

Optimization of the Scale and Structure of Professional Degree Graduate Education: Based on the Analysis of Shandong Universities

Le Luo¹, Ying Zhou^{1,*}, An Mao^{2,*}

¹College of Economics and Management, Shandong Agricultural University, Taian, China

²College of Forestry, Shandong Agricultural University, Taian, China

Email address:

luole@sdau.edu.cn (Le Luo), 38777058@qq.com (Ying Zhou), dannymaoan@126.com (An Mao)

*Corresponding author

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Abstract: According to the relevant requirements of the Ministry of education to expand the cultivation categories of professional degree graduate students, China's professional degree graduate education will have a good chance to develop fast. It is expected that by 2025, the enrollment of professional master's degree students will account for two-thirds of the enrollment of master's degree students, which will become an important component of graduate education. With the development of professional degree postgraduate education, the allocation of its education scale and structure has gradually become the focus of attention of relevant scholars in China and abroad. Therefore, in order to discuss the relationship between the cultivation of professional degree postgraduates and the needs of China's economic and social development, taking Shandong province, which is a big agricultural and manufacturing province in China, as an example, this paper analyzes the current situation of the scale and structure of professional postgraduates' education in Shandong province, using the gray correlation method to evaluate the relationship between the higher discipline structure, educational hierarchy, and industrial structure of professional degree postgraduates. It also explained the problem that the professional degree graduate education in Shandong province does not match the local economic development in the process of industrial transformation, and proposed measures to optimize the scale and structure of professional degree graduate education in Shandong province from the aspects of expanding the scale of professional degree education, optimizing the discipline structure of professional degree, building a diversified training system, and realizing the path of symbiotic development, and provide relevant policies and suggestions to promote local economic and social development.

Keywords: Professional Degree Postgraduate, Discipline Structure, Educational Level Structure, Industrial Structure

1. Introduction

At present, with the continuation of Sino US trade friction, science and technology friction and the serious threat of the COVID-19, new challenges have been posed to the cultivation of high-level applied talents in China's industry, medical care and finance. According to the relevant requirements of the Ministry of education on expanding the cultivation categories of professional degree graduate students, China's professional degree graduate education will usher in a new climax. It is expected that by 2025, the enrollment of professional master's degree

students will account for two-thirds of the enrollment of master's degree students, which will become an important component of graduate education. Colleges and universities that undertake the task of graduate training will also gradually develop into the main position for training application-oriented talents in China [1]. Therefore, how to match the education and training of professional degree graduates with the development of social economy has become an urgent problem for relevant experts and scholars.

Taking Shandong province, which is a big agricultural and manufacturing province in China, as an example, this paper discusses what kind of educational scale and structure allocation strategy should be adopted in the development of professional degree graduate education in Shandong province. At present, Shandong Province is speeding up the adjustment and optimization of its industrial structure. With the rapid rise of a large number of high-tech industries, the demand for doctoral and postgraduate students in related disciplines is unprecedented. For this reason, the paper uses the gray correlation method to calculate, arrange, compare and evaluate the higher discipline structure, educational hierarchy and industrial structure of professional degree graduates. Through the gray correlation numerical analysis, the main factors affecting the industry of Shandong province are obtained, which reveals the problems of professional master's education in the process of industrial transformation in Shandong province. Put forward measures for optimizing the scale and structure of postgraduate education in Shandong Province, and provide relevant policies and suggestions for the development of local economy and society [2].

2. Analysis of Research Status at Home and Abroad

With the development of professional degree postgraduate education in more and more countries, the allocation of its education scale and structure has gradually become the focus of attention of relevant scholars at home and abroad. The paper searches and analyzes the literature on the scale and structure of professional degree postgraduate education at home and abroad, as well as their correlation, mainly focusing on the following three aspects:

2.1. Scale of Professional Degree Postgraduate Education

From the perspective of the scale of postgraduate education, since the reform and opening up, the scale of postgraduate education in China has expanded rapidly, with the scale expansion rate reaching 35% in some years. At present, the total number of postgraduate students has reached 2.44 million, and the total number of graduate students who have graduated is about 8 million [3]. Zhang *et al.* found that in cities with better economic development, the size of university graduate students has an obvious effect on the growth of GDP in the region, while the cultivation ability of university graduate students in cities with poor economic development has a small contribution to GDP in the region [4]. Li analyzed the problems such as the incongruity between the size of GDP and the scale of graduate education in some regions of China, the regional economic development speed and the development speed of graduate education, and found that the GDP growth rate has a great impact on the professional degree graduate education resources [5]. Lei Kun *et al.* found that the number of professional degrees granted by China is significantly lower

than that of the United States, Japan, Germany and other countries, and the number of professional master's degrees granted by China is less than half of that of the United States. Compared with India, which is a developing country, India has the largest scale of graduate education in the world. Their professional master's students account for a large proportion of the total number of graduate students, and most of them are science and engineering majors. However, the growth rate of professional master's degree students is far lower than that of doctoral students, but the cultivation of doctoral students is mainly to meet their teaching and scientific research needs [6].

2.2. Professional Degree Postgraduate Education Structure

Li *et al.* analyzed the current situation and hierarchical structure of professional degree graduate education in China, clarified the task of training universities and research institutes for professional degree graduate students, thus proposed countermeasures and suggestions for optimizing the hierarchical structure of professional degree graduate education in China, and suggested that the education level of professional degree graduate students should be adjusted according to the classification of disciplines and majors [7]. Li *et al.* found that "the development of all disciplines is too balanced without structural change" by analyzing the changes in the discipline structure of professional degree graduate education in China, and proposed that professional degree graduate education in China should be classified by different disciplines and specialties according to the different needs of talents at different levels [8]. Through research, Wang Li and others found that although China's professional degree postgraduate education has a history of more than 30 years since its inception, there is an imbalance in the structural development of China's postgraduate education, and there is a shortage of high-level applied talents [9].

2.3. Correlation Between the Scale and Structure of Professional Degree Graduate Education

Huang stressed that we should reform the existing postgraduate training mode, improve the quality of postgraduate education, combine the needs of regional economic and social development, speed up the transformation of postgraduate education structure, and increase the training of applied professional degree graduates [10]. Wang pointed out that the development of postgraduate education is the demand for the further development of regional economy. Since the reform and opening up, China is experiencing an industrial revolution and the updating of the talent structure. Whether we can optimize the scale and structure of postgraduate education in time or appropriately in advance, and cultivate a large number of graduate students with practical application ability has become a bottleneck restricting the economic transformation and upgrading of China [11]. Wu *et al.*

discussed and analyzed how China's professional degree graduate education structure adapts to economic development, and proposed the need to optimize the structure of professional degree graduate education [12].

To sum up, there are several research questions. For the training needs of talents at different levels, how should the structural differences in disciplines and specialties of professional degree graduate education in China be reflected? How should the scale and structure of professional degree postgraduate education in China be coordinated with social and economic development, so as to achieve the perfect combination of the training of high-level applied postgraduates and the needs of economic and social development? Therefore, this paper puts forward the following research hypothesis: because the tertiary industry in Shandong Province is highly dependent on high-level talents. If the discipline structure of professional degree education is adjusted, the impact on the tertiary, secondary and primary industries in Shandong Province will be gradually decreasing. If we adjust the level structure of professional degree education, the impact on the tertiary industry, secondary industry and primary industry of Shandong Province will also decrease gradually. For Shandong Province, in order to promote the transformation of its industrial structure to "three two one", it is necessary to adjust the discipline structure of professional degree education, pay more attention to the development of disciplines that have a greater relationship with the industrial structure, and strengthen the development of tourism, humanities, law and other disciplines that have a higher correlation with the tertiary industry.

3. Analysis of the Scale and Structure of Professional Postgraduate Education in Shandong Province

3.1. The Scale of Professional Degree Development Is "Upside Down" to Its Own Economic Scale

Compared with other similar provinces in China, Shandong Province is a typical agricultural and industrial

province. However, the development level of postgraduate education related to agriculture and industry is relatively backward, and the proportion of its education scale to the total scale is low. In addition, there is a problem that the development of professional degree postgraduate education structure is not coordinated. Through the retrieval and analysis of relevant literature, it is found that the level of regional economic and social development is highly related to the level of professional degree graduate education in the region. And through the statistical analysis of the coefficient between the level of professional degree graduate education in developed countries such as Europe and the United States and regional economic and social development, it is found that the coefficient of the United States is 0.929, Japan is 0.976, and the UK is 1 [13]. Although the economy of Shandong Province ranks the third in the country, its postgraduate education level is far behind Beijing, Shanghai, Jiangsu and other regions with better economic development. The level of professional degree postgraduate education is not coordinated with the regional economic development, making it difficult to meet the needs of social and economic development.

3.2. Mismatch Between Professional Degree Structure and Industrial Structure

At present, the growth rate of GDP in Shandong Province mainly depends on the primary and secondary industries, which indicates that the disciplines most closely related to the economic and social development of Shandong Province are agricultural and engineering majors. It also points out that the rapid economic development of Shandong Province requires a large number of high-level applied talents in agricultural and industrial related majors as an effective support. However, at present, the structural layout of postgraduate professional degrees in Shandong Province mainly focuses on the secondary industry led by industry and the tertiary industry led by financial services. Therefore, the dislocation of the structural layout of postgraduate education will inevitably affect the coordinated development of local economy and society [14].

Table 1. Discipline Distribution of Postgraduates in Shandong Province.

Disciplines	PhD students		PhD students		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Engineering	69	27.82%	14247	33.52%	14316	33.49%
Medical Science	179	72.18%	7696	18.11%	7875	18.42%
Management	—	—	8294	19.51%	8294	19.40%
Education	—	—	3547	8.35%	3547	8.30%
Law	—	—	1807	4.25%	1807	4.23%
Art	—	—	1861	4.38%	1861	4.35%
Agronomy	—	—	1989	4.68%	1989	4.65%
Literature	—	—	1470	3.46%	1470	3.44%
Economics	—	—	1520	3.58%	1520	3.56%
History	—	—	72	0.17%	72	0.17%
Total	248	100.00%	42503	100.00%	42751	100.00%

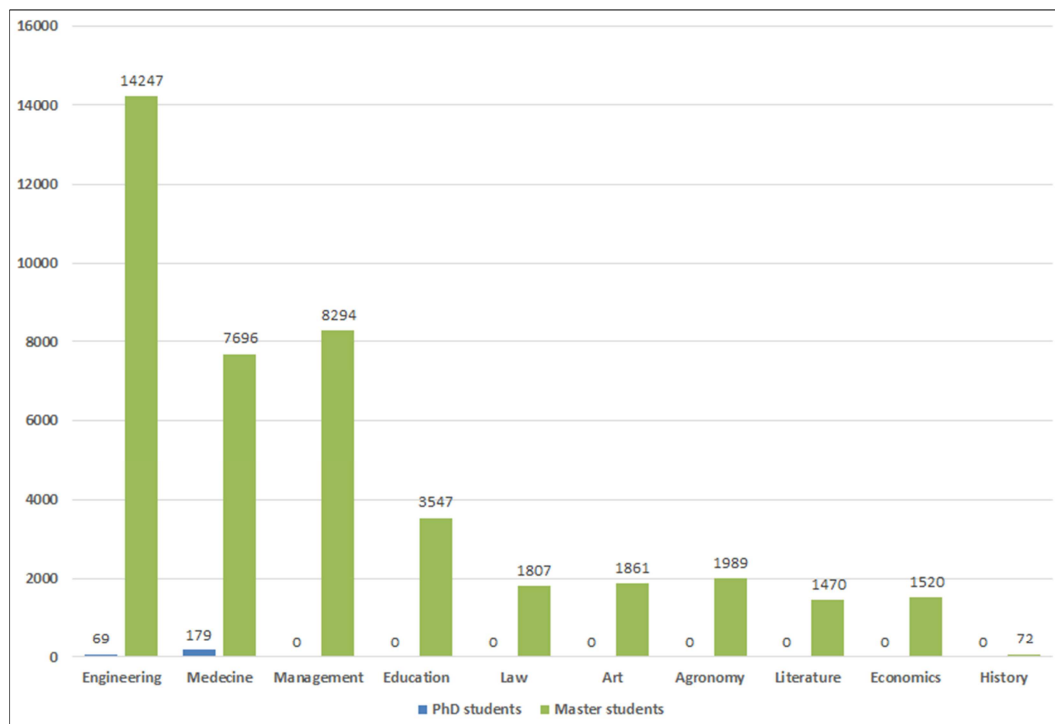


Figure 1. Shandong Province Professional Degree Postgraduates' Disciplinary Category Structure.

3.3. Single Level and Structure of Colleges and Universities for Training Professional Degree Graduates

At present, the cultivation of professional degree postgraduates in Shandong Province is only carried out in some colleges and universities, and the level of these colleges and universities is on the high side, mainly subordinate universities and provincial key universities. The participation of undergraduate and vocational colleges is limited, and the training unit of professional degree graduates is single, so the relevant educational resources in the province are not fully utilized [15]. There are great differences in educational methods and objectives between academic and professional postgraduates. However, most colleges and universities have failed to achieve differentiated education, and their training modes are basically the same [16]. Can the orientation of postgraduate education in colleges and universities change from the traditional theoretical research teaching to the applied teaching required by the training objectives of professional degrees? That is, curriculum, training mode, teacher allocation and combination of production, teaching and research, which still needs a long time of practice to prove. At the same time, we can also try the mode of characteristic application-oriented undergraduate colleges, higher vocational colleges and enterprises jointly cultivating professional degree graduates [17].

3.4. Evaluation System of Professional Degree Graduate Education Structure and Industrial Structure

At present, there are many evaluation methods for the relationship between professional degree education structure

and industrial structure. Therefore, we should conduct comprehensive measurement and choose appropriate evaluation methods to analyze according to the professional degree graduate education structure and industrial structure, so as to ensure the integrity and feasibility of the evaluation system. This paper uses the gray comprehensive evaluation method to quantitatively analyze the dynamic development process of the system, Research the relationship between the scale structure of professional degree graduate education and industrial structure [18]. For the calculation process of grey correlation, firstly, it is necessary to use SPS software to analyze the main components. Its essence is to reduce the number of variables. By using the method of descending order, according to the actual needs, select a few variables to reflect the initial variables; Based on the mathematical analysis of MATLAB and grey relational theory, edit the relevant calculation program, and finally draw the relationship between the scale structure of graduate education and industrial structure. The specific analysis steps are as follows:

- 1) This paper makes statistics on the number of graduates of various disciplines, the number of graduates of various academic levels and the output value of three major industries in Shandong Province from 2011 to 2020, and makes factor analysis on the statistical data.
- 2) The main component score table of the discipline structure, number of graduates at academic level and industrial structure of Shandong Province is obtained through analysis, and the scores of the two main components are calculated. The calculation method is as follows: by multiplying the number of factors by the square root of the characteristic root, the count of the

basic score is obtained, and the structure of the three indicators in the basic sub table is calculated accordingly.

- 3) Calculate the comprehensive score table of the three indicators from 2011 to 2020, and on the basis of the two principal component score tables, match the weights of each factor to obtain a comprehensive score table. The calculation formula is as follows:

$$F = \frac{\lambda_1}{\lambda_1 + \lambda_2} F1 + \frac{\lambda_2}{\lambda_1 + \lambda_2} F2$$

Among λ_1 and λ_2 are the characteristic roots of the two principal components. By bringing the two characteristic

roots into the above formula, we can get the score table of the three indicators of professional degree graduate education in Shandong Province from 2011 to 2020. Because there is only one principal component, the principal component score is the comprehensive score of the industrial structure, so we can get the comprehensive score table of the disciplinary structure, educational level structure and industrial structure of Shandong Province. Based on the above process, the SPSS software is used to conduct the principal component analysis on the structure of higher disciplines, academic level structure and industrial structure of Shandong Province from 2011 to 2020, as shown in Table 2.

Table 2. Analysis Table of Discipline Structure, Academic Level Structure and Industrial Structure of Professional Degree Postgraduates.

Year	Discipline structure	Hierarchical structure	Industrial structure
2011	-3.32	-3.74	-3.63
2012	-1.79	-1.84	-2.74
2013	-3.73	-1.97	-2.34
2014	-2.35	-1.2	-1.42
2015	-1.17	-0.43	-0.52
2016	0.36	0.52	0.13
2017	1.78	1.15	0.65
2018	1.24	1.86	1.13
2019	2.15	1.48	1.97
2020	3.32	1.97	2.71

In this paper, the grey correlation method is used to quantify the correlation between variables, and the dynamic change process of the relationship between discipline structure, educational hierarchy and industrial structure is analyzed. When using Matlab software to calculate and analyze, the larger the calculated value is, the closer the relationship between the discipline structure and the industrial structure of professional degree graduates is, and vice versa. The specific calculation process of this method is as follows:

- (1) Determine the reference sequence and comparison sequence. Suppose that the reference sequence is $x_0 = \{x_0(k) \mid k = 1, 2, \dots, m\}$ and the comparison sequence is

$x_i = \{x_i(k) \mid k = 1, 2, \dots, n\}$, where m and n are the length of the reference sequence and the length of the comparison sequence respectively.

- (2) Through the normalization of the data, the grey correlation coefficient between the discipline structure and the industrial structure of professional degree postgraduates is calculated.

$$\delta(k) = \frac{\min \min |x_0(t) - x_z(t)| + \rho \max \max |x_0(t) - x_z(t)|}{|x_z(k) - x_0(k)| + \rho \max \max |x_0(t) - x_z(t)|}$$

Where: $z=1, 2, \dots, n$; $t=1, 2, \dots, m$. ρ is the resolution coefficient, taken as 0.5; $\delta(k)$ is the grey correlation coefficient.

Table 3. Relevance of three industries.

Relevance and sorting	Primary output value (Z1)	Second output value (Z2)	Tertiary output value (Z3)
Relevance R	R1=0.51	R2=0.55	R3=0.71
Sorting	R3 > R2 > R1		

It can be seen from the above table that the grey correlation between the discipline structure and the industrial structure of professional degree graduate education in Shandong Province is greater than 0.5, which means that the relationship between them is relatively close, that is, if the structure of professional degree graduate education is changed, the impact on the industrial structure will be

increased. By using the method of grey correlation degree, this paper sorts the correlation degree between the discipline structure of professional degree graduate education and the three industries, and draws the following conclusion: if the discipline structure of professional degree graduate education is changed, the impact on the third, second and first industries will be gradually decreasing.

Table 4. The grey correlation between the discipline structure and the industrial structure of professional degree graduate education in shandong province.

	Philosophy (X1)	Economics (X2)	Law (X3)	Education (X4)	Literature (X5)	History (X6)
Relevance R	R1=0.53	R2=0.77	R3=0.65	R4=0.86	R5=0.78	R6=0.77
	Neo Confucianism (X7)	Engineering (X8)	Agronomy (X9)	Medical Science (X10)	Management (X11)	Art (X12)
	R7=0.67	R8=0.81	R9=0.84	R10=0.92	R11=0.91	R12=0.95
Relevancy sort	R12 > R10 > R11 > R4 > R9 > R8 > R5 > R6 = R2 > R7 > R3 > R1					

Through the analysis of the above table of grey correlation between the discipline structure and industrial structure of professional degree graduate education in Shandong Province, it is found that there is a high correlation between them. If the discipline structure of professional degree graduate education in Shandong Province is changed, the industrial structure of the province will be affected to varying degrees, and the impact on the tertiary, secondary and primary industries will

decrease in turn. Therefore, Shandong Province needs to adjust the discipline structure of professional degree graduate education, improve the importance of natural disciplines represented by agronomy, engineering and medicine, and further strengthen the development of law, science and other disciplines, so as to promote the industrial structure of Shandong Province to change to the "three two one" decreasing hierarchical structure.

Table 5. The grey correlation between the hierarchy of professional degree education and industrial structure in shandong province.

Relevance and sorting	Primary output value (Z1)	Second output value (Z2)	Tertiary output value (Z3)
Relevance R	R1=0.51	R2=0.56	R3=0.61
Sorting	R3>R2>R1		

From the above table, we can see that the gray correlation between the professional degree graduate education hierarchy and the industrial structure in Shandong Province is greater than 0.5, which indicates that the professional degree graduate education hierarchy in Shandong Province has a greater impact on the regional industrial structure. Specifically, from the perspective of the gray correlation between the professional degree graduate education level and the three industries in Shandong Province, the impact of the professional degree graduate education level on the tertiary industry, the secondary industry and the primary industry in Shandong Province is decreasing gradually. Therefore, the industrial structure of Shandong Province needs to be transformed from "two three one" to "three two one", so as to match the level structure of professional degree graduate education with the regional industrial structure.

4. Countermeasures for the Optimization of Educational Scale and Structure of Professional Degree Postgraduates

Through the above analysis, in view of the mismatch between professional degree graduate education and local economic development in the process of industrial transformation in Shandong Province, we need to focus on expanding the scale of professional degree education, optimizing the configuration of professional degree discipline structure, expanding the scale of professional degree education, and promoting the formation of a long-term mechanism of professional degree education. The specific countermeasures and suggestions are as follows:

4.1. Make Effective Use of Higher Education Resources in the Province and Rationally Expand the Scale of Professional Degree Education

Actively expand the scale of professional degree postgraduates in Shandong Province, so that the main growth point of the education scale of professional degree postgraduates will be changed from national subordinate universities to provincial and municipal universities, and according to the needs of local economic and social

development, develop the specialties urgently needed by regional economic development into regional characteristic specialties to make up for the lack of disciplines set up by local colleges and universities, Thus leading to the impact of insufficient local economic and social development. The growth mode of the scale of professional degree postgraduates in Shandong Province needs to be adjusted according to the local economic and social development as follows: First, on the basis of making full use of the advantages of the degree scale of ministerial and provincial universities, we should strengthen the development of applied professional postgraduate education, focusing on training the practical application ability of professional degree postgraduates; Second, actively guide and support provincial colleges and universities as well as municipal colleges and universities that have not yet carried out professional degree education. On the basis of the actual situation of local economic and social development, and in combination with the existing social practice platform of colleges and universities, local governments and enterprises should be united to build a joint training mode of cooperation between colleges and enterprises, colleges and universities and local governments. Colleges and universities need to strengthen the development of their own advantageous majors, Promote the development of advantageous majors to professional degree postgraduates; Third, colleges and universities need to fully consider the advantages of existing professional disciplines, and in combination with the characteristics of the regional industrial layout, set up the corresponding types of characteristic disciplines in a timely manner, establish a graduate education system of characteristic professional degrees in colleges and universities across the province, meet local needs, improve the professional needs of employees, and thus meet the local needs for the improvement of the professional requirements of employees.

4.2. Optimize the Structure of Professional Degrees and Disciplines Based on the Layout of Local Industrial Structure

In order to meet the current rapid economic growth mode dominated by the primary and secondary industries, adjust

and optimize the discipline structure of professional degree graduates according to the local actual industrial structure to meet the development needs of the discipline structure corresponding to the local industrial layout. First, according to the modern industrial system framework set up in the province, the modern agricultural specialties closely related to the primary industry, such as agriculture, forestry, animal husbandry and agricultural promotion, will be gradually expanded and strengthened; Focus on the development of advanced manufacturing disciplines closely related to the secondary industry, such as machinery, vehicle engineering, electronic information and software engineering, and actively promote the development of modern service industry disciplines closely related to the tertiary industry, such as finance, tax, insurance, law and e-commerce. Second, broaden the categories of professional degree disciplines, optimize the discipline structure of professional degree graduate education, add a new batch of professional degree graduate disciplines that meet the needs of industrial structure adjustment and upgrading in the province, and then choose which professional disciplines to give priority to according to the needs of economic and social development in the province. Third, it is necessary to actively develop the academic postgraduate majors with strong application and classify them into professional degree types, and actively innovate the training mode of postgraduate education.

4.3. Actively Enrich the Main Body of Professional Degree Education and Build a Diversified Training System

Professional degree postgraduate education should be open to schools at all levels, and local characteristic undergraduate colleges and demonstrative higher vocational colleges should be included in the professional degree postgraduate training system. At present, the cultivation of professional master's degree graduates is mainly carried out in subordinate colleges and provincial colleges, while characteristic application-oriented undergraduate universities and demonstrative higher vocational schools are excluded. However, characteristic application-oriented undergraduate universities and demonstrative higher vocational schools have the advantage of being more closely connected with the social industry, and such universities have a more obvious application-oriented orientation. Therefore, the development of professional postgraduates' degrees in Shandong Province needs to make full use of the educational resources in the region and establish a corresponding access system, so as to allow the characteristic undergraduate colleges and demonstrative higher vocational schools of high-quality professional degree education to be included in the training system. Featured application-oriented undergraduate colleges and universities carry out professional degree and master's education. They can work with provincial and ministerial level graduate schools, research institutes and local enterprises to cultivate application-oriented master's students. With dynamic evaluation as the guarantee for the training effect of graduate students, they can conduct continuous evaluation on such featured undergraduate colleges and

universities, and cultivate the ability of featured application-oriented undergraduate colleges and universities to independently cultivate application-oriented master's students; At the same time, local demonstrative higher vocational schools are encouraged to try to carry out the training of professional degree postgraduates, so as to gradually carry out professional degree postgraduate education in the provincial education system from point to point.

4.4. Promote the Formation of a Long-Term Mechanism of "Production, Education and Research" Cooperation, and Realize the Symbiotic Development Path

Actively guide professional degree training institutions, local high-tech enterprises and scientific research institutes to jointly establish a joint training platform for production, teaching and research, so as to realize the pattern of joint development of high-level applied talents and local scientific and technological innovation. With the rapid economic and social development of Shandong Province, enterprises have invested more and more funds in the research and development of new products. They have undertaken a large number of scientific and technological research projects, thus gradually cultivating a group of engineers with rich research and development experience. Moreover, such enterprises have a large number of research and experimental instruments and production and manufacturing equipment suitable for industrialization. They should make full use of these social resources, Colleges and universities need to establish an industry university research joint training platform with science and technology enterprises. Through this platform, colleges and enterprises can give full play to their respective advantages, thus realizing resource sharing and complementary advantages. It can further expand the professional knowledge structure of professional degree graduates, further improve students' practical application ability and innovation and entrepreneurship ability, and also improve their contribution to local science and technology research and development.

5. Conclusion

In order to discuss the relationship between the cultivation of professional degree postgraduates and the needs of China's economic and social development, this study took Shandong province as an example and analyzed the current situation of the scale and structure of professional postgraduates' education. The gray correlation method was used in this study to evaluate the relationship between the higher discipline structure, educational hierarchy, and industrial structure of professional degree postgraduates. The results showed that the professional degree graduate education in Shandong province did not match the local economic development in the process of industrial transformation. Therefore, some measures were proposed to optimize the scale and structure of professional degree graduate education in Shandong province and some relevant policies and

suggestions were also provided to promote local economic and social development.

Author Contributions

The Manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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