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# What Research Should Vocational Education Colleges Conduct? An Empirical Study Using Data Envelopment Analysis

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**Abstract:** Higher vocational education (HVE) aims to cultivate high-quality technical and skilled talents so that the educated have the professional ethics, scientific culture, professional knowledge, technical skills, and other comprehensive professional qualities and action abilities required for engaging in a specific profession to achieve sustainable career development. Two problems related to critical management strategies for sustainable development activated this study: Should HVE colleges conduct academic research? What types of research should HVE colleges do? This article attempts to empirically study the second question while affirming the answer to the first question. HVE colleges focus on talent cultivation, which does not mean they will never engage in academic research. The key is to decide and evaluate the research types for HVE colleges. First, a survey was conducted on the current status and practical needs of HVE colleges globally and especially in China, and it was found that there is a mutually beneficial relationship between teaching and research in HVE colleges. Then, the positioning of HVE colleges for academic research was analyzed from three aspects—research type, performance assessment, and combination comparison—and three types of research positioning were proposed, i.e., applied research type, educational research type, and comprehensive research type. Then, three assessment index systems of academic research positioning types were designed from two input and output levels, and a research performance assessment model was established using data envelopment analysis (DEA). Finally, taking 22 vocational colleges in Shanghai as examples, a comparative study was conducted on the assessment results of three research types to determine the research types of different HVE colleges. Based on their educational history and academic research resources, HVE colleges can choose their research types. The HVE management department can guide HVE colleges to conduct differentiated academic research and support teaching and talent cultivation through input–output analysis for sustainable educational and teacher development.

**Keywords:** higher vocational education; academic research; efficiency assessment; educational research; application research



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## 1. Introduction

According to the characteristics of regional industries and talent demand, how to strengthen the academic research level of higher vocational education (HVE) to promote the cultivation of high-quality applied talents and teachers' sustainable development has become a hot topic. Should HVE colleges conduct academic research? As generally believed, HVE aims to cultivate students' applied skills. HVE should prioritize developing technology-oriented talents and provide industrial technology development services. However, there is controversy over whether HVE colleges should conduct research and what kind of research should be conducted in HVE. Universities can act as a "knowledge

pipeline". Through research activities, HVE colleges can connect global innovation networks and facilitate the acquisition of advanced scientific and technological knowledge in their respective regions. In transitioning from "teaching" to "teaching and research", HVE colleges carry out academic research activities that improve teachers' teaching ability and the quality of HVE. Indeed, teachers' sustainable development is a key to HVE sustainability. What types of research should HVE colleges do? Choosing the correct type of academic research for HVE while balancing social services and academic research is a way to improve organizational performance and the foundation for improving the cultivation of applied talents and social service capabilities.

To better serve the cultivation of applied talents, HVE colleges and education management departments are facing the problem of how to position the academic research type of the school [1,2]. In the field study on the HVE colleges in Shanghai, we identified two key questions. What kind of research activities should HVE choose? How do we evaluate the current research status of HVE colleges in the context of limited research resources and determine research types that meet their characteristics based on this? Through interviews with HVE scholars and managers, we found many practices and explorations on these issues in HVE colleges and management departments, but relevant research is relatively rare in the literature. Different HVE colleges should analyze the input–output performance of research resources in HVE based on their actual situation and determine the development of appropriate academic research activities. To help adjust the investment of funds, workforce, and equipment in HVE, guide colleges to develop research that leverages their advantages and ultimately promotes teaching and talent cultivation.

HVE has significantly contributed to China's economic development in the context of "Made in China". In the face of the continuous development of the demand for applied talents, in May 2022, the revised Vocational Education Law of the People's Republic of China was officially implemented. It established the equal importance of HVE and general education in legal form, and proposed that "the state encourages and supports scientific and technological research in vocational education," juxtaposing academic research and teaching as the main tasks of HVE, emphasizing the value of promoting teaching through research, and requiring HVE to promote the coordinated development of research and education.

Developing assessments that are fit to assess professional competence in HVE requires reconsidering assessment methods, quality criteria, and (self) assessment [3]. This article divides the research types of HVE into three types: applied, educational, and comprehensive. The assessment index system for three kinds of academic research is designed on the basis of the two levels of input and output. The research efficiency assessment model is established using data envelopment analysis (DEA) [4,5], and the combined analysis positioning criteria for assessment results are formulated. Additionally, taking 22 HVE colleges in Shanghai as empirical objects, the combined analysis of performance assessment of research types is used to determine the research positioning of different HVE colleges, which is beneficial for HVE colleges to adjust their research resource investment direction based on their research characteristics.

The paper is organized as follows: In Section 2, we review pioneering studies on HVE topics related to research types and college resilience. In Section 3, we introduce the DEA efficiency assessment method. In Section 4, we present the case of Shanghai HVE colleges. These two sections elucidate the methodology and data. Regarding the results and discussion sections, Section 5 details the numerical analysis processes and results. We then discuss the managerial and policy-making implications in Section 6. Finally, we conclude the study in Section 7.

## 2. Related Studies on Vocational Education

The following studies aim to answer two questions regarding HVE management and sustainable development strategies: (1) Should HVE colleges conduct academic research? Additionally, (2) What types of research should HVE colleges do? In Section 2.1, higher

vocational and academic education differ in their cultivation purposes while consistently educating talents through advanced science and technologies. Section 2.2 reviews positive, negative, and dialectic comments on transitioning from higher vocational to academic education. In Section 2.3, the resilience of higher vocational education demands introducing academic research achievements to HVE for talent cultivation and the sustainable development of teachers. In Section 2.4, China's practice concludes that HVE colleges should conduct academic research, and the main problem is choosing the types of research for HVE colleges.

### *2.1. Higher Vocational and Academic Education*

Higher vocational and academic education systems play complementary roles in cultivating talents. General and vocational education tracks with different programs characterize many educational systems. By differentiating the tertiary system into vocational and academic colleges, graduates face a variety of valuable options, allowing them to self-select an educational type that best matches their individual preferences [6]. Skill-use differentials between vocational and tertiary-educated workers are small to modest, and the most evident differences relate to analytical and manual skills [7]. While the education departments officially set vocational and academic qualifications at the same level, vocational education is positioned at the bottom of the educational hierarchy and suffers considerable societal prejudice [8]. Australia promoted vocational education and training as a pathway for students of low socioeconomic status to enter higher education. Universities must continue to promote vocational education pathways and normalize diverse conceptions of success to encourage persistence when academic achievement goals are not immediately reached [9]. General education and vocational education are similar in status but indicate different levels of education in China. It is urgent to optimize the investment and make innovations in the system and mechanism of funding for China's vocational education [10]. The hierarchically stratified education system may be a source of economic inequality in China [8].

Higher vocational and academic education systems affect the sustainable development of talents' careers and that of industries. Structural conflicts exist between academic and vocational post-compulsory secondary education, involving the adverse selection of vocational education [11]. Vocational education enhances smooth transitions into the labor market. However, this initial advantage might vanish over the course of the career and eventually become a disadvantage because vocationally trained workers' skills become outdated faster [7]. In the labor market, vocational graduates earn less than academic graduates; the type of post-secondary education is significantly correlated with the likelihood of obtaining white-collar high-skilled positions, and vocational graduates face greater job precariousness than academic graduates [8]. Assessing the relative value of vocational education requires assessing how the curriculum responds to economic structure and industrial changes. The decline in matching between workers and firms has benefited vocationally educated workers [12]. Vocational education is advantageous early in the career, but general education may help later, which is shaped and affected by employers' preferences and industrial development stages [13]. The effect of vocational education on economic growth appears to be greater than that of university education. Additionally, the reversed result of economic growth on vocational education seems stronger than on university education [14]. Adolescents must decide on their post-compulsory education at the end of lower secondary school while facing realistic and social dimensions positively interrelated with the choice of education types [15].

### *2.2. Transition from Higher Vocational to Academic Education*

Positive, negative, and dialectic comments exist on transitioning from higher vocational to academic education in HVE sustainability. The HVE colleges should create and support students' sustainable development through transitioning to academic education.

First, positive comments support the transition. Under the background of the knowledge economy era, colleges and universities of HVE should take cultivating interdisciplinary talents with knowledge, skills, ability, and quality for society as the teaching objective, innovate the development mode, and update the educational concept [16].

Second, negative comments emphasize a conditional transition. Students with a vocational education background will experience struggles as they transition to higher education. Widening epistemic access and implementing pedagogies can ease these transitional frictions, potentially increasing the chances of successful higher education participation and completion [17]. Conditioning on tertiary educational attainment and improved access to better vocational education will probably contribute more than a significant increase in regular college attainment. Comparing the U.S. to Germany suggests that pushing more students to bachelor's degree-granting colleges may no longer be the most efficient way to deal with the challenges caused by the decline in manufacturing employment affecting lower-income households [18].

Third, dialectic comments encourage self-motivation, interests, and career planning. The division between academic and vocational education is a predominant feature of upper secondary and higher education in many other countries. A minority of students have not proceeded to higher education through traditional academic education but have enrolled in vocational education. Those enrolling through the vocational route are more often mature students from lower parental educational backgrounds. They have usually completed a more prolonged study path and begin to see themselves as future higher education students later in life. There are also differences in how students with diverse educational backgrounds experience their sense of belonging to the higher education community [19]. There was no long-term effect on enrollment in further education or labor market outcomes, and the benefits of opening pathways from vocational to higher education may be outweighed by the cost of a more demanding curriculum [20].

### *2.3. Higher Vocational Education Resilience*

Cooperation between vocational education and industries helps increase teachers' resilience and ease prevailing pressures. The teacher resilience problem is prevalent in vocational education systems. Resilience measures the teachers' career sustainability. At a macro-contextual level, vocational education teachers face low social recognition. At a micro-system level, teachers' frustration relates to students' low vocational motivation and maturity and specific emerging instructional challenges in vocational subject teaching. Regarding resources, teachers perceived the possibility of diversifying their professional role by alternating school and extracurricular activities as a supportive factor [21].

HVE colleges are essential to regional innovation systems and skilled workers' roles in implementing new technologies in manufacturing industries. The collaboration between industry actors and HVE colleges helps develop fresh education programs tailored for contemporary and future manufacturing. HVE colleges are essential for manufacturers' competitiveness. Skilled workers and engineering technicians are crucial to implementing new manufacturing technologies. The HVE colleges and regional innovation systems co-evolve with emerging technologies in terms of changing knowledge demands in the industry, prompting new education programs in HVE colleges [22]. A cooperative education experience (or internship placement) is an essential component of the curricula of vocational higher education. Incorporating an internship (i.e., workplace learning experience) and professional mentoring into vocational higher education curricula would advance students' personal growth and future careers [23]. The orientation of HVE towards competence-based education has led to fundamental changes in the work of HVE teachers [24]. Many countries' policymakers widely believe that HVE and training are central to economic prosperity and social well-being. A growing policy concern is ensuring that vocational teachers can maintain and develop their 'craft' skills and pedagogy through continuing professional development [25].

Embedding in the labor market and industries contributes to HVE resilience. The labor market returns for HVE vary over the life cycle. Graduates with an occupation-specific educational degree transition smoothly into the labor market but experience difficulties when their specific skills become obsolete later in their careers. This life course penalty to HVE is expected to be particularly strong during rapid technological change [26]. Not only historically evolved understandings and interactions with actual labor market outcomes of HVE seem to function as the main reinforcing mechanisms [11]. A more occupation-specific educational degree increases the likelihood of employment in early life and lowers the average job status. This initial advantage of a higher employment probability declines with age, and the disadvantage in job status increases as workers grow older. These lifecycle effects have not, or only marginally, changed over time [26].

From an overall perspective, there is an interactive relationship between the development of HVE and the upgrading of industrial structures. The rationalized and advanced industrial structure promoted the scale of development of HVE and the quality of HVE [27]. There is a strong association between firms' positive assessments of vocational colleges and the vocational colleges' educational and developmental functions [28]. In light of the booming international experience and domestic policy orientation, school-enterprise cooperation has gradually become the key to improving the quality of HVE [29]. Policy proposals promoting HVE focus on the school-to-work transition. However, with technological change, gains in youth employment may be offset by less adaptability and diminished engagement later in life [30].

### *2.4. Higher Vocational Education in China*

How HVE and training systems are structured varies significantly from country to country because different countries have different objectives for their HVE systems, and HVE is embedded differently within any country's education and labor market systems [31]. The HVE sector in China is influenced by a complex interweaving of policy actors working across various industry alliances and related government and associated bodies. The interplay between these actors is a new form of policy network involving a more variegated conception of private-public engagement than typically described in Western and other developing country contexts and involving connections with data infrastructures that are only just emerging as key to the delivery of HVE within such alliances in China [32].

Historically, Chinese educational philosophy has been dominated by Confucianism and, since 1949, by Marxism. However, rapid industrialization, ideological demands, and loyalty to traditions have led HVE to adopt various Western philosophies to move the country forward without challenging the status quo too vigorously [33]. Upper secondary technical and HVE accounted for 41% of total enrollment at upper secondary colleges in China [34]. Compared to general education, the types of research that HVE colleges in China should engage in are unclear, and the colleges' internal research management and construction are relatively weak. There is a structural contradiction between insufficient investment in human, financial, and material resources and excessive investment in related resources. HVE sustainability is increasingly concerned by the management departments, according to the interviews in this study. Many HVE colleges have even experienced the phenomenon of "academic drift," imitating the academic research of ordinary undergraduate colleges.

The discussion on whether and what types of research should be conducted by HVE colleges in China began in the early 21st century. In early representative views, although HVE focused on talent cultivation, it did not mean that the HVE colleges and teachers would never conduct academic research. The key was to determine the correct direction of research. From a time perspective, the discussion on academic research in HVE can involve three stages: the first stage is the discussion on whether HVE should conduct research, and the relevant viewpoints are mainly in newspapers and magazines. The second stage, marked by the convening of the first national HVE work in 2011, clarifies the academic research mission of HVE in all sectors of society. The discussion on the research

theme of HVE has shifted from "whether to conduct academic research" to "what to do academic research", and educational research and academic research have become the keys to constructing the connotation of HVE. The third stage was in 2016, when China's economic development entered a new stage of high-quality development from high-speed scale growth. HVE generally recognizes that HVE has entered a stage of connotative development. If the balance between academic research and teaching is ignored, future high-quality development will face insurmountable bottlenecks and peaks. Research on how to carry out high-quality research and evaluate the research performance of HVE has become a hot field.

The research activities carried out in HVE have gained widespread recognition from various sectors of society, and research on the assessment of research performance in HVE is gradually increasing. However, there is relatively little research carried out in HVE. From the perspective of different research types, assessment indicators are designed separately to evaluate the research performance of HVE, and a comparative analysis to determine the research positioning becomes essential.

## 3. Indicators and Methods for Assessing HVE Research Types

### *3.1. Research Criteria of the Multi-Input Multi-Output HVE System*

Academic research activities in universities belong to a complex system with multiple inputs and outputs. The objectivity of research performance assessment and the credibility of assessment results depend on a reasonable assessment index system. There is more research on assessment for general universities but less on research assessment for HVE. First, there are differences in educational level, development positioning, and business priorities between HVE and ordinary universities, and there are also significant differences in quality and school positioning between HVE. If there is no distinction between the assessment of research types and positioning, all assessment indicators of general universities can be used for reference, or HVE can be evaluated for research performance according to the same indicator system. It will inevitably lead to a serious deviation from reality in the assessment results, questioning their scientific and objective nature and making it difficult to avoid the academic research assessment of HVE becoming a mere formality.

In this study, we constructed an assessment index system in three steps. First, we interviewed the principals and vice presidents of HVE colleges in Shanghai. After analyzing the materials they provided, we used text content and grounded analysis to extract three types of research: applied, educational, and comprehensive. We then re-interviewed them to verify the types and their meanings. The applied research and comprehensive types are common sense, while the educational type may not include all research activities besides the applied research type; however, it should still be considered an important type. Comprehensive academic research balances applied and academic research. Second, we interviewed leaders from the Personnel, Academic Affairs, and Science and Technology Offices in HVE colleges in Shanghai to identify the inputs and outputs of the research types. We visited them three times to verify the input/output criteria. Third, we interviewed the HVE management department of the Shanghai Municipal Education Commission to verify the research types and their inputs/outputs. The research types were confirmed, and the inputs/outputs were adjusted according to the interviewees. After about three formal and informal rounds of interviews, we finally set up the assessment index system in Table 1.

The comprehensive academic research assessment indicators include three input and three output indicators. The input and output comprehensively consider two aspects: educational research and applied research. The indicators for applied research include four input indicators and three output indicators, with a focus on reflecting the input and output of applied research types. The assessment indicators for educational research include three input indicators and three output indicators, with an emphasis on reflecting the input and output of research related to education and teaching.

**Table 1.** Indicators for assessing three types of HVE research.

| Research Type | I/O | Index | Indicators | Quantization Data Item |
|---|---|---|---|---|
| Comprehensive | I | 1 | Research workforces | Number of researchers |
| | | 2 | Research funds | The monetary amount of research funds |
| | | 3 | Teaching and research device investment | Number of funds for teaching and research devices |
| | O | 1 | Industrial research projects | The monetary amount industrial research funds |
| | | 2 | Research papers | Number of research papers published |
| | | 3 | Published textbooks | Number of textbooks published |
| Applied | I | 1 | Teachers with postgraduate degrees | Number of teachers with master's degrees or above |
| | | 2 | Research funding | Amount of research funds |
| | | 3 | Teaching and research device investment | The monetary amount of teaching and research devices |
| | | 4 | Industry-co-invested research colleges | Number of industry-co-invested research colleges |
| | O | 1 | Industrial research projects | The monetary amount of industrial research projects |
| | | 2 | Research papers | Number of core papers published |
| | | 3 | Patents | Number of invention patents granted |
| Educational | I | 1 | Specialized teachers | Number of teachers with master's degrees or above |
| | | 2 | Research funds | The monetary amount of academic research funds |
| | | 3 | Teaching and research platform investments | Number of teaching and research platforms |
| | O | 1 | Educational research projects | Number of educational research-related projects |
| | | 2 | Teaching achievement awards | Number of awards for teaching results |
| | | 3 | Published textbooks | Number of textbooks published |

The index system should reflect the sustainable development of HVE and teachers. So, Table 1 emphasizes the funds and investment in HVE colleges and teachers and the achievements of teachers.

### *3.2. The DEA Model*

The research activities in HVE colleges are complex systems with various inputs and outputs. Teaching and academic research are public services to people and industries to a certain extent. Therefore, it is unsuitable for the assessment model to use the market price to measure the input and output. The comprehensive performance assessment of academic research is unique, and the general performance assessment method is challenging. DEA is an efficiency assessment method based on relative efficiency. It mainly uses mathematical programs to evaluate the efficiency of decision-making units (DMUs) with some inputs and outputs. The DEA method has the following advantages: first, it extends the concept of engineering efficiency of a DMU with a single input and a single output to the relative efficiency assessment of similar DMUs with multiple inputs and outputs without determining the functional relationship between inputs and outputs or estimating the parameters. Second, DEA automatically sets the weights of inputs and outputs according to the optimality principle, avoiding the error caused by subjective weighting. Third, it is not affected by the measurement units of various indicators and can process data on multiple scales. The DEA method has been widely applied to evaluating the work efficiency of similar organizations and shows high superiority and applicability in avoiding subjective impressions, simplifying algorithms, and reducing error.

With the development of relevant DEA theories, new models are constantly emerging, but the basic models mainly include the CCR [35] model with constant returns to scale and the BCC model [36] with variable returns to scale [37–39]. This study uses them to evaluate the efficiency of academic research activities in higher vocational colleges. The reasons are as follows: First, CCR and BCC can deal with the input–output efficiency of multiple inputs and multiple outputs, thus reducing the inaccurate measurement of outputs by the

univariate production function model. Second, the types of input and output variables of research activities in HVE colleges are quite different, and the measurement units and scales of various indicators are different. The two DEA methods have the characteristics of solid adaptability and can accept the situation of varying indicator units.

Under constant returns to scale, the CCR model can evaluate scale and technology efficiency. In contrast, the BBC model improves the CCR model for the condition of variable returns to scale by dividing the technology efficiency into pure technology efficiency and scale efficiency and mainly adding constraints to the CCR model to achieve measuring the return on the scale to compare the relative technology efficiency between decision-making units. Assuming that there are $n$ DMUs, each has $m$ inputs and $s$ outputs. The [CCR] and [BBC] use known data, $(X_j, Y_j)$ for each DMU $j$. Here, $X_j = \left[X_{1j}, X_{2j}, \cdots, X_{mj}\right]^T$, $Y_j = \left[Y_{1j}, Y_{2j}, \cdots, Y_{sj}\right]^T$. The [CCR] and [BCC] are used to assess the efficiencies of a DMU $k$.

$$[CCR]\min z^{OE} = \theta - \varepsilon\left(E^T s^- + E^T s^+\right)$$

Subject to

$$\begin{cases} \sum_{j=1}^{n} \lambda_j X_j + s^- = \theta X_k \\ \sum_{j=1}^{n} \lambda_j Y_j - s^+ = Y_k \\ \lambda_i \geq 0, j = 1, 2, \cdots, n \\ s^- \geq 0, s^+ \geq 0 \end{cases}$$

$$[CCR]\min z^{TE} = \theta - \varepsilon\left(E^T s^- + E^T s^+\right)$$

Subject to

$$\begin{cases} \sum_{j=1}^{n} \lambda_j X_j + s^- = \theta X_0 \\ \sum_{j=1}^{n} \lambda_j Y_j - s^+ = Y_0 \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \lambda_i \geq 0, j = 1, 2, \cdots, n \\ s^- \geq 0, s^+ \geq 0 \end{cases}$$

In the models [CCR] and [BCC], $\varepsilon$ is the Archimedes infinitesimal coefficient. In this study, set $\varepsilon = 0.001$. Besides the decision variable $\lambda$, the variables $(s^-, s^+)$ relax the inputs and outputs, and $\theta$ denotes the efficiency. As the difference between the two models, the constraint $\sum_{i=1}^{n} \lambda_j = 1$ introduces non-linear relations to [BCC]. The objective values $(z^{OE}, z^{TE})$ represent the overall and technology efficiencies (OE and TE), and $z^{OE}/z^{TE}$ is the scale efficiency, $z^{SE}$. When $\theta = 1$ and $s^- = s^+ = 0$, the DMU $k$ is DEA efficiency; when $\theta < 1$, the DMU $k$ is not DEA efficiency.

### *3.3. Identify Research Types by DEA*

To explore the types of research at higher vocational colleges, we developed the following criteria for assessing HVE colleges using DEA:

First, suppose a given HVE college's three research types are all in an effective state. In that case, it indicates that the inputs and outputs of research resources in various aspects, such as educational research, applied research, and comprehensive research, have all reached satisfactory results. The development prospect is good, and the college can choose the comprehensive research type.

Second, if two or one of the three research types is DEA-effective, it indicates that the development of this college has a specific emphasis and is suitable for the development orientation of educational research or applied research.

Third, suppose the comprehensive performance assessment of the three research types is ineffective. It indicates that the college should re-examine the inputs and outputs of

research resources, adjust the direction of inputs of research resources, and identify the research types that can give full play to their advantages and specialties.

## 4. The Case Study and Assessment Procedure

In the following studies, the DMUs are 22 HVE colleges in Shanghai. We obtain the inputs and outputs of the DMUs from the following report books and databases (2021): the National Annual Statistical Report on Science and Technology of Colleges and Universities, the Annual Quality Report of HVE colleges, the Collection Form of Innovative Information of Colleges and Universities, and the public data sources, including the China National Knowledge Network. Moreover, we have reviewed the 22 colleges to obtain and verify the data.

The assessment process consists of four steps. First, we adopted and implemented the two-stage out-oriented DEA models and prepared the data for inputs and outputs. Second, we assessed the research performances of the 22 DMUs when the research type was applied, educational, or comprehensive using [CCR] and [BCC]. Third, we carried out the projection analysis on the DMUs, considering the slack degrees and improvement spaces of the inefficient DMUs. Finally, we compared the performance assessment results of the three research types. Additionally, determine the research types of Shanghai's 22 HVE institutes. Further, optimize the optimal allocation strategy of resources through comprehensive assessment comparison, input redundancy, and output insufficiency. Table 2 lists the 22 HVE colleges and their abbreviations.

**Table 2.** The considered Shanghai's 22 HVE colleges.

| No. | College (DMU) | Abbreviation |
|---|---|---|
| 1 | Shanghai Bond Vocational and Technical College | BOND |
| 2 | Shanghai Urban Construction Vocational College | UCON |
| 3 | Shanghai Publishing and Printing College | PUBP |
| 4 | Shanghai Film Art Vocational College | FILM |
| 5 | Shanghai Electronic Information Vocational and Technical College | ELEC |
| 6 | Shanghai Donghai Vocational and Technical College | DONG |
| 7 | Shanghai Business Foreign Language Vocational College | LANG |
| 8 | Shanghai Vocational and Technical College of Industry and Commerce | COMM |
| 9 | Shanghai Vocational College of Arts and Crafts | ARTC |
| 10 | Shanghai Maritime Vocational & Technical College | MARI |
| 11 | Shanghai Jiguang Polytechnic College | JIGU |
| 12 | Shanghai Jiaotong Vocational and Technical College | JIAO |
| 13 | Shanghai Vocational College of Science and Technology | SCIT |
| 14 | Shanghai Lida College | LIDA |
| 15 | Shanghai Institute of Tourism | TOUR |
| 16 | Shanghai Civil Aviation Vocational and Technical College | CAVI |
| 17 | Shanghai Minyuan Vocational and Technical College | MINY |
| 18 | Shanghai Agricultural and Forestry Vocational and Technical College | ARGF |
| 19 | Shanghai Sibo Vocational and Technical College | SIBO |
| 20 | Shanghai Xingjian Polytechnic College | XINJ |
| 21 | Shanghai Zhendan Vocational College | ZDAN |
| 22 | Shanghai Zhongqiao Vocational and Technical University | ZHQT |

## 5. Empirical Analysis Results

### *5.1. Efficiency of HVE Colleges Considering Comprehensive Research Type*

(1) Overall efficiency (OE)

Considering the type of comprehensive research, there is a significant difference in the level of OE among the 22 colleges. The highest value of OE is 1, the lowest value is only 0.241, the average value is 0.7554, the median value is 1, and the standard deviation is 0.2975. There are 12 colleges with an OE of 1, which is DEA technology effective, accounting for 54.5% of all colleges. Table 3 presents the colleges' OE efficiency. DEA-efficiency colleges include ARTC, UCON, PUBP, ELEC, ARGF, BOND, FILM, LANG, XINJ, MINY, SIBO, and LIDA.

**Table 3.** Efficiency assessment results of the comprehensive research type.

| HVE College | *OE* | *TE* | *SE* | Return to Scale |
|---|---|---|---|---|
| ARTC | 1 | 1 | 1 | Constant |
| UCON | 1 | 1 | 1 | Constant |
| PUBP | 1 | 1 | 1 | Constant |
| ELEC | 1 | 1 | 1 | Constant |
| ARGF | 1 | 1 | 1 | Constant |
| BOND | 1 | 1 | 1 | Constant |
| FILM | 1 | 1 | 1 | Constant |
| LANG | 1 | 1 | 1 | Constant |
| XINJ | 1 | 1 | 1 | Constant |
| MINY | 1 | 1 | 1 | Constant |
| SIBO | 1 | 1 | 1 | Constant |
| LIDA | 1 | 1 | 1 | Constant |

The above 12 colleges have a situation of pure TE and SE, indicating that these colleges have made reasonable allocations of resources and output in research activities and have made full development and utilization of human resources, funds, and equipment investment, that is, resource investment has achieved the maximum output. If these 12 colleges want to improve their outputs further, they must add researchers, funding, or device investments. These 12 colleges have distinctive and professional schools such as ARTC, PUBP, ARGF, and FILM, as well as comprehensive disciplinary development schools such as UCON, ELEC, etc.

(2) Pure technology efficiency (TE)

There are 13 DEA pure technology efficiency colleges, accounting for 59% of the evaluated colleges. In addition to 12 colleges with DEA overall efficiency, ZHQT is a new one. The resource allocation for research inputs and outputs in these 13 colleges is appropriate. Looking at all 22 colleges, the TE has a maximum value of 1, a minimum value of 0.430, an average value of 0.848, a median value of 1, and a standard deviation of 0.2133. ZHQT is currently the only vocational undergraduate college in Shanghai, and the pure technical efficiency of research performance is efficient, indicating that the college's overall efficiency and technical inefficiency are caused by SE inefficiency.

Moreover, the returns to scale of ZHQT are showing an increasing state, indicating that the current scale inefficiency is caused by insufficient resource investment and that resource investment should be appropriately increased. MARI's returns to scale are increasing, indicating the need for a significant increase in research resource investment. In addition, eight colleges have ineffective pure technical efficiency, accounting for 36% of all HVE

colleges. For these colleges, it is necessary to strengthen the allocation of input and output resources for research activities.

(3) Scale efficiency (SE)

The combination of SE and TE in colleges causes OE. Therefore, their SE is also ineffective for colleges that do not use DEA technology effectively. Considering the comprehensive research type, 22 colleges achieve a maximum value of 1, a minimum value of 0.385, an average value of 0.871, a median value of 1, and a standard deviation of 0.211. Among them, 12 schools have unchanged returns to scale and belong to economies of scale, accounting for 54%. Seven schools have shown decreasing returns to the scale, accounting for only 32%. For these colleges, it is necessary to appropriately reduce research resource investment to reduce or eliminate the relative surplus of research resource investment. Only three schools have shown an increasing return to the scale, namely ZHQT, DONG, and MARI, accounting for 14%. These three HVE colleges have a relatively insufficient investment in academic research resources. Therefore, increasing investment in research resources is necessary for better educational research results.

(4) Projection analysis

To improve the research OE of the colleges that are not efficient, we used projection analysis to clarify each college's input redundancy and output shortage. Among the 22 colleges, 8 have excess investment and insufficient outputs, as shown in Table 4.

**Table 4.** Efficiency projection analysis of the comprehensive research type.

| HVE College | $S_1^+$ | $S_2^+$ | $S_3^+$ | $S_1^-$ | $S_2^-$ | $S_3^-$ |
|---|---|---|---|---|---|---|
| ZHQT | 79.164 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| DONG | 4.684 | 0.000 | 4.397 | 24.744 | 0.000 | 4653.741 |
| COMM | 0.000 | 0.000 | 0.713 | 131.512 | 0.000 | 7766.604 |
| JIGU | 46.936 | 0.000 | 0.000 | 0.000 | 0.000 | 1044.480 |
| JIAO | 4.040 | 0.000 | 0.238 | 65.694 | 0.000 | 4883.445 |
| SCIT | 0.000 | 0.000 | 0.475 | 0.000 | 0.000 | 766.143 |
| TOUR | 663.847 | 0.000 | 0.156 | 0.000 | 58.687 | 0.000 |
| CAVI | 187.626 | 0.000 | 0.000 | 74.235 | 0.000 | 0.000 |
| ZDAN | 0.000 | 0.758 | 0.000 | 105.421 | 0.000 | 0.000 |

### *5.2. Efficiency of HVE Colleges Considering Applied Research Type*

(1) Overall efficiency (OE)

Significant differences exist in the performance assessment results of the applied research type, with the highest OE value of 1, the lowest value of 0, the average value of 0.7524, the median value of 0.99, and the standard deviation of 0.3485. Table 5 lists the colleges, $OE = 1$. Among the 22 colleges, 11 have $OE = 1$, accounting for 50%, and there is a significant change compared to the comprehensive research assessment results. Some colleges considering the comprehensive research type are DEA technologically effective, but may not be DEA technologically effective when considering the applied research type, such as ARTC, MINY, and SIBO. Other colleges considering the comprehensive research type are not DEA technologically effective, such as DONG and JIAO.

**Table 5.** Efficiency assessment results of the applied research type.

| HVE College | *OE* | *TE* | *SE* | Return to Scale |
|---|---|---|---|---|
| UCON | 1 | 1 | 1 | Constant |
| PUBP | 1 | 1 | 1 | Constant |
| ELEC | 1 | 1 | 1 | Constant |
| ARGF | 1 | 1 | 1 | Constant |
| BOND | 1 | 1 | 1 | Constant |
| FILM | 1 | 1 | 1 | Constant |
| DONG | 1 | 1 | 1 | Constant |
| LANG | 1 | 1 | 1 | Constant |
| XINJ | 1 | 1 | 1 | Constant |
| JIAO | 1 | 1 | 1 | Constant |
| LIDA | 1 | 1 | 1 | Constant |

Further, we discover that 11 colleges are DEA technologically and scale effective. As an explanation, the colleges' input and output allocation in applied research is relatively reasonable. The colleges have fully developed relevant input and achieved satisfactory results. We can see from the 11 colleges with effective OE that most have disciplinary characteristics, such as PUBP, ARGF, FILM, and JIAO.

(2) Pure technology efficiency (TE)

Among all 22 colleges, pure TE of the applied research type can reach the highest value, 1. The lowest pure TE value is 0.376, the median value is 1, and the standard deviation is 0.1881. There are two more colleges of pure TE considering applied research types than those of OE. These two colleges incur DEA technology efficiency but not DEA overall efficiency, which indicates that the scale inefficiency determines the overall inefficiency. Further, the returns to the scale of these two colleges are decreasing, indicating that the scale inefficiency is caused by excessive investment in research resources. The investment in research resources can be appropriately reduced. There are eight universities with ineffective pure technological efficiency considering applied research, accounting for 36% of all colleges. In the next step, these colleges must strengthen the level of applied research resource investment and achievement output.

(3) Scale efficiency (SE)

Considering applied research, the SE of 22 colleges has a maximum value of 1, a minimum value of 0, a median of 0.99, and a standard deviation of 0.3089. Among the 22 colleges, 11 have unchanged returns to scale and exhibit economies of scale, accounting for 50%; only two colleges show a decreasing return on the scale, accounting for only 9%. These two colleges should reduce their investment in related research resources and strive to eliminate the relative surplus of applied research resources. There are nine colleges with increasing returns to scale, accounting for 41%. The investment in applied research resources in these nine colleges is insufficient and should be increased.

(4) Projection analysis

Table 6 presents the projection analysis of performance assessment for the colleges considering applied research. As seen in the table, nine schools have a certain degree of excess investment and insufficient output. Most HVE colleges have redundant inputs and inadequate outputs. There is only one college with inadequate output and the three schools only have redundant investments.

**Table 6.** Efficiency projection analysis of the comprehensive research type.

| HVE College | $S_1^+$ | $S_2^+$ | $S_3^+$ | $S_1^-$ | $S_2^-$ | $S_3^-$ | $S_4^-$ |
|---|---|---|---|---|---|---|---|
| ARTC | 0.000 | 0.000 | 0.000 | 0.000 | 614.795 | 0.000 | 6.366 |
| ZHQT | 0.000 | 7.624 | 0.000 | 106.761 | 0.000 | 0.000 | 7.697 |
| COMM | 0.000 | 0.000 | 0.092 | 0.000 | 0.000 | 0.000 | 0.000 |
| JIGU | 2.174 | 0.000 | 0.299 | 0.000 | 0.000 | 0.000 | 0.000 |
| SCIT | 29.199 | 0.000 | 0.250 | 0.000 | 15.281 | 0.000 | 22.161 |
| TOUR | 0.000 | 0.000 | 0.503 | 0.000 | 0.000 | 910.460 | 0.969 |
| CAVI | 52.980 | 0.000 | 0.125 | 0.000 | 146.085 | 0.000 | 0.000 |
| MINY | 5.326 | 0.000 | 0.062 | 0.000 | 0.000 | 0.000 | 0.000 |
| ZDAN | 0.000 | 0.000 | 0.143 | 4.570 | 0.000 | 0.000 | 0.000 |

### *5.3. Efficiency of HVE Colleges Considering Educational Research Type*

(1) Overall efficiency (OE)

Considering educational research, the DEA-efficiency results of the colleges are shown in Table 7. The colleges' overall efficiencies have a maximum value of 1, a minimum value of 0.106, an average value of 0.7279, a median value of 0.791, and a standard deviation of 0.3002. Only nine colleges are DEA-efficient in the evaluation results, including ARTC, PUBP, ELEC, BOND, MARI, XINJ, JIAO, TOUR, and MINY. The other 13 colleges are not DEA-efficient. Twelve colleges considering comprehensive research are DEA technologically efficient; eleven colleges considering applied research are DEA technologically efficient; and only nine colleges considering educational research are DEA technologically efficient. These nine colleges with overall efficiency are pure technology and scale efficient. Their investments in educational research have been fully and efficiently developed.

**Table 7.** Efficiency assessment results of the educational research type.

| HVE College | *OE* | *TE* | *SE* | Return to Scale |
|---|---|---|---|---|
| ARTC | 1 | 1 | 1 | Constant |
| PUBP | 1 | 1 | 1 | Constant |
| ELEC | 1 | 1 | 1 | Constant |
| BOND | 1 | 1 | 1 | Constant |
| MARI | 1 | 1 | 1 | Constant |
| XINJ | 1 | 1 | 1 | Constant |
| JIAO | 1 | 1 | 1 | Constant |
| TOUR | 1 | 1 | 1 | Constant |
| MINY | 1 | 1 | 1 | Constant |

(2) Pure technology efficiency (TE)

Considering the educational research type for all the colleges, the highest pure technology efficiency is 1, the lowest is 0.161, the average is 0.7933, the median is 1, and the standard deviation is 0.3006. Compared to the nine colleges of DEA overall and technological efficiency, there are four more colleges with pure technology efficiency, reaching 13, accounting for 59% of all 22 colleges, namely UCON, DONG, LANG, and SIBO. The comprehensive efficiency technology of these four schools is ineffective, while pure technology is effective, indicating that they are not efficient overall because of scale inefficiency. Furthermore, the returns to scale of these four colleges are decreasing, indicating that the current investment in research activities is excessive and should be appropriately reduced.

There are nine colleges with ineffective pure technological efficiency in educational research, accounting for 41% of all HVE colleges.

(3) Scale efficiency (SE)

Considering the educational research type for all the colleges, the highest and lowest scale efficiencies are 1, 0.604, 0.9086, 0.9945, and 0.1296, respectively. There are nine colleges with constant returns to scale, accounting for 41%, while the other eight colleges have a decreasing return to scale, accounting for 36%. Only five colleges have an increasing return to scale, accounting for 23%. Most colleges have a relatively excessive investment in educational research resources and should control or even reduce their investment in educational research resources.

(4) Projection analysis

The projection analysis of all the colleges considering the educational research type is shown in Table 8. There are ten colleges with excess input and insufficient output. In addition to ARTC having input redundancy and MINY only having output insufficiency, the other seven HVE colleges also have input redundancy and output insufficiency.

**Table 8.** Efficiency projection analysis of the educational research type.

| HVE College | $S_1^+$ | $S_2^+$ | $S_3^+$ | $S_1^-$ | $S_2^-$ | $S_3^-$ |
|---|---|---|---|---|---|---|
| ARGF | 0.361 | 0.000 | 0.470 | 0.000 | 0.000 | 0.000 |
| ZHQT | 0.800 | 0.000 | 0.000 | 0.000 | 76.265 | 0.000 |
| FILM | 0.264 | 0.000 | 0.000 | 0.000 | 0.000 | 0.187 |
| COMM | 0.004 | 0.000 | 0.020 | 0.000 | 0.000 | 1.035 |
| JIGU | 0.270 | 0.000 | 0.000 | 0.000 | 0.000 | 0.850 |
| SCIT | 0.178 | 0.000 | 0.953 | 0.000 | 0.000 | 2.359 |
| TOUR | 0.000 | 0.000 | 0.000 | 0.000 | 99.889 | 0.000 |
| CAVI | 0.472 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| ZDAN | 0.513 | 0.283 | 0.000 | 0.000 | 0.000 | 0.000 |
| LIDA | 0.209 | 0.761 | 0.000 | 0.000 | 0.000 | 0.161 |

## 6. Managerial and Policy-Making Implications

This study aims to answer two research questions regarding HVE and teachers' sustainable development: Should HVE colleges conduct academic research? What types of research should HVE colleges do? The research on the questions contributes to management strategies, especially financial support and cooperation with industries and governments. As studied in Section 2, the HVE colleges should conduct academic research. In Sections 3–5, we study the method used to decide the research types for HVE colleges. In the following, we summarize the research on the second question.

Considering the three research types (comprehensive, applied, and educational), we compared the input–output efficiency assessment results of 22 HVE colleges in Shanghai. The HVE colleges can be divided into four types. First, if the college is DEA-efficient considering all three research types, it belongs to the comprehensive research type. Second, the college is more effective than applied research or educational research. Under this research positioning, the college is technologically efficient for two types of the three research types, including three subtypes, i.e., comprehensive educational research, comprehensive applied research, and applied or educational research. Third, the college is efficient only for one type of research, including three subtypes: comprehensive, educational, and applied. Fourth, the college is inefficient when considering the three research types. Table 9 lists the first and second categories of HVE colleges.

**Table 9.** The HVE colleges in the first and second categories.

| HVE College | Efficiency | | | Efficient Types |
|---|---|---|---|---|
| | Comprehensive | Applied | Educational | |
| PUBP | 1 | 1 | 1 | 3 |
| ELEC | 1 | 1 | 1 | 3 |
| ARTC | 1 | 0.804 | 1 | 2 |
| UCON | 1 | 1 | 0.604 | 2 |
| ARGF | 1 | 1 | 0.867 | 2 |
| FILM | 1 | 1 | 0.727 | 2 |
| LANG | 1 | 1 | 0.710 | 2 |
| JIAO | 0.548 | 1 | 1 | 2 |
| MINY | 1 | 0.291 | 1 | 2 |
| LIDA | 1 | 1 | 0.106 | 2 |

(1) Category 1. Three research types are simultaneously DEA-efficient.

When the assessment results of three different research types are DEA-efficient, the colleges can achieve comprehensive research development by balancing educational research and applied research. Specifically, these colleges include four: PUBP, ELEC, BOND, and XINJ. The number of colleges of this kind is relatively small, accounting for 18% of all 22. However, based on the analysis of raw data on the research investments of these colleges, BOND and XINJ's research inputs are very small, and the outputs are much greater than the inputs, resulting in the situation where DEA efficiency is achieved, but the research performance cannot be effectively obtained in the assessment. The research performance analysis considers the ratio of research inputs to outputs, which does not mean that the number and overall level of research in these two colleges are the best. Therefore, only PUBP and ELEC are retained in this category (three research types are all efficient).

(2) Category 2. Two research types are simultaneously DEA efficient.

In this category, the colleges are efficient for two types of research. We can obtain three combinations of three research types that are efficient, i.e., comprehensive and applied, comprehensive and educational, and applied and educational. Each combination must contain the applied or educational research type. There are eight colleges, accounting for 36% of all. Among them are three colleges with a comprehensive focus on educational research, four colleges with a focus on applied research, and only one with a focus on applied research.

(3) Category 3. Only one research type is simultaneously DEA efficient.

If a college is DEA-efficient only for one of the three research types, it belongs to this category. According to the comprehensive performance evaluation results, one, two, and one college focus on comprehensive, educational, and applied research. The total number in this category is only 4, accounting for 18% of all colleges.

(4) Category 4. Three research types are not DEA efficient.

When a college is not efficient for each of the three research types, it should choose educational research or applied research as its research development goals based on their characteristics, introduce high-level educational or applied researchers, and combine the training of existing internal teachers to determine the appropriate direction of research resource investments.

The evaluation model and analysis results of research types in HVE proposed in this article have the following generality in developing sustainable educational management strategies and policies.

First, the research types in HVE colleges can be classified based on their actual research resources and performance. Taking China as an example, in the current classification and evaluation system, HVE colleges are ranked as technical and skilled colleges without considering detailed classifications of research types. This is not conducive to objectively and quantitatively evaluating the true research capabilities of HVE colleges, and it is also challenging to formulate incentive policies and measures. Therefore, we focus on the requirements and characteristics of the development of HVE, starting with the goal of promoting teaching through academic research, and study three types of research: comprehensive research, applied research, and educational research.

Second, according to the characteristics of research types, we can optimize the resource allocation of different HVE colleges. According to the research types of HVE colleges, starting from their actual situations and advantages, the education regulatory authorities can encourage them to choose appropriate research types through various means, such as funding investment, policy support, and technical training, to reduce the cost of improving research capabilities. The education regulatory department should also actively guide colleges and teachers to recognize the importance and necessity of promoting high-quality teaching through academic research. For HVE colleges with a specific research foundation and strength, research funding should be increased according to the characteristics of suitable research types, guiding research activities to feed back into teaching and student cultivation. Education regulatory authorities should consider preferential policies to encourage them through special funds for research activities that match majors with high social demands and good employment prospects.

Third, based on performance evaluation and comparison of research type combinations, we can determine suitable research types for HVE colleges. This article conducts a case study on 22 HVE colleges in Shanghai. The analysis results show that two HVE colleges have three types of research performance that are technically effective, six schools have three research types whose performance evaluations are technically inefficient, and other colleges have one or two technically inefficient research types. Therefore, Shanghai HVE colleges can plan suitable research types and outcomes based on the evaluation results of the three research types and the actual situations of their recent research investments and outputs to optimize research resource investments and maximize research effectiveness.

## 7. Conclusions

The educational development model of emphasizing teaching and neglecting academic research in HVE is not conducive to the sustainable development of both students and teachers. Choosing appropriate research types will affect the HVE colleges, students, and teachers' sustainable development, and the governments should develop management strategies and conduct financial support and investment by considering the HVE colleges' research type decisions. There is no unified view on which research type to choose for HVE. Based on the HVE colleges' research resources and practical situations, this article considers three types of research: comprehensive, applied, and educational. We establish input and output evaluation indicators for each type based on literature and survey research. Based on DEA, we construct research efficiency evaluation models and research-type decision-making methods based on the combination of research types. Additionally, we use Shanghai HVE colleges as a case study to collect data and conduct empirical research.

In future research, we will further improve data collection and quantification methods for evaluation indicators of different research types. The data used in this article is mainly quantitative and does not fully reflect the quality of the research. At the same time, the scientific research activities of higher HVE institutions are a dynamic process with specific differences in input and output each year. To reflect the scientific research characteristics and problems of different schools more comprehensively, we will collect annual historical data to dynamically evaluate the scientific research performance of higher HVEs, considering their organizational impacts. In addition, this article studies three types of scientific research activities and their combinations, which can also be classified in other dimensions, to

guide higher HVE to focus on the application of advanced science and technology and the sustainable development of the environment, economy, and society [40]. Moreover, the central and local education commissions should consider the research types of HVEs when making policies and allocating educational funds. We will study the impact of HVE research types on education management strategies and policy-making. Studying education management strategies for sustainable development concerning different research types is also beneficial.

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## References

1. Barnard, H.; Cowan, R.; Muller, M. Global excellence at the expense of local diffusion, or a bridge between two worlds? Research in science and technology in the developing world. *Res. Policy* **2012**, *41*, 756–769. [CrossRef]
2. Zhou, W.; Li, Y.; Hsieh, C.-J.; Chang, K.-C.; Kiang, Y.-J.; Ken, Y. Research Performance and University-Industry-Government Funding Sources in Taiwan's Technological and Vocational Universities. *Innov. Manag. Policy Pract.* **2016**, *18*, 340–351. [CrossRef]
3. Baartman, L.; Gulikers, J.; Dijkstra, A. Factors influencing assessment quality in higher vocational education. *Assess. Eval. High. Educ.* **2013**, *38*, 978–997. [CrossRef]
4. Emrouznejad, A.; Yang, G.-L. A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016. *Socio-Econ. Plan. Sci.* **2018**, *61*, 4–8. [CrossRef]
5. Liu, J.S.; Lu, L.Y.Y.; Lu, W.-M.; Lin, B.J.Y. A survey of DEA applications. *Omega-Int. J. Manag. Sci.* **2013**, *41*, 893–902. [CrossRef]
6. Backes-Gellner, U.; Geel, R. A comparison of career success between graduates of vocational and academic tertiary education. *Oxf. Rev. Educ.* **2014**, *40*, 266–291. [CrossRef]
7. Schulz, W.; Solga, H.; Pollak, R. Vocational education, tertiary education, and skill use across career stages. *Eur. Sociol. Rev.* **2023**, *39*, jcac074. [CrossRef]
8. Wang, G.; Wang, Z. Vocational education: A poor second choice? A comparison of the labour market outcomes of academic and vocational graduates in China. *Oxf. Rev. Educ.* **2023**, *49*, 408–427. [CrossRef]
9. Vanderburg, R.; Harris, L.; Dargusch, J.; Richardson, S. Low socioeconomic status students transitioning from Vocational Education and Training (VET) to university: Examining definitions of success. *High. Educ. Res. Dev.* **2023**, *42*, 742–756. [CrossRef]
10. Xue, E.; Li, J. Exploring the type-based vocational education system: Insights from China. *Educ. Philos. Theory* **2022**, *54*, 1670–1680. [CrossRef]
11. Loogma, K.; Umarik, M.; Sirk, M.; Liivik, R. How history matters: The emergence and persistence of structural conflict between academic and vocational education: The case of post-Soviet Estonia. *J. Educ. Chang.* **2019**, *20*, 105–135. [CrossRef]
12. Hartog, J.; Raposo, P.; Reis, H. Fluctuations in the wage gap between vocational and general secondary education: Lessons from Portugal. *J. Popul. Econ.* **2022**, *35*, 643–675. [CrossRef]
13. McDonald, P.; Korber, M. Employer preferences for vocational over general education: Evidence from an employer survey experiment. *Res. Soc. Stratif. Mobil.* **2023**, *83*, 100756. [CrossRef]
14. Vu, T.B.; Hammes, D.L.; Im, E.I. Vocational or university education? A new look at their effects on economic growth. *Econ. Lett.* **2012**, *117*, 426–428. [CrossRef]
15. Juettler, A.; Schumann, S.; Neuenschwander, M.P.; Hofmann, J. General or Vocational Education? The Role of Vocational Interests in Educational Decisions at the End of Compulsory School in Switzerland. *Vocat. Learn.* **2021**, *14*, 115–145. [CrossRef]

16. Sun, W.; Cui, H.; Xu, C. Innovative Mode of Integrated Development of Higher Vocational Education Based on Social Interaction Theory. *Educ. Sci.-Theory Pract.* **2018**, *18*, 3043–3051.
17. Katartzi, E.; Hayward, G. Conceptualising transitions from vocational to higher education: Bringing together Bourdieu and Bernstein. *Br. J. Sociol. Educ.* **2020**, *41*, 299–314. [CrossRef]
18. Aizenman, J.; Jinjarak, Y.; Ngo, N.; Noy, I. Vocational Education, Manufacturing, and Income Distribution: International Evidence and Case Studies. *Open Econ. Rev.* **2018**, *29*, 641–664. [CrossRef]
19. Haltia, N.; Isopahkala-Bouret, U.; Jauhiainen, A. The vocational route to higher education in Finland: Students' backgrounds, choices and study experiences. *Eur. Educ. Res. J.* **2022**, *21*, 541–558. [CrossRef]
20. Ollikainen, J.-P.; Karhunen, H. A tale of two trade-offs: Effects of opening pathways from vocational to higher education. *Econ. Lett.* **2021**, *205*, 109945. [CrossRef]
21. Boldrini, E.; Sappa, V.; Aprea, C. Which difficulties and resources do vocational teachers perceive? An exploratory study setting the stage for investigating teachers' resilience in Switzerland. *Teach. Teach.* **2019**, *25*, 125–141. [CrossRef]
22. Lund, H.B.; Karlsen, A. The importance of vocational education institutions in manufacturing regions: Adding content to a broad definition of regional innovation systems. *Ind. Innov.* **2020**, *27*, 660–679. [CrossRef]
23. Wan, C.-S.; Yang, J.-T.; Cheng, S.-Y.; Su, C. A longitudinal study on internship effectiveness in vocational higher education. *Educ. Rev.* **2013**, *65*, 36–55. [CrossRef]
24. de Bruijn, E. Teaching in innovative vocational education in the Netherlands. *Teach. Teach.* **2012**, *18*, 637–653. [CrossRef]
25. Lloyd, C.; Payne, J. Raising the quality of vocational teachers: Continuing professional development in England, Wales and Norway. *Res. Pap. Educ.* **2012**, *27*, 1–18. [CrossRef]
26. Rozer, J.J.; Bol, T. Labour Market Effects of General and Vocational Education over the Life-Cycle and across Time: Accounting for Age, Period, and Cohort Effects. *Eur. Sociol. Rev.* **2019**, *35*, 701–717. [CrossRef]
27. Sun, G.; Ding, Z.; Babaee, M. An Empirical Study on the Relationship between the Development of Vocational Education and the Upgrading of Industrial Structure in China. *Rev. Cercet. Si Interv. Soc.* **2018**, *62*, 40–55.
28. Olazaran, M.; Albizu, E.; Otero, B.; Lavia, C. Vocational education-industry linkages: Intensity of relationships and firms' assessment. *Stud. High. Educ.* **2019**, *44*, 2333–2345. [CrossRef]
29. Wu, X.; Wang, M. Selection of Cooperative Enterprises in Vocational Education Based on ANP. *Educ. Sci. Theory Pract.* **2018**, *18*, 1507–1515.
30. Hanushek, E.A.; Schwerdt, G.; Woessmann, L.; Zhang, L. General Education, Vocational Education, and Labor-Market Outcomes over the Lifecycle. *J. Hum. Resour.* **2017**, *52*, 48–87. [CrossRef]
31. Pilz, M. Typologies in Comparative Vocational Education: Existing Models and a New Approach. *Vocat. Learn.* **2016**, *9*, 295–314. [CrossRef]
32. Hardy, I.; Liu, S. Complex connectivities: Policy networks, data infrastructures and vocational education reform in China. *Int. J. Educ. Res.* **2022**, *115*, 102045. [CrossRef]
33. Schmidtke, C.; Chen, P. Philosophy of Vocational Education in China: A Historical Overview. *J. Philos. Educ.* **2012**, *46*, 432–448. [CrossRef]
34. Guo, D.; Wang, A. Is vocational education a good alternative to low-performing students in China. *Int. J. Educ. Dev.* **2020**, *75*, 102187. [CrossRef]
35. Charnes, A.; Cooper, W.W.; Rhodes, E.L. Evaluating program and managerial efficiency: An application of data envelopment analysis to program follow through. *Manag. Sci.* **1981**, *27*, 668–697. [CrossRef]
36. Banker, R.D.; Charnes, A.; Cooper, W.W. Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Manag. Sci.* **1984**, *30*, 1078–1092. [CrossRef]
37. Adler, N.; Friedman, L.; Sinuany-Stern, Z. Review of ranking methods in the data envelopment analysis context. *Eur. J. Oper. Res.* **2002**, *140*, 249–265. [CrossRef]
38. Cook, W.D.; Seiford, L.M. Data envelopment analysis (DEA)—Thirty years on. *Eur. J. Oper. Res.* **2009**, *192*, 1–17. [CrossRef]
39. Cook, W.D.; Tone, K.; Zhu, J. Data envelopment analysis: Prior to choosing a model. *Omega-Int. J. Manag. Sci.* **2014**, *44*, 1–4. [CrossRef]
40. Jaeger, C. Choice for China: What Role for Vocational Education in Green Growth? *China World Econ.* **2014**, *22*, 55–75. [CrossRef]