



An Empirical Study on National Scholarship for Postgraduate Performance Based on Negative Binomial Regression Model

Taking a Provincial University of Science and Engineering as an Example

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Abstract. In the new era, education information has become a booster for the modernization of education in China. An essential part of education informatization is to cultivate the information ability of students and colleges. As an important direction in the field of higher education research, the National Scholarship for Postgraduate is of great significance to the cultivation of postgraduates. This paper takes scholarship for postgraduate recipients from a provincial science and technology university from 2019 to 2021 as the research objects, takes the information of the “National Scholarship for Postgraduate Approval form” as the primary data source. Stata and Negative Binomial Regression model were used to analyze the differences in the output of scientific research achievements of the winners under different discipline backgrounds, and the regression model was used for significance analysis. The research shows that: the overall performance of national scholarship for postgraduate is significant, and the implementation of national postgraduate scholarships for liberal arts postgraduates is better than that for science and engineering postgraduate. However, there are differences in the type and quantity of scientific research results between different disciplines, and the differences in the discipline categories of the winners significantly affect the output of their scientific research results.

Keywords: national scholarship for postgraduate · the Negative Binomial Regression model · science and engineering postgraduates · liberal arts postgraduates · performance

1 Introduction

With the rapid development of the times, the influence of information technology on education has become more and more prominent. It is a strategic choice for the reform and innovation of China's educational undertakings to drive the modernization of education with educational informatization and realize the leap-forward development of education (Wu 2016, Li 2016, Zhou 2016, Lu 2016) [5]. On the one hand, the national scholarship

for postgraduate can show the informatization level of universities. On the other hand, it can show the actual performance level of universities through data.

The national scholarship for postgraduates is the highest honorary award established by the state for full-time outstanding graduate students. In September 2012, the Ministry of Finance and the Ministry of Education jointly issued a document to develop the national scholarship for postgraduate, which stipulates that 1 billion yuan will be invested annually to reward 45,000 postgraduate students who meet the specified conditions are eligible to apply. At present, the research on the postgraduate scholarship system is relatively comprehensive, and in-depth discussions have been carried out on the value orientation, problems and countermeasures, and implementation effects of the postgraduate scholarship policies. However, there are few empirical research on the performance of national scholarship for postgraduate by taking a specific university as an example.

This paper takes 116 national scholarship for postgraduate winners (from now on, referred to as “winners”) from a provincial science and technology university from 2019 to 2021 as the object. It uses Stata and Negative Binomial Regression analysis techniques to analyze the winners’ scientific research achievements and practical experience. The analysis truly reflects the incentive effect of the university’s national scholarship for postgraduate in the past three years. Considering sample acquisition’s feasibility, this paper’s research object is only postgraduate students.

2 Research Hypothesis

Different discipline training methods will lead to differences in the output of postgraduate scientific research results. The core selection criterion of the national scholarship for postgraduate system is the scientific research achievements of postgraduates, which ignores the “implicit” problem of the scientific research ability of liberal arts postgraduates. They [6] found that in science and engineering colleges because science and engineering postgraduate students are backed by the school’s disciplinary advantages and faculty, they have more opportunities to participate in various scientific research projects, and can better understand industry development trends. However, liberal arts postgraduate students lack logical reasoning, and it is difficult to touch the essence of the problem. They [7] believe that liberal arts postgraduate students in science and engineering colleges generally have issues such as few scientific research innovation ideas, low academic achievements, and insufficient grasp of scientific research laws. They (Yang 2021, Yang 2021, Deng 2021) [1] explained why the scientific research of liberal arts postgraduates in science and engineering colleges is inadequate through a questionnaire survey. More studies have shown that in terms of academic research, science and engineering postgraduate students pay more attention to the accumulation and application of practical experience, the academic accumulation cycle is relatively short, and the academic achievements are more “explicit” [4]. For liberal arts postgraduate students to be academically creative, it will take a longer cycle, a broader underlying theory, and the results are usually presented as thesis work. At the same time, the academic ability of liberal arts postgraduate students cannot be fully expressed in the form of academic achievements. Therefore, this paper assumes that:

H1: The output of international journal papers of science and engineering postgraduate students is significantly higher than that of liberal arts postgraduate students.

H2: The output of domestic journal papers of science and engineering postgraduate students is significantly higher than that of liberal arts postgraduate students.

H3: The number of patents of science and engineering postgraduate students is significantly higher than that of liberal arts postgraduate students.

H4: The number of scientific research awards of science and engineering postgraduate students is significantly higher than that of liberal arts postgraduate students.

3 Research Design

3.1 Research Samples

This paper takes a total of 116 national scholarship for postgraduate recipients from 2019 to 2021 in a provincial science and engineering university as the research object. It sorts out all the winners' approval forms and achievement statistics. According to the International Standard Classification of Educational revised by the United Nations Educational Scientific and Cultural Organization in 2011, and the "Catalogue of Degree Awarding and Talent Training Disciplines (2021)" promulgated by the Academic Degrees Committee of the State Council and the Ministry of Education in 2021, the categories of the liberal arts include eight disciplines: philosophy, economics, law, education, literature, history, management, and art. Science and engineering include four disciplines: science, engineering, agriculture, and medicine. The statistical results combined with the actual situation of the school are shown in Table 1.

3.2 Establishment of Indicators

The "National Scholarship for Postgraduate Approval form" is uniformly formulated by the Ministry of Education. The content includes the applicant's basic information, reasons for application, evaluation opinions, recommendation opinions, opinions of grass-roots units, etc. The statistical table of the results of the university's national scholarship for postgraduate applicants includes papers, patents, scientific research awards, and honorary awards. This paper sorts out and categorizes the approval form and achievement statistics table of the winners, and organizes them into papers (international journal papers, domestic journal papers), patents (invention patents, other patents), scientific

Table 1. Sample distribution of winners in 2019–2021 (n = 116).

	Sample category	Sample size	Percentage (%)
Gender	male	50	43.1
	Female	66	56.9
Subject category	Science and engineering	85	73.3
	Liberal arts	31	26.7

research awards (national, provincial, school-level), and honorary awards. They [8] used indicators such as high-level academic papers, published works, patent applications and awards of scientific research achievements to evaluate the performance of postdoctoral scientific and technological personnel training. They [3] used papers and patents as indicators of doctoral students’ academic output. Postgraduate students participate in writing and publishing academic papers, especially international high-level academic papers are a sign of the comprehensive ability of postgraduates in scientific research. Scientific research awards directly reflect postgraduates’ scientific research ability, and patents and honorary awards can be regarded as indicators of postgraduate students’ practical innovation ability [2]. Therefore, “academic papers”, “scientific research awards”, “patents” and “honorary awards” can be regarded as performance evaluation indicators for talent training. This paper will take the number of published papers per capita, the number of patents obtained per capita, the number of scientific research awards per capita, and the number of honorary awards per capita as the leading indicators of performance evaluation.

At the same time, in order to further explore the impact of disciplinary differences on the output of postgraduate scientific research results, based on operability and ease of comparability, this paper also uses “number of papers in international journals”, “number of papers in domestic journals”, “number of patents” and “research awards” to measure the scientific research output of national scholarship for postgraduate recipients. Because “number of papers in international journals”, “number of papers in domestic journals”, “number of patents” and “research awards” are all variables with non-negative counts. At present, non-negative count variables. Presently, non-negative count variables are often analyzed using two regression models, the Poisson Regression model, and the Negative Binomial Regression model. Because the variance of the statistics in this paper is significantly more significant than the mean and has the characteristics of excessive dispersion, the Poisson Regression model is excluded. Therefore, in this paper, the Negative Binomial Regression model is proposed to examine the disciplinary differences in the output of scientific research results of national scholarship for postgraduate recipients. In the process of constructing the above regression equation, the “discipline category of the winner” is included as an explanatory variable in the regression equation. The winner’s gender, the winner’s grade, the winners’ political outlook, and the winner’s tutors’ titles are controlled during the research process. The measurement and descriptive statistical analysis of specific variables are shown in Table 2.

Table 2. Measurement and descriptive statistical analysis of variables.

Variable		Mean	Standard deviation	Properties	Variable measurement
Control variable	Winner’s gender	–	–	Classification	“Female” = 0, “male” = 1
	Winner’s grade	–	–	Classification	“Grade 2 master” = 0, “Grade 3 master” = 1

(continued)

Table 2. (continued)

Variable		Mean	Standard deviation	Properties	Variable measurement
	Winner's political outlook	–	–	Classification	“Non-CCP member” = 0, “CCP member” = 1
	Winner's tutors' titles	–	–	Classification	“Associate professor and others” = 0, “Professor” = 1
Explain variable	Subject category	–	–	Classification	“Science and engineering” = 0, “liberal arts” = 1
Be explained variable	International journal papers	1.16	1.027	Continuous	With the postgraduate students as the first author or tutor as the first authorship, postgraduate student as second authorship number of papers published in international journals
	Domestic journal papers	0.73	1.218	Continuous	With the postgraduate students as the first author or tutor as the first authorship, postgraduate student as second authorship number of papers published in domestic journals
	Patents	1.22	2.594	Continuous	With the postgraduate students as the first author or tutor as the first authorship, postgraduate student as second authorship number of patents granted
	Scientific research awards	1.84	2.453	Continuous	Postgraduate students as participants have won various scientific and technological achievement awards at or above the university level and scientific and technical competition awards

Table 3. Statistics of scientific research achievements per capita of laureates in 2019–2021 (n = 116).

Year	Per capita papers		Per capita patents	
	International Journal	domestic journals	invention patents	other patents
2019	1.11	1.16	0.29	1.21
2020	1.15	0.54	0.33	0.97
2021	1.18	0.51	0.28	0.54

4 Empirical Analysis

4.1 Analysis of Various Scientific Research Achievements of the Winners

This paper makes statistics on the per capita scientific research achievements of the winners from 2019 to 2021, and the results are shown in Table 3. Compared with 2019, the per capita number of international journal papers and the per capita invention patents of the winners in 2021 have increased, while the per capita domestic journal papers and the per capita other patents have decreased. It reflects the winners have shifted their attention to higher-level journals and higher-level patent applications, paid more attention to the output of innovative results, and pursued high-level scientific research results.

4.2 Analysis of Various Competitions and Honorary Awards

Postgraduate students participate in various scientific research achievement appraisals, discipline competitions and other activities, which is conducive to enabling them to apply the theory so that they have learned to practice and improve their scientific research ability. It can be seen from Table 4 that compared with 2019, the per capita national competition, per capita school competition and per capita honorary award of the winners in 2021 have increased, while the per capita provincial competition has decreased, which is probably because the postgraduate students' scientific research practice ability has been enhanced, and more national awards have been won, rather than folded in provincial competitions. The increase in per capita honorary awards reflects the overall development of postgraduate students and improves their recognition from all sectors of society.

4.3 Analysis of Scientific Research Achievements in Different Disciplines

It can be seen from Table 5 that the per capita international journal papers, per capita domestic journal papers, per capita patents and per capita scientific research awards are inferior to those of science and engineering postgraduate students. This phenomenon further verifies the theory proposed by some scholars that “the academic achievements of science and engineering postgraduate students are more ‘explicit’”. To have more opportunities to participate in the national award selection, postgraduate students are

Table 4. Winners' per capita competition and honour awards statistics in 2019–2021 (n = 116).

Year	Per capita competition			Per capita honorary awards
	National	Provincial	University	
2019	0.25	0.82	0.63	0.18
2020	0.39	0.33	1.08	0.31
2021	0.72	0.54	0.69	0.49

Table 5. Statistics of per capita scientific research achievements of winners in different disciplines from 2019 to 2021 (n = 116).

Year	Liberal arts				Science and engineering			
	Paper		Patent	Research award	Paper		Patent	Research award
	International Journal papers	Domestic journal papers			International Journal papers	Domestic journal papers		
2019	0.50	1.30	0.20	1.90	1.32	1.11	1.96	1.71
2020	0.70	0.40	0.80	1.40	1.31	0.59	1.48	1.93
2021	0.91	0.36	0.27	1.81	1.43	0.57	1.04	2.00

keener to participate in various competitions than papers and patents that spend more time and experience.

At the same time, it can be seen from the table that compared with 2020, the per capita number of international journal papers for liberal arts postgraduate students in 2021 has increased by 30%. The per capita number of domestic journal papers has decreased by 10%, the number of patents decreased by 66%. And the per capita scientific research awards have increased by 29%. The per capita number of international journal papers for science and engineering postgraduate students has increased by 9%, the per capita number of domestic journal papers has decreased by 3%, the number of patents has reduced by 30%, and the per capita scientific research awards have increased by 4%. In general, the scientific research achievements of liberal arts postgraduate students raised more than that of science and engineering postgraduate students, and the performance of the national scholarship for postgraduate system for liberal arts postgraduate was greater than that of science and engineering postgraduate. This phenomenon may be related to the university's emphasis on improving the scientific research capabilities of liberal arts postgraduate students.

4.4 Regression Analysis of the Output of Scientific Research Achievements in Different Disciplines

Table 6 presents the differences in the number of international journal papers, domestic journal papers, patents, and scientific research awards among the recipients of national

Table 6. Regression analysis results of the differences in subject categories of graduate students’ “scientific research output”.

Variables	Interpreted variables			
	International journal papers (model 1)	Domestic journal papers (model 2)	Patents (model 3)	Scientific research awards (model 4)
Subject (refer to science and engineering)	-1.726***	-1.125***	-2.054***	-0.721***
Gender (refer to female)	0.353**	-0.275	0.425	-0.074
Grade (refer to grade2 master)	0.157	0.636*	-0.433	0.079
Politics status (refer to non-CCP member)	0.117	-0.461	0.193	0.145
Teacher title (refer to associate professors and others)	0.212	0.327	0.720**	0.046
Constant	-0.226	-0.571	-0.107	0.362
N	116	116	116	116

Note: (1) * means $p < 0.1$, ** means $p < 0.05$, *** means $p < 0.01$; (2) Model 1, Model 2, Model 3 and Model 4 all use Negative Binomial Regression, which presents estimated results as regression coefficients.

scholarships in science and engineering and liberal arts. As shown in model 1 of Table 6, in the case of controlling the gender of the winner, the grade of the winner, the political profile of the winner, and the title of the tutor of the winner, the number of international journal papers published by national scholarship winners is significantly higher than that for liberal arts postgraduate national scholarship winners add 1.726 articles, and hypothesis 1 is supported. As shown in model 2 in Table 6, under the control of variables such as the gender of the winners, the number of domestic journal papers for the recipients of national scholarships for science and engineering postgraduate students significantly increased by 1.125 papers compared to the recipients of national scholarships for postgraduates in liberal arts. Hypothesis 2 is supported. As shown in Model 3 in Table 6, in the case of controlling the variables such as the gender of the winners, the number of patents of the national scholarship recipients of the science and engineering postgraduate students significantly increased by 2.054 patents compared to recipients of the national scholarship for postgraduates in liberal arts. Hypothesis 3 is supported. As shown in Model 4 Table 6, while controlling for variables such as the recipient’s gender,

the national scholarship recipients' subjects of the science and engineering postgraduate students, the number of research awards was significantly increased by 0.721 items than that of liberal arts national scholarship for postgraduate recipients. Hypothesis 4 is supported.

5 Conclusions and Discussion

The results of this paper show that the school's national scholarship for postgraduate performance is significant. Since 2019, the winners have improved in quantity and quality of various indicators of per capita scientific research results. In this sense, the performance of national postgraduate scholarship is remarkable. At the same time, it was found that the school, the national scholarship for postgraduate system performs better for liberal arts postgraduate students. But the study also shows apparent differences between the scientific research achievements of the liberal arts and science and engineering winners, and the academic performance of liberal arts postgraduate students in both knowledge output and innovation ability is significantly inferior to that of science and engineering postgraduate students. This is contrasted with the production of social sciences in the fields of liberal arts and science and engineering. The conclusions of the different studies are consistent. In addition, in the investigation process, this paper found that most of the school's data materials are paper documents, there is no corresponding scholarship information management system, and the informatization level is poor.

Considering the availability and operability of the samples, the research objects of this paper only include the recipients of the national scholarship for postgraduate of science and engineering universities, and the recipients of postgraduate national scholarships for comprehensive universities and liberal arts universities are not discussed. The performance levels of graduate national scholarships at other universities may vary depending on the recipients. Moreover, this paper does not include the indicator of postgraduate students' academic input in the analysis process. It is impossible to analyze the difference in academic input of winners of liberal arts and science and engineering. This is also where follow-up research needs to dig deeper.

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