

Research on the Over-education of Doctoral Students in the Post-epidemic Era-An Evolutionary Perspective

Zeyu Xing^a, Jing Wang^{b*}, Jing Huang^c, Xin Zheng^d

School of Management, Zhejiang University of Technology, Liuhe Street, Hangzhou

^axingzeyusmile@163.com, ^bwxb5112@163.com, ^c2317256104@qq.com, ^d1966261433@qq.com

Corresponding Author : wxb5112@163.com

Abstract

Influenced by the epidemic situation, there will be over-education in the employment of doctoral students, and it is difficult to keep up with the pace of "double-first-class" construction. There are many reasons for the employment of doctoral students, the fundamental reason is that the supply of doctoral students exceed the demand of society. This paper states the employment situation and existing problems of doctoral students under the theory of over-education, and analyzes the employment situation of doctoral students based on the work competition model and the evolutionary game theory. According to the results of the evolutionary game model, this paper puts forward some countermeasures and suggestions to solve the employment problem of doctoral students from three aspects: government, enterprises and doctoral students, so as to meet the requirements of "double first-class" construction.

Keywords: "Double first-class"; Excessive education; Evolutionary game; Employment of doctoral students

1.INTRODUCTION

In the post-epidemic era, with the continuous enrollment expansion of colleges and universities, some colleges and universities have been upgraded to undergraduate colleges, the number of college graduates has been increasing, and the employment contradiction has become increasingly prominent. The employment of college students has aroused great concern of the whole society. The intensification of this contradiction not only leads to the increased pressure of students and their families, but also affects social stability and economic development to a certain extent. The number of college graduates is increasing year by year, but the employment rate is obviously declining. Under such a severe situation, some university graduates choose to continue to pursue master's degree or doctoral degree directly, so as to meet the requirements of relevant employment units and realize their employment aspirations. This move makes the supply of doctoral education exceeds the demand, which is mainly manifested in the following characteristics: first of all, the employment areas are getting better, mainly concentrated in developed cities and coastal cities; secondly, there are different levels of differences in the

employment of doctoral students, and the influence of "985" institutions and "211" institutions still exists; finally, the doctoral major does not match the actual job position. The survey results show that, while the overall salary of the whole country is rising, however, the salary of doctoral students does not rise, but falls. This series of phenomena and existing problems have seriously hindered the grand blueprint for the construction of "double first-class" universities and disciplines in China.

About the meaning of over-education, relevant scholars mainly analyzed it from macro and micro aspects: from macro, over-education means that the supply of education exceeds the demand of education; microscopically, over-education means that the stock of education owned by individuals exceeds the demand of existing occupations [4]. The specific forms of over-education are different in different countries. However, the phenomenon of over-education in China is mainly manifested in the employment of students, especially the employment of doctoral students in recent years [8]. In view of the employment problem of doctoral students, scholars have made extensive and in-depth research from human capital theory, labor market segmentation theory, dependency theory, screening theory and job competition model [10]. And

the methods of literature and theoretical analysis combined with empirical research are used to explore the solutions to the phenomenon of over-education. The above research focuses more on qualitative research. Even though some scholars use quantitative methods to do research, most of their research data come from the intuitive feelings of respondents, and such personal subjective feelings can easily influence the survey data, and affect the credibility of the final research results [7]. Evolutionary game theory is a theory that combines game theory analysis with dynamic evolutionary process analysis. With the change of time and the acquisition of effective information, doctoral students will constantly adjust their employment strategy to choose the best employment position [1][9]. Therefore, it is of great significance to use evolutionary game theory for reference to make a mathematical modeling analysis of doctoral education under over-education, and to provide suggestions and opinions for the formulation of government policies and the solution of doctoral employment under over-education.

2.CONSTRUCTION OF EVOLUTIONARY GAME MODEL OF DOCTORAL EMPLOYMENT PROBLEM

2.1. Work competition model

The competition model considers two ranks: job ranks and job seekers. Every job in the job ranks has its required skills, productivity characteristics and salary scale standard ranking; Job seekers also form ranks for competing jobs, and the relative position of individuals is determined by a series of their own characteristics, such as education level, work experience, etc. These characteristics enable employers to estimate the cost of job training required by individuals. The higher the number of job seekers, the lower the training cost required by the employer, and the better the chances of getting a job in front of the ranks. In order to get ahead of job seekers, individuals will invest in education, hoping that additional education will improve their chances of getting a better job. The competition mode analyzes the causes of over-education from the perspective of job seekers. There is uncertainty in the employment of labor force, and graduate students with high education will have a psychological price for salary, working environment, job stability and development prospects when applying for jobs. If the employers don't meet their standards, they would rather be temporarily unemployed, don't want to bend to an unsatisfactory job. However, jobs have different requirements for skills, quality and work experience of the required personnel, and it is difficult for employers to predict the job performance of job seekers in the future (many jobs are obtained on jobs). The contradiction between job seekers and jobs has become an important reason that affects students' employment.

2.2. Basic assumptions

It is assumed that in a natural environment, there are employers 1 and job seekers 2. In this paper, job seekers refer to doctoral students. Employers, that is, enterprises need to find employees corresponding to their own positions, and doctoral students, that is, students need to find an ideal job that suits them.

Assume that all participants are bounded rationality, and the information they have is not completely symmetrical; In the evolutionary game model, both sides of the game are in the initial stage of the game; Other subjects that may have an impact on the game process are not considered in the game process.

Assume that the normal income of the enterprise is R_1 and the normal income of the students is R_2 under no circumstances. When the enterprise recruits students, the extra income is E_1 , and the matching rate of the students who find the required positions is A , the extra income becomes $R_1 + aE_1$, otherwise it is $R_1 + (1-a)E_1$. When students participate in the recruitment of enterprises and enterprises choose not to recruit, they will bear the corresponding talent loss F_1 . Among them, the cost of choosing recruitment is C . When students get an extra income of S_1 when they participate in enterprise recruitment, and the matching rate of finding an ideal position that matches their ability and degree is B , the extra income becomes $R_2 + bS_1$, otherwise it is $R_2 + (1-b)S_1$. When students participate in enterprise recruitment, they will generate corresponding opportunity cost F_2 ; When an enterprise chooses to recruit, students will face the risk of unemployment when they don't participate in enterprise recruitment. Among them, the cost of students participating in enterprise recruitment is i .

2.3. Evolutionary Game Analysis

According to the above assumptions, in order to realize technological innovation, meet the needs of self-development talents and maximize profits, enterprises need to find employees corresponding to their positions. As students graduate soon, they need to find an ideal job that suits them when faced with the important choice at the crossroads of life. Assume that the probability of an enterprise choosing to recruit is x , The probability of students participating in enterprise recruitment is y . The payment matrix of enterprise and student strategy under the market mechanism is shown in Table 1:

Table 1. Strategic Payment Matrix of Enterprises and Students under Market Mechanism

Enterprise	Student	
	Participation (y)	Not participation ($1-y$)
Recruitment	$R_1 + aE_1 - C; R_2 + bS_1 - I$	$R_1 + (1-a)E_1 - C; R_2 - M$

(x)		
Not recruitment	$R_1 - F_1; R_2 + (1-b)S_1 - F$	$R_1; R_2$
$(1-x)$	$z - I$	

The replication dynamic equation of the enterprise is:

$$dx/dt = x(1-x)[2yaE_1 + yF_1 - yE_1 + (1-a)E_1 - C]$$

The replication dynamic equation of the student:

$$dy/dt = y(1-y)[2xbS_1 + xM + xF_2 - xS_1 + (1-b)S_1 - F_2 - I]$$

The system has five local equilibrium points, and the equilibrium points are analyzed, shown in Table 2.

Table 2. Analysis results of local stability under market mechanism

	Equilibrium point	DetJ	TrJ	Local stability
O	$x=0, y=0$	+	-	ESS
A	$x=0, y=1$	+	+	Unstable
B	$x=1, y=0$	+	+	Unstable
C	$x=1, y=1$	+	-	ESS
D	$x^* = \frac{F_2 + I - (1-b)S_1}{2bS_1 + M + F_2 - S_1}$ $y^* = \frac{C - (1-a)E_1}{2aE_1 + F_1 - E_1}$	-	0	Saddle point

The game evolution phase diagram between enterprises and students is shown in Figure 1.

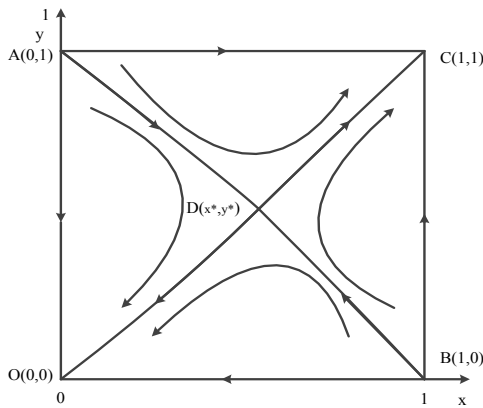


Figure 1. Phase diagram of evolutionary game between enterprises and students

According to the figure, regardless of the initial state, after a long-term game, the two sides will evolve to the strategy of recruitment and participation, no recruitment and no participation. When $S_{OADB} < S_{CADB}$, the probability of both parties choosing to recruit and participate is greater than the probability of choosing not to recruit and participate; when $S_{OADB} > S_{CADB}$, the probability of both parties choosing not to recruit and not to participate is high; when $S_{OADB} = S_{CADB}$, the probability of the system evolving to two equilibrium strategies is equal. By analyzing S_{OADB} , the area factor

can be transformed into the influencing factors of enterprise recruitment and students' participation in enterprise recruitment. Next, let's put $S_{OADB} = S_3$, $S_{CADB} = S_4$.

According to S_3 , we can get the following conclusions from the area relation formula:

(1) When $0 \leq a \leq \frac{1}{2}$, $C > E_1$, S_3 is the increasing

function of a . With the gradual increase of matching rate, the probability of enterprises moving towards recruitment and students moving towards participation gradually becomes smaller. Enterprises finally choose not to recruit, and students choose not to participate in the strategy.

(2) When $\frac{1}{2} < a \leq 1$, $C > E_1$, S_3 is the decreasing

function of a . With the gradual increase of the matching rate, the probability of the evolution of enterprises to the direction of non-recruitment and students to the direction of non-participation gradually decreases. Enterprises finally choose recruitment and students choose participation strategies.

(3) When $S_1 + M - F_2 - 2I > 0$, S_3 is the increasing function of b . With the gradual increase of matching rate, the probability of students' participation in the direction and enterprises' evolution in the direction of recruitment gradually decreases. Finally, students choose not to participate, and enterprises choose not to recruit.

(4) When $S_1 + M - F_2 - 2I < 0$, S_3 is a decreasing function of b . With the increasing of matching rate, the probability of students' evolution to the direction of non-participation and enterprises' evolution to the direction of non-recruitment gradually decreases. Finally, students choose to participate in enterprise recruitment, and enterprises choose recruitment strategies.

2.4. Empirical analysis

Based on the conclusions (1)-(4) of the above evolutionary game model, this paper compares and analyzes the overall employment situation of doctoral students in four normal universities under the construction of "double first-class" in 2021, and provides countermeasures and suggestions for solving the employment problem of doctoral students in the post-epidemic era.

It can be seen from the employment quality report of graduates in 2021 that the contracted employment rate of Northeast Normal University is 75.01%, and the proportion of students' employment units that are enterprises is the lowest, only 9.79%, which is the lowest among four normal universities. The reason is that because of the unique geographical location of

Northeast Normal University, fewer employers choose to recruit in this school, accounting for only 13.56%. Employers think that the recruitment cost here is too high, and they are not sure whether they can find students who match the required positions. Faced with such a severe situation, most doctoral students will choose basic education, institutions, scientific research units and higher education industry based on the characteristics of normal universities, and choose not to participate in enterprise recruitment according to past experience. As a result, the employment rate of Northeast Normal University is low, and some people choose to stay unemployed or become freelancers. This phenomenon verifies the conclusion (1) of the evolutionary game model.

In contrast, the overall contracted employment rate of doctoral students in Huazhong Normal University is the highest, reaching 90.32%. The reason is that the signing destinations of doctoral graduates include: institutions, enterprises and other units, while in Huazhong Normal University, the proportion of students' employment units as enterprises accounts for 29.92%, which is the highest among the four normal universities. The nature of employers ranks second among enterprises, accounting for 38.70%, and students' employment satisfaction is also the highest, which will obviously increase the overall contracted employment rate of doctoral students. This result verifies the conclusion (2) of the evolutionary game model, that is, a higher matching rate can meet the needs of students and enterprises respectively. As far as enterprises themselves are concerned, facing higher recruitment costs, considering the needs of future development and talent reserve, we will eventually choose recruitment. Faced with a good enterprise, excellent enterprise culture and ideal development platform, students will actively participate in enterprise recruitment, thus realizing their own value.

Beijing Normal University has the lowest contract employment rate, only 64.22%, which is the lowest among the four normal universities. The reason is that Beijing Normal University has the highest proportion of flexible employment, reaching 25.73%, and a large proportion of flexible employment belongs to self-employment. Employment and people's livelihood, entrepreneurship is a national strategy, Beijing Normal University is located in the capital of China. We have been studying the spirit of employment and entrepreneurship of the CPC Central Committee and the State Council, promoting employment and encouraging entrepreneurship, and carrying out precise employment and entrepreneurship according to the characteristics of graduates. The school has issued and implemented a series of policies and plans to encourage doctoral students to start their own businesses, which have achieved remarkable results. Among the students who have signed up for employment, students' employment

satisfaction is very high, thanks to Beijing Normal University's elaborate recruitment service and the expansion of employment resources. This result well verifies the conclusion (3) of the evolutionary game model, that is, some students will eventually choose to give up participating in enterprise recruitment when they can't find a job that is very satisfactory to them and the potential unemployment risk. Seek employment in other areas with stable development or high income.

As a "double first-class" university, East China Normal University is located in Shanghai, occupying advantages in all aspects, with the highest proportion of employers, reaching 53.76%, and a high contracted employment rate of 85.51%. This is inseparable from the multi-level, refined and unique campus recruitment system established by East China Normal University. Based on its unique geographical advantages, East China Normal University expands employment resources with large famous enterprises, and establishes cooperation in personnel training and internship with many famous enterprises. At the same time, there are many jobs in basic education, higher education and government institutions in Shanghai, and their demand are also great. Faced with many employment opportunities, most students' unions measure the stable income brought by basic education and higher education and the promising future income brought by participating in the recruitment and selection of employers. Based on the special attributes of normal colleges, most doctoral students will eventually choose basic education, higher education and government institutions. This result well verifies the conclusion (4) of the evolutionary game model.

3.CONCLUSIONS AND SUGGESTIONS

"Double first-class" universities and disciplines are being implemented, and the development plan of higher education in the next 30 years has a new blueprint. Affected by the epidemic situation, there will be over-education in the employment of doctoral students, and it is difficult to keep pace with the "double first-class" construction. From the perspective of talent training, the key to the "double first-class" construction is to build a world-class doctoral education, which needs the guidance of the "double first-class" construction strategy and the support of conditions in multiple senses. This initiative concerns the government, enterprises and the employees themselves. Based on the evolutionary game theory and game model results, we can get the following suggestions:

From the perspective of doctoral students: doctoral students need to change their job-seeking concept, adjust their mentality, and avoid impetuous psychology such as "eyes are superior but eyes are inferior". In addition, the choice of employment area should be rational, no matter where it suits you, it is the most

important thing. Before entering the society, doctoral students should learn their professional knowledge well, seize the opportunity of social practice as much as possible, and improve their ability to face the demands of the future labor market [5].

From the view of enterprises: First, enterprises should actively update the recruitment concept and employment system, and focus on comprehensive quality as much as possible when recruiting talents, instead of blindly pursuing high education. Second, enterprises should strengthen exchanges and cooperation with universities. Third, as a new talent pool for technological innovation, if students can be employed by enterprises for a long time and become regular employees in the future, it will not only reduce the recruitment cost of enterprises but also realize the long-term development of enterprises. The in-depth understanding of the long-term contact and running-in of internship students in enterprises has reduced the incidence of information asymmetry between enterprises and employees, and further reduced the incidence of over-education [3][6].

From the perspective of government: the government is the promoter of education and plays an important role in the development of education. First of all, the government should strengthen economic development, increase educational opportunities, adjust employment distribution, and encourage doctoral students to start businesses. Secondly, government should actively promote the upgrading of industrial structure and actively support the development of high-tech industries by various means, so as to create more high-level employment opportunities and attract more high-level talents, thus alleviating the phenomenon of low-level talents. Specifically, we should strengthen industry-university cooperation and realize diversified educational investment mechanism. Finally, the government should build a bridge between enterprises and students, and formulate relevant policies to urge relevant departments to publish the supply and demand information of enterprises and individuals on time [2].

Acknowledgement

This paper is funded by the Projects of the National Social Science Foundation of China (Grant 21BJY240).

REFERENCE

- [1] Bedemariam R, Ramos J. Over-education and job satisfaction: The role of job insecurity and career enhancing strategies[J]. *European Review of Applied Psychology*, 2021, 71(3): 100632.
- [2] De Santis M, Florensa M, Gáname M C, et al. Job Satisfaction of Recent University Graduates in Economics Sciences: The Role of the Match Between Formal Education and Job Requirements[J]. *Journal of Happiness Studies*, 2021, 22(7): 3157-3197.
- [3] Elumalai K V, Sankar J P, Kalaichelvi R, et al. Factors affecting the quality of e-learning during the COVID-19 pandemic from the perspective of higher education students[J]. *COVID-19 and Education: Learning and Teaching in a Pandemic-Constrained Environment*, 2021, 189.
- [4] Epstein B, Shapiro A F. Employment and firm heterogeneity, capital allocation, and countercyclical labor market policies[J]. *Journal of Development Economics*, 2017, 127: 25-41.
- [5] Frank K, Hou F. Over-education and well-being: how does education-occupation mismatch affect the life satisfaction of university-educated immigrant and non-immigrant workers?[J]. *Ethnicity & health*, 2018, 23(8): 884-901.
- [6] Fu Y C, Lin Y H, Wang W C. Over-Education of Youth Generation in OECD Countries: The Comparative Study Based on PIAAC[J]. *Journal of Educational Research and Development*, 2021, 17(3): 71-105.
- [7] Kudo K, Volet S, Whitsed C. Intercultural relationship development at university: A systematic literature review from an ecological and person-in-context perspective[J]. *Educational Research Review*, 2017, 20: 99-116.
- [8] Li F, Morgan W J, Ding X. The expansion of higher education, employment and over-education in China[J]. *International Journal of Educational Development*, 2008, 28(6): 687-697.
- [9] Liao Shanguang. The Game and Balance between University Dormitory Management and Students' Rights [J]. *Educational Theory and Practice*, 2015,(33):15-17.
- [10] Waibel S, Rüger H, Ette A, et al. Career consequences of transnational educational mobility: A systematic literature review[J]. *Educational Research Review*, 2017, 20: 81-98.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

