</td>
<td>0.699</td>
<td>13</td>
<td>0.154</td>
<td>19</td>
<td>0.706</td>
<td>11</td>
<td>0.63</td>
<td>0.64</td>
<td>U14</td>
</tr>
<tr>
<td>U14</td>
<td>0.668</td>
<td>14</td>
<td>0.128</td>
<td>24</td>
<td>0.676</td>
<td>13</td>
<td>0.69</td>
<td>0.33</td>
<td>U15</td>
</tr>
<tr>
<td>U15</td>
<td>0.659</td>
<td>15</td>
<td>0.691</td>
<td>7</td>
<td>0.657</td>
<td>14</td>
<td>0.36</td>
<td>0.65</td>
<td>U16</td>
</tr>
<tr>
<td>U16</td>
<td>0.639</td>
<td>16</td>
<td>0.531</td>
<td>12</td>
<td>0.645</td>
<td>15</td>
<td>0.30</td>
<td>0.31</td>
<td>U17</td>
</tr>
<tr>
<td>U17</td>
<td>0.627</td>
<td>17</td>
<td>0.707</td>
<td>6</td>
<td>0.415</td>
<td>25</td>
<td>0.30</td>
<td>0.35</td>
<td>U18</td>
</tr>
<tr>
<td>U18</td>
<td>0.604</td>
<td>18</td>
<td>0.482</td>
<td>13</td>
<td>0.608</td>
<td>16</td>
<td>0.30</td>
<td>0.30</td>
<td>U19</td>
</tr>
<tr>
<td>U19</td>
<td>0.588</td>
<td>19</td>
<td>0.620</td>
<td>9</td>
<td>0.532</td>
<td>21</td>
<td>0.30</td>
<td>0.31</td>
<td>U20</td>
</tr>
<tr>
<td>U20</td>
<td>0.588</td>
<td>20</td>
<td>0.625</td>
<td>8</td>
<td>0.450</td>
<td>23</td>
<td>0.30</td>
<td>0.40</td>
<td>U21</td>
</tr>
<tr>
<td>U21</td>
<td>0.587</td>
<td>21</td>
<td>0.140</td>
<td>21</td>
<td>0.593</td>
<td>17</td>
<td>0.35</td>
<td>0.34</td>
<td>U22</td>
</tr>
<tr>
<td>U22</td>
<td>0.583</td>
<td>22</td>
<td>0.154</td>
<td>20</td>
<td>0.588</td>
<td>18</td>
<td>0.45</td>
<td>0.54</td>
<td>U23</td>
</tr>
<tr>
<td>U23</td>
<td>0.564</td>
<td>23</td>
<td>0.065</td>
<td>26</td>
<td>0.578</td>
<td>19</td>
<td>0.51</td>
<td>0.30</td>
<td>U24</td>
</tr>
<tr>
<td>U24</td>
<td>0.528</td>
<td>24</td>
<td>0.128</td>
<td>23</td>
<td>0.533</td>
<td>20</td>
<td>0.42</td>
<td>0.39</td>
<td>U25</td>
</tr>
<tr>
<td>U25</td>
<td>0.487</td>
<td>25</td>
<td>0.547</td>
<td>11</td>
<td>0.212</td>
<td>26</td>
<td>0.30</td>
<td>0.69</td>
<td>U26</td>
</tr>
<tr>
<td>U26</td>
<td>0.442</td>
<td>26</td>
<td>0.112</td>
<td>25</td>
<td>0.446</td>
<td>24</td>
<td>0.45</td>
<td>0.41</td>
<td>U27</td>
</tr>
<tr>
<td>U27</td>
<td>1.000</td>
<td>1</td>
<td>1.000</td>
<td>1</td>
<td>1.000</td>
<td>1</td>
<td>0.580</td>
<td>0.480</td>
<td></td>
</tr>
<tr>
<td>U28</td>
<td>0.054</td>
<td>2</td>
<td>0.016</td>
<td>1</td>
<td>0.054</td>
<td>1</td>
<td>0.300</td>
<td>0.530</td>
<td></td>
</tr>
<tr>
<td>U29</td>
<td>0.343</td>
<td>3</td>
<td>0.422</td>
<td>1</td>
<td>0.316</td>
<td>1</td>
<td>0.300</td>
<td>0.320</td>
<td></td>
</tr>
<tr>
<td>Minimum value</td>
<td>0.442</td>
<td>2</td>
<td>0.065</td>
<td>1</td>
<td>0.212</td>
<td>1</td>
<td>0.300</td>
<td>0.300</td>
<td></td>
</tr>
<tr>
<td>Maximum value</td>
<td>0.996</td>
<td>1</td>
<td>1.000</td>
<td>1</td>
<td>1.000</td>
<td>1</td>
<td>0.690</td>
<td>0.690</td>
<td></td>
</tr>
<tr>
<td>Average value</td>
<td>0.738</td>
<td>1</td>
<td>0.442</td>
<td>1</td>
<td>0.689</td>
<td>1</td>
<td>0.418</td>
<td>0.465</td>
<td></td>
</tr>
</tbody>
</table>

Note: 26 DFCUs are ranked by the values of CTREs.

Table 4 shows that:

(1) The CTREs of 26 DFCUs have no duplicate values when the standards are adopted. Therefore, the model gives a distinction among the values of CTREs. Their average value is 0.738, which is higher than that of the average standard. The average value of the research efficiency of the 26 DFCUs is higher than that of the teaching efficiency. The research efficiency of 18 DFCUs is higher than that of the teaching efficiency, which is 69.2% of the total. Therefore, DFCUs in China may lean more efforts toward scientific research.

(2) The CTREs of U1, U2, U3 and U4 are higher than that of other DFCUs, which are close to 1 and are the top four of the totals. U6, U7, and U10 have the largest teaching efficiency value, which is 1. The research efficiency of U1, U2, U3, and U4 is 1. The efficiency of scientific research of U2, U3, and U4 is much higher than that of teaching, and
the difference is more than 0.80, while the teaching efficiency of U10 and U25 is higher than that of scientific research, with a difference of over 0.30. It could be seen that there are some differences between these rankings of the CTREs of DFCUs and the rankings of traditional universities. Moreover, some DFCUs have paid more attention to teaching while others have put more effort into research.

(3) Table 5 shows the ratio of the shared indicators that are allocated to the teaching stage.

<table>
<thead>
<tr>
<th>Shared Indicators</th>
<th>Average</th>
<th>Equal to 30%</th>
<th>Less than 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of professors</td>
<td>41.8%</td>
<td>7</td>
<td>26.9%</td>
</tr>
<tr>
<td>Annual budget</td>
<td>46.5%</td>
<td>2</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

Table 5. The ratio of the shared indicators that are allocated to the teaching stage.

More than 50% of the DFCUs will allocate more than 50% of the number of professors and the annual budget to research in order to achieve better research efficiency and maximize CTRE activities. Thus, more DFCUs are willing to assign shared inputs to research.

6. Analysis of the Factors Influencing the CTREs of DFCUs in China

The purpose of the evaluation of CTREs of DFCUs is to determine their efficiency and to explore how to effectively improve their comprehensive efficiency. Therefore, it is necessary to find the key influencing factors to improve efficiency. The Grey Correlation Analysis Model is used here to determine the key influencing factors (Tao) [33]. The grey correlation degrees between CTRE and its evaluation indicators were calculated, as shown in Table 6.

Table 6. Grey Correlation Degree between the evaluation index of CTREs in DFCUs.

<table>
<thead>
<tr>
<th>No.</th>
<th>Index</th>
<th>Indicator Name</th>
<th>Grey Correlation Degree</th>
<th>Sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I₁</td>
<td>Number of professors</td>
<td>0.826</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>I₂</td>
<td>Annual budget</td>
<td>0.839</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>I₃</td>
<td>Quality of enrolled students</td>
<td>0.791</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>O₁</td>
<td>National Teaching Achievement Award</td>
<td>0.784</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>O₂</td>
<td>Prize in the student innovation competition</td>
<td>0.765</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>O₃</td>
<td>Salary of graduates</td>
<td>0.839</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>O₄</td>
<td>National Science and Technology Achievement Award</td>
<td>0.821</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>O₅</td>
<td>Number of subjects in the top 1% of ESI</td>
<td>0.834</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>O₆</td>
<td>Number of citations per article</td>
<td>0.809</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>O₇</td>
<td>Number of highly cited papers</td>
<td>0.848</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>O₈</td>
<td>Equivalent number of granted invention patents</td>
<td>0.827</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>O₉</td>
<td>Number of words in published monographs</td>
<td>0.836</td>
<td>4</td>
</tr>
</tbody>
</table>

Average value 0.818

The grey correlation degree is between 0.765 and 0.848, with an average value of 0.818. It indicates that there is a strong correlation between each evaluation index and CTRE. The key influencing factors are selected from the evaluation indicators with the top 25% of Grey Correlation Degrees. Thus, O₇, I₂, and O₃ are the key factors influencing the CTRE of DFCUs.

7. Conclusions and Prospects

7.1. Research Conclusions

The evaluation index system and joint DEA model have been established to evaluate the CTREs of DFCUs in China. The algorithm steps to solve the model have been given. It shows that the model is feasible and has distinction by the empirical study with the data of
26 DFCUs in 2018. On this basis, the key influencing factors of the CTREs of DFCUs are analyzed. The main conclusions are shown as follows:

(1) The evaluation index system contains four kinds of indicators such as shared input, teaching input, teaching output, scientific output and 12 other indicators. The number of professors and the annual budget are defined as shared input indicators. The quality of enrolled students is selected as a teaching input indicator. The national teaching achievement award, the salary of graduates, etc., are defined as teaching output indicators. National science and technology achievement awards, the number of highly cited papers, etc., are chosen as research output indicators. The collection sources of the index and their calculation methods have been given.

(2) Joint DEA has been constructed to evaluate CTREs of DFCUs. The shared input indicators are divided into two parts, one for the teaching phase and the other for the scientific research phase. According to the DEA model, teaching efficiency ($ET_{p0}$), research efficiency ($ER_{p0}$) and CTREs of the DFCUs($ETR_{p0}$) are calculated by the ratio of the weighted sum of the indicators of output divided by the weighted sum of the indicator values of input. The objective of the joint DEA model is the maximum of CTREs of each DFCU under the constraints of $ETR_{p0} \leq 1$, $ET_{p0} \leq 1$, $ER_{p0} \leq 1$ of all DFCUs and other constraints. After the specified ratio value of the shared index to be allocated to the aching phase is given a certain step length, the model has been transformed into linear constraints and could be solved by the Linprog function in MATLAB. CTREs of DFCUs could be obtained by the maximum value of the joint DEA model to be solved under the different proportions of the shared index to be allocated to the teaching phase.

(3) The empirical research to evaluate CTREs of 26 DFCUs is based on the data from 2018. It is proved that the model is available and could give a distinction among the values of CTREs. The average research efficiency is higher than the average teaching efficiency. More than 50% of the DFCUs allocate more than 50% of the shared resources to the research phase according to the optimal allocation of shared input indicators. It is shown that the construction of DFCUs in China attaches relatively more importance to the research phase. The key factors influencing the CTREs of DFCUs such as the number of highly cited papers, annual budget and salary of graduates are obtained by the Grey Correlation Analysis Model.

7.2. Research Implications

According to the key influencing factors of CTREs of DFCUs, the following suggestions may help to improve the CTREs of DFCUs:

(1) Improve the quality and quantity of highly cited papers. The dissemination of high-level papers is one of the objectives for DFCUs in China to “realize the promotion of scientific research level”, which was presented in Construction Overall Plan. First, analyzing the distribution characteristics of the ESI papers published by DFCUs in China scientifically is necessary, and then discussing how to increase the number of highly cited papers published could also be helpful. Research Scholars have pointed out in such areas the United States, the United Kingdom and other countries are good; the more prominent problems have also been pointed out, although China has become a country with a high output of highly cited papers; however, the output of highly cited papers in basic medicine and cosmic sciences in China is relatively low (Su et al.) [34]. Therefore, DFCUs need to improve international cooperation, form international exchange circles, actively promote exchange programs with prestigious foreign universities to learn more from prestigious foreign universities and focus on making up for their own problems in order to improve the quality and quantity of high-level papers. Second, strengthen the ability of journal publicity, enhance the awareness of ESI journal submission, and improve the competitiveness of ESI disciplines in DFCUs. It is necessary to actively guide researchers to broaden the source channels of academic journals, improve the ability of researchers to publish high-quality papers and encourage them to submit their high-quality papers to ESI source journals. Third, increase the cultivation of ESI-source journals and the construction of the teaching
and research stage of DFCUs, at the same time, strengthen the construction of world-class academic journals, select multiple journals with international influence, increase the human and financial support for such journals, improve the quality of the journals, and cultivate a number of high impact ESI-source journals in China.

(2) Increase the annual budget. Funding is the basis for the construction of DFCUs. First, government funding for special construction should be planned in a targeted manner. It is clearly pointed out in the “Construction Guidance” that one of the principles to be adhered to in the construction of DFCUs is: “rooted in China and serving the major strategic needs of the country”; therefore, according to the current and future strategic development needs of the country, the government should adopt special methods such as bidding or commissioning, complete government fundings in the form of special construction funds, and build a corresponding assessment mechanism to highlight the DFCUs construction to serve the national strategic development needs. Second, give full play to the advantages of DFCUs, which have many knowledge industries and patented technologies and other scientific and technological achievements; increase technological innovation, transformation and technology transfer; therefore, DFCUs could charge fees for transferring intellectual property rights, set up incubation enterprises with intellectual property shares, or use intellectual property rights to invest in the DFCUs in turn. The DFCUs could draw profits from the enterprises, so as to open up sources of funding for the DFCUs. Third, actively guide outstanding alumni to donate to their alma mater, and the alumni associations of DFCUs start by caring for students’ study and life, so that students could feel the warmth from their alma mater and alumni, and cultivate their alma mater complex and sense of gratitude and return (Guo) [35]; for alumni who have graduated and left the university, strengthen alumni’s cohesion through understanding, classification, communication and cooperation, deepen their sense of identity and belonging to their alma mater, realize the virtuous cycle between service and return, so as to truly achieve a win-win situation between the university and alumni (Zhu) [36]; through various forms, such as the establishment of the university education foundation, supervise the use of donation funds and enhance the willingness of outstanding alumni to donate to their alma mater to run the school. Finally, the marketization of some logistics of colleges and universities should be properly implemented. The marketization of logistics entities and industries such as construction, buildings and school supermarkets, could increase certain sales and service income for colleges and universities, thus becoming an important aspect of diversified fundraising (Li et al.) [37], but for the service sectors involving food safety issues such as canteens, are not marketed in principle. Through the above-mentioned ways, the joint construction mechanism combining government, society and universities will be improved, and a pattern of diversified input and joint support could be formed.

(3) Increase the quality of graduates. The salary of graduates is an important symbol for the recognition of the quality of talent training in the development of DFCUs, in order to keep the quality of talent training and research projects consistent with social and economic development and to cultivate a full range of talents to meet the needs of social and economic development. Therefore, with the implementation and development of a series of major national strategies such as Made in China 2025, new engineering construction, high-quality development and the transformation of old and new dynamics, DFCUs should take the following measures to improve the quality of talent cultivation: First, the DFCUs should update their teaching and cultivation programs, add courses or subject systems covering the needs of the above major strategic development in China to their professional curricula, and each major should fully consider the actual needs of students when formulating professional training programs, and offer more relevant elective courses for students to choose, so as to cultivate the professional talents required by China’s social and economic development, which is fundamental to improve. This is the fundamental objective to improve the quality of talent training. Second, the DFCUs should do a good job of career planning for students as early as possible, so that students could position themselves as early as possible for their future development direction and choice to engage
in research, take up professional skills as employees or start their own business; students should strengthen the study of courses and skills that match their own positioning so that students could have strong career competence and the quality of talent cultivation is also improved. Finally, through school-enterprise cooperation and industry-university-research cooperation, we could develop training programs that meet the needs of enterprises and industries by combining the development of professional knowledge with the needs of enterprises and industries, so as to improve the quality of talent training.

7.3. Research Prospects

In the future, based on the research in this paper, we could further enrich the theory and method of the evaluation of the construction performance of DFCUs in China. The main work is as follows: First, a Malmquist index model could be constructed based on the joint DEA model with years of data. Second, the CTRE index system of DFCUs will be optimized based on future National Guidance.

Author Contributions: Conceptualization, M.T.; Methodology, M.T.; Software, W.C.; Formal analysis, H.L.; Data curation, D.M.; Writing—original draft, D.M.; Writing—review and editing, J.Z.; Funding acquisition, H.L. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by the National Education Science Planning Project of China under Grant BIA180213 and the project is “Research on Performance Evaluation of Teaching-scientific Research Linkage in ‘Double first-class’ Universities in China”.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

7. Wang, X.; Liu, B.; Li, J. Evaluation and Research of World Class University: An Interview with Dr. John Vaugh, the Executive Vice President of AAU. *Int. Comp. Educ.* 2010, 32, 13–19.
10. Yue, W.J.; Sun, C.Q. Research on the construction of world class universities based on university ranking evaluation system. *J. Henan Univ. (Soc. Sci. Ed.)* 2019, 3, 122–128. [CrossRef]


18. Huang, X.; Chen, Y. Evaluation of science and technology innovation capability of “double-class” universities: international experience and inspiration—Based on the examination of research evaluation systems in the UK, France, the US and Australia. *Jiangsu High. Educ.* 2017, 1, 93–98. [CrossRef]

19. Luo, Y. Institutional analysis of university evaluation in China—Also on the evaluation of universities under the construction of “double first-class”. *Tsinghua J. Educ.* 2017, 38, 37–44. [CrossRef]


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