

## Research Article

# A Fractional Grey Multivariable Model for Modeling Fresh Graduates' Career Choice

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Aiming at exploring the effect of four factors on fresh graduate's three popular career choices of continuing studying, working in state-owned enterprises, and working in private enterprises, this paper collects the specific information of 3237 students and builds the GM (0, N) model. The four variables include student's grade point average (GPA), socioeconomic status (SES), gender, and whether the student comes from an urban household. Furthermore, this paper also considers the effect of the fractional order and proposes a fractional grey model (FGM (0, N) model) to enhance the performance of the traditional model. Eventually, the study finds that there are still some students with financial problems, which makes some negative effects on their choices of continuing studying and working in state-owned enterprises. Additionally, all the other three factors show the positive influence on the three choices. Besides, GPA shows the most positive effect on the choices of continuing studying as well as working in a state-owned enterprise; gender and SES have the greatest impact on the choice of working in a private enterprise.

## 1. Introduction

With the development of the society, the career choice of the fresh graduates has become more abundant; students can choose to continue studying, start their own businesses, or go directly to work in state-owned enterprises. At the same time, people's attention to employment tends to increase; there is now a large amount of literature that studies what factors affect people's career choices. Sehagl and Nasim [1] proposed that technology management skills and communication skills played an important role in choosing jobs. Gokuladas [2] focused on studying the factors influencing the first-career choice of undergraduate engineers and found that students from urban areas were more likely to be driven by intrinsic factors, while those from rural/semiurban were more likely to be influenced either by extrinsic or interpersonal reasons. Koch et al. [3] proposed that interest was also an important factor, and the high school counselor was the least influential person with respect to students' choice of careers in construction management. Mead et al. [4], Myburgh [5], and Greenman [6] made the conclusion that there were significant differences among racial/ethnic

groups in factors that appeared to influence their career paths. Educational level of parents had also been proved to be an influential factor [7]. While in some papers, firsthand information sources (e.g., the work experience and personal experiences) were more influential than secondhand sources (e.g., class materials and faculty) [8]. Moreover, some people thought "students' self-efficacy and occupational aspiration" were the most important factor, followed by "tradition and cultural value," "career guidance," "support from parents," and "external consultation" [9].

In summary, there are many studies on exploring the influence of factors on fresh graduate's career choices. And, governments can take advantage of all the papers to provide the most suitable assistance to different students. However, there is no doubt that how to confirm student's need and provide suitable help is still complicated. Aiming at providing some reference for this problem, this paper selects four variables directly related to students and plans to explore the effect of these four factors on fresh graduate's career choices. These factors include student's grade point average (GPA), gender, family socioeconomic status (SES), and whether the student comes from an urban household or

not. Similarly, after summarizing the development direction of the graduates, this paper mainly selects three choices, including continuing study (Choice-1), working in private enterprises (Choice-2), and working in state-owned enterprises (Choice-3).

To finish the task, this paper builds the GM (0,  $N$ ) model. And, there are two reasons for choosing this model: the first one is that grey system theory has been widely used in various fields such as natural science, social science, and engineering science [10]. And, there are many papers that can prove the good performance of the grey models. Additionally, the second reason is that, based on the results of the GM (0,  $N$ ) model, this paper can obtain the effect of factors. Besides, due to the requirement of a high accuracy, the fractional orders have been added into this model, which have been proved to increase the performance of the models.

The purposes of this paper are as follows:

Firstly, some statistical description analysis can be performed to obtain the most popular career choice of fresh graduates and the specific information of students' family socioeconomic status.

Secondly, this paper plans to propose a fractional grey model (FGM (0,  $N$ ) model) by considering the function of the fractional order, while building the GM (0,  $N$ ) model.

Thirdly, the FGM (0,  $N$ ) model is built to explore the effect of four factors on fresh graduate's career choices. Additionally, based on the results of models with similar performance, robustness of results can be tested. Accordingly, some suggestions on how to set up courses for students with different performances can be made.

There are four main contributions in this paper:

On one hand, there are two theoretical contributions: firstly, after getting the bad results of the GM (0,  $N$ ) model, this paper chooses to consider the effect of the fractional order and proposes a new model, the GM (0,  $N$ ) model with the fractional order (FGM (0,  $N$ ) model). After comparing the accuracy, we find that the FGM (0,  $N$ ) model can help scholars make better predictions. Besides it, since there are few studies on exploring the effect of SES on graduates' career choices, what we do in this paper can perfectly fill in the research gap.

On the other hand, this paper also has a significant implication contribution in two parts: the strongest one is to provide a guideline for the universities to set up the courses based on the results obtained in this paper. Students with suitable skills can be better suitable for the development of the society. Besides, this can also help save the sources of enterprises to teach students. The other contribution is that the results of data description can tell that there are still many students with financial problems, which significantly affect their career choice. Thus, scholars and governments should pay more attention to consider how to provide some necessary help.

The remaining of this paper is organized as follows: in Section 2, related works are introduced. Section 3 introduces some models used in the paper as well as the statistical description of the dataset. Section 4 shows the analysis results. Section 5 presents the conclusion and some suggestions.

## 2. Literature Review

To clearly show the summary of the recent studies, this paper divides the whole section into three parts. The first part contains the main studies on the effect of some factors on student's performance, while the work related to the models has been shown in parts 2 and 3.

*2.1. The Relationship between Students' Performance and Their Socioeconomic Status as Well as Other Factors.* Until now, the relationship between the fresh graduates' socioeconomic status backgrounds and their choices is yet to be understood completely. We focus on performance on graduates' choices in an urban school district to identify what role SES plays.

The excessive gap between the rich and the poor is still one of the important existing problems in the world. According to data released by the World Bank, 5% of the people in the United States hold more than 60% of the country's wealth. In 2018, China's Gini coefficient for measuring the gap between the rich and the poor reached 0.474, far exceeding the international warning line of 0.4, which shows that there is a large gap between the rich and poor. However, economic conditions will significantly affect people's decision-making, for example, the benevolence-dependability value of those of lower perceived socioeconomic status significantly affected their intertemporal choices [11]. The effect of poverty on students' achievement has also been widely studied. Recent studies showed that students from low socioeconomic status backgrounds had lower academic performance and a chronic risk of lower academic growth during early adolescence [12, 13]. We recognize that other factors aside from student poverty may contribute to explain variations in achievement. For example, Li et al. [14], based on a two-year longitudinal dataset of 942 middle-school students from a high-poverty district, found that emotional control had the strongest relation with GPA instead of the social perceptions and academic performance.

*2.2. Recent Studies on the GM (0,  $N$ ) Model.* Grey systems, proposed by Deng [15, 16], have been widely utilized to cope with uncertain problems with poor and incomplete information [17]. And, there are many popular grey models, such as Grey Verhulst model [18], Grey Markov model [19], and so forth [20–22]. Among them, the GM (1, 1) model is the main forecasting model in grey systems. By accumulating generation operation in the GM (1, 1) model, the random disturbance of a short sequence is weakened [23, 24]. This model has been extensively used in various fields, especially in the field of energy consumption [25–28].

The abovementioned grey models all are used in time series prediction and not suitable for making predictions on cross-sectional data. Thus, this paper chooses to use the GM (0, N) model which can help deal with this problem and obtain the effect of input variables on the output factor. The GM (0, N) model is a special form of the GM (1, N) model with no derivatives. The two models (GM (0, N) model and GM (1, N) model) are a typical multivariable forecast model in grey system theory [29]. Kung and Wen [30] successfully used the GM (0, N) model to analyze several variables of firm attributes. Tian et al. [31] proposed a novel GM (0, N) model to solve the problem of cost forecasting of commercial aircraft. Due to the successful applications of using the GM (0, N) model to explore the influence of variables in previous papers, this study also plans to take good advantage of this method to obtain the effect of several factors on fresh graduate's career choices.

**2.3. Application of the Fractional Order.** Fractional calculus has been used in various fields of science, engineering, applied mathematics, and economics [32]. Similarly, numeric studies on fractional grey models have been performed in recent years. Previous GM (1, 1) models have been based on first-order accumulation techniques which revealed only partial memories and lacked the potential to represent overall memories fairly [33]. The fractional model has an accumulated generating order that can effectively manifest the nonlinear characteristics of real systems [34]. Due to the positive effect of the fractional order, scholars pay more attention to explore the possibility of combining the traditional models with the fractional order [35–37]. And, most of the results show that the performance of the fractional models can be better.

Based on the above summary, it is not difficult to get the following conclusions: firstly, fresh graduates' career choices can be affected by many variables. However, SES, as one of the main influential factors for students' performance, has not been widely used in forecasting students' career choices. Therefore, it is reasonable for us to consider the effect of SES, which is also one of the contributions in this paper. Secondly, there are many papers to prove the good performance of the GM (0, N) model in predictions and the positive effect of the fractional order to enhance the performance of the model. Thus, this paper proposes a fractional GM (0, N) model (FGM (0, N)) reasonably.

### 3. Methods

**3.1. The Brief Introduction of Classic GM (0, N) Model.** Let

$$X_1^{(0)} = (x_1^{(0)}(1), x_1^{(0)}(2), \dots, x_1^{(0)}(n)), \quad (1)$$

be the data sequence of system behavior characteristic and

$$\begin{aligned} X_2^{(0)} &= (x_2^{(0)}(1), x_2^{(0)}(2), \dots, x_2^{(0)}(n)), \\ X_3^{(0)} &= (x_3^{(0)}(1), x_3^{(0)}(2), \dots, x_3^{(0)}(n)), \\ &\vdots \\ X_N^{(0)} &= (x_N^{(0)}(1), x_N^{(0)}(2), \dots, x_N^{(0)}(n)), \end{aligned} \quad (2)$$

be the sequence of related factors:

$$X_i^{(1)} = (x_i^{(1)}(1), x_i^{(1)}(2), \dots, x_i^{(1)}(n)), \quad (3)$$

which is the 1-AGO sequence of  $X_i^{(0)}$ , where  $x_i^{(1)}(k) = \sum_{l=1}^k x_i^{(0)}(l)$ ,  $i = 1, 2, \dots, N$ , and

$$\begin{aligned} x_1^{(1)}(k) &= b_2 x_2^{(1)}(k) + b_3 x_3^{(1)}(k) + \dots \\ &\quad + b_N x_N^{(1)}(k) + a, \quad k = 2, 3, \dots, n, \end{aligned} \quad (4)$$

which is the basic form of the GM (0, N) model.

The GM (0, N) model has similarities with multiple regression, but there is a fundamental difference. The GM (0, N) model generates series 1-AGO series by the accumulation of the original data.

Let  $X_i^{(0)}$  and  $X_j^{(1)}$ ,  $j = 2, 3, \dots, N$ , be described as in Definition 1, and the input matrix and the output vector of the model are, respectively,

$$\begin{aligned} B &= \begin{bmatrix} x_2^{(1)}(1) & x_3^{(1)}(1) & \dots & x_N^{(1)}(1) & 1 \\ x_2^{(1)}(2) & x_3^{(1)}(2) & \dots & x_N^{(1)}(2) & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_2^{(1)}(n) & x_3^{(1)}(n) & \dots & x_N^{(1)}(n) & 1 \end{bmatrix}, \\ Y &= \begin{bmatrix} x_1^{(1)}(1) \\ x_1^{(1)}(2) \\ \vdots \\ x_1^{(1)}(n) \end{bmatrix}, \end{aligned} \quad (5)$$

Let the parameters be listed as  $\hat{a} = [b_2, b_3, \dots, b_N, a]^T$ , and the equation form of the GM (0, N) model is  $Y = B\hat{a}$ ; then, the least square estimation of the model is  $\hat{a} = (B^T B)^{-1} B^T Y$ .

**3.2. Introduction to the FGM (0, N) Model.** The fractional order accumulation generation method and prediction model have been proved to be an effective method to improve the accuracy of the grey models [33]. Therefore, a novel model, the FGM (0, N) model, is proposed in this paper to reduce the prediction error.

Let

$$X_1^{(0)} = (x_1^{(0)}(1), x_1^{(0)}(2), \dots, x_1^{(0)}(n)), \quad (6)$$

be the data sequence of system behavior characteristic and

$$\begin{aligned} X_2^{(0)} &= (x_2^{(0)}(1), x_2^{(0)}(2), \dots, x_2^{(0)}(n)), \\ X_3^{(0)} &= (x_3^{(0)}(1), x_3^{(0)}(2), \dots, x_3^{(0)}(n)), \\ &\vdots \\ X_N^{(0)} &= (x_N^{(0)}(1), x_N^{(0)}(2), \dots, x_N^{(0)}(n)), \end{aligned} \tag{7}$$

be the sequence of related factors.

Let  $x_i^{(r)}(k) = \sum_{l=1}^k \binom{k-l+r-1}{k-l} x_i^{(0)}(l)$ ,  $i = 1, 2, \dots, N$  and  $k = 1, 2, \dots, n$ , be the  $r$  ( $0 < r < 1$ ) order-accumulated generating operator ( $r$ -AGO). Set  $\begin{pmatrix} r-1 \\ 0 \end{pmatrix} = 1$ ,

$$\begin{aligned} \binom{k-1}{k} &= 0, \quad k = 1, 2, \dots, n, \quad \text{and} \quad \binom{k-l+r-1}{k-l} = ((r+k-l-2) \cdots (r+1)r)/(k-l)!, \\ X_i^{(r)} &= (x_i^{(r)}(1), x_i^{(r)}(2), \dots, x_i^{(r)}(n)), \end{aligned} \tag{8}$$

which is the  $r$  order accumulated generation sequence.

Let

$$X_1^{(0)} = (x_1^{(0)}(1), x_1^{(0)}(2), \dots, x_1^{(0)}(n)), \tag{9}$$

be the data sequence of system behavior characteristic. Let  $\alpha^{(1)} x_1^{(1-r)}(k) = x_1^{(1-r)}(k) - x_1^{(1-r)}(k-1)$  be the  $r$  ( $0 < r < 1$ ) order-inverse accumulated generating operator ( $r$ -IAGO):

$$\alpha^{(1)} X_1^{(0)} = \alpha^{(1)} X_1^{(1-r)} = (\alpha^{(1)} x_1^{(1-r)}(1), \alpha^{(1)} x_1^{(1-r)}(2), \dots, \alpha^{(1)} x_1^{(1-r)}(n)), \tag{10}$$

which is the  $r$  order inverse accumulated generation sequence.

Let  $X_i^{(0)}$  and  $X_j^{(1)}$ ,  $j = 2, 3, \dots, N$ , be described as in Definition 1:

$$x_1^{(r)}(k) = b_2 x_2^{(r)}(k) + b_3 x_3^{(r)}(k) + \dots + b_N x_N^{(r)}(k) + a, \quad k = 2, 3, \dots, n, \tag{11}$$

which is the basic form of the FGM (0, N) model.

The least square method is used to estimate the parameters,  $\hat{a} = [b_2, b_3, \dots, b_N, a]^T = (B^T B)^{-1} B^T Y$ :

$$\begin{aligned} B &= \begin{bmatrix} x_2^{(r)}(1) & x_3^{(r)}(1) & \cdots & x_N^{(r)}(1) & 1 \\ x_2^{(r)}(2) & x_3^{(r)}(2) & \cdots & x_N^{(r)}(2) & 1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_2^{(r)}(n) & x_3^{(r)}(n) & \cdots & x_N^{(r)}(n) & 1 \end{bmatrix}, \\ Y &= \begin{bmatrix} x_1^{(r)}(1) \\ x_1^{(r)}(2) \\ \vdots \\ x_1^{(r)}(n) \end{bmatrix}. \end{aligned} \tag{12}$$

### 3.3. Modeling Steps of the FGM (0, N) Model

Step 1: determine the system behavior characteristic data sequence  $X_1^{(0)}$  and related factor sequence  $X_j^{(0)}$ ,  $j = 2, 3, \dots, N$

Step 2: calculate and generate system behavior characteristic data sequence, and related factor sequences, and  $r$  ( $0 < r < 1$ ) order accumulated generation sequences  $X_i^{(r)}$ ,  $i = 1, 2, \dots, N$

Step 3: the FGM (0, N) model was established by the sequence generated by  $r$  ( $0 < r < 1$ ) order accumulation

Step 4: the least square method is used to estimate the parameter  $\hat{a} = [b_2, b_3, \dots, b_N, a]^T$

Step 5: according to formula (11), the prediction of sequence data is realized

Step 6: the final data  $\hat{X}_1^{(0)}$  is obtained by using  $r$ -IAGO inverse accumulated generating operator to restore the predicted data

Besides, the accuracy of this article is measured by the ratio of the number of correct predictions to the total number.

## 4. Explore the Effect of Factors on Fresh Graduate's Career Choice: An Application of the FGM (0, N) Model

In this section, two models (GM (0, N) model and FGM (0, N) model) have been performed to forecast graduates' career choices and identify the influential factors. The career choices mainly contain three parts, including continuing studying, working in state-owned enterprises, and working in private enterprises. Besides, this paper only selects four different input variables, including GPA, gender, SES, and whether the student comes from an urban household or not.

And, in order to compare the results of models, this paper sets the ratio of the training set and test set as 8 : 2.

**4.1. The Statistical Description of the Dataset.** This article takes 3237 fresh graduates as the research object. It can be seen from Figure 1 that more than 60% of students still regard direct employment as their first choices after graduation and tend to choose to sign employment agreements to protect their rights and interests. As people’s living standards improve, the number of students studying abroad has also increased, which accounts for 14% of the total number and even exceeds the number of people who choose to study for a postgraduate degree in China. This may be caused by the fact that the overseas postgraduate education system is shorter than that in China and studying abroad can avoid being forced to work directly because of failing to pass the postgraduate entrance examination in China. In addition, only 2% of the students do not find a job and wait for work at home, which shows that China has solved the problem of high unemployment at this stage well.

This article also counts the number of students who have declared economic problems. As shown in Figure 2, 89% of the students have no family financial problems, while 11% of the students have poor family financial status, of which 7% of students’ family economic status is defined as general poverty, while 4% of students’ family economic status is extremely poor. In other words, more than 10% of the families still have financial problems, and nearly 5% of the families have serious financial problems. This also reflects the large gap between the rich and the poor that has emerged in the country at this stage. And, the explanation and statistical description of whole variables have been shown in Tables 1 and 2.

**4.2. Influential Factors for Fresh Graduate’s Career Choice of Continuing Studying.** In this part, we totally collect the specific information of 3237 students (male: 33% and female: 67%), and the average GPA is 3.73. In addition, this paper sets the output number of 26.6% of the whole dataset (choice of continuing studying) as 1 and the others as 0.

It is not difficult to obtain from Figure 3 that the results of the GM (0, N) model are 53.9% and 56.57%, respectively, for the training set and testing set. Besides, as the fractional order changes, the performance of the model changes a lot. Among them, although the training-set accuracy of the models with the fractional order ranging from 0.2 to 0.9 is all

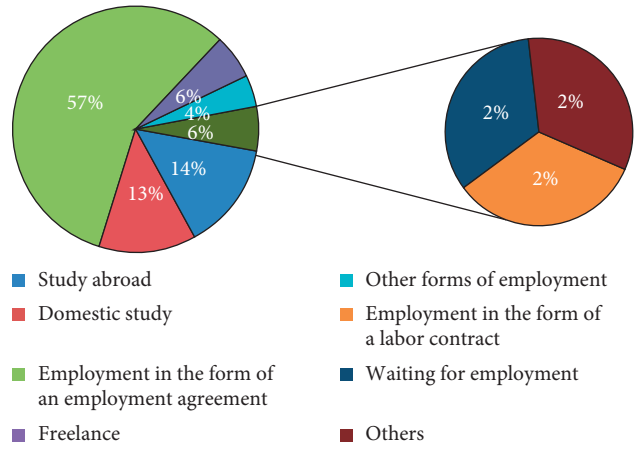


FIGURE 1: Career choice of graduates.

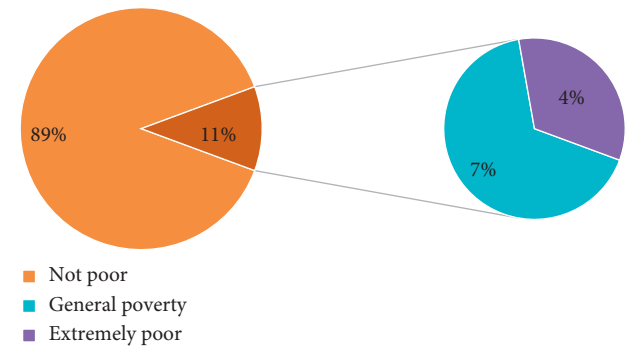


FIGURE 2: Students’ family socioeconomic status.

over 50%, there are much fluctuation in the testing-set accuracy. And, the testing-set accuracy is smaller than the result of the traditional model.

However, if we set the fractional order to 0.1, the training-set and testing-set accuracy is 73.86% and 74.81%, respectively, which mean that the performance of this model is much better than the traditional one. And, we can choose this one to identify the influential factors.

From the results shown in Table 3, this paper easily gets the effect of different factors on fresh graduate’s career choices according to the coefficient. And, if we set  $r$  equaling to 0.1, we can use the least square method to estimate the parameter  $\hat{a} = [b_2, b_3, \dots, b_N, a]^T = [0.095, -0.092, 0.171, 0.019, -0.858]^T$ . And, the equation is

$$\begin{aligned} \text{choice}^{(0.1)}(k) &= 0.095 \text{Town}^{(0.1)}(k) - 0.092 \text{SES}^{(0.1)}(k) + 0.171 \text{GPA}^{(0.1)}(k) \\ &+ 0.019 \text{Gender}^{(0.1)}(k) - 0.858. \end{aligned} \tag{13}$$

If we change the value of  $r$ , the specific parameters and equation will also change.

We can get the following conclusions: firstly, GPA shows the most positive effect, followed by town. This means



TABLE 1: Explanation of variables.

Variable	Explanation
Town	Whether the student comes from an urban household or not (yes = 1; no = 0)
SES	Student's socioeconomic status (general = 0; poor = 1; extremely poor = 2)
GPA	Student's grade point average
Gender	Male = 1; female = 0

TABLE 2: Statistical description of the original data.

	Obs.	Mean	Std. dev.	Min	Max
Whether continuing studying	3237	0.2666	0.4423	0	1
GPA	3237	3.7270	0.5000	1.54	4.76
Gender	3237	0.3299	0.4703	0	1
SES	3237	0.1504	0.4508	0	2
Town	3237	0.5555	0.4970	0	1
Whether working in a state-owned enterprise	2374	0.1664	0.3725	0	1
Whether working in a private enterprise	2374	0.6184	0.4859	0	1
GPA	2374	3.6387	0.4990	1.54	4.76
Gender	2374	0.3475	0.4763	0	1
SES	2374	0.1651	0.4696	0	2
Town	2374	0.5202	0.4997	0	1

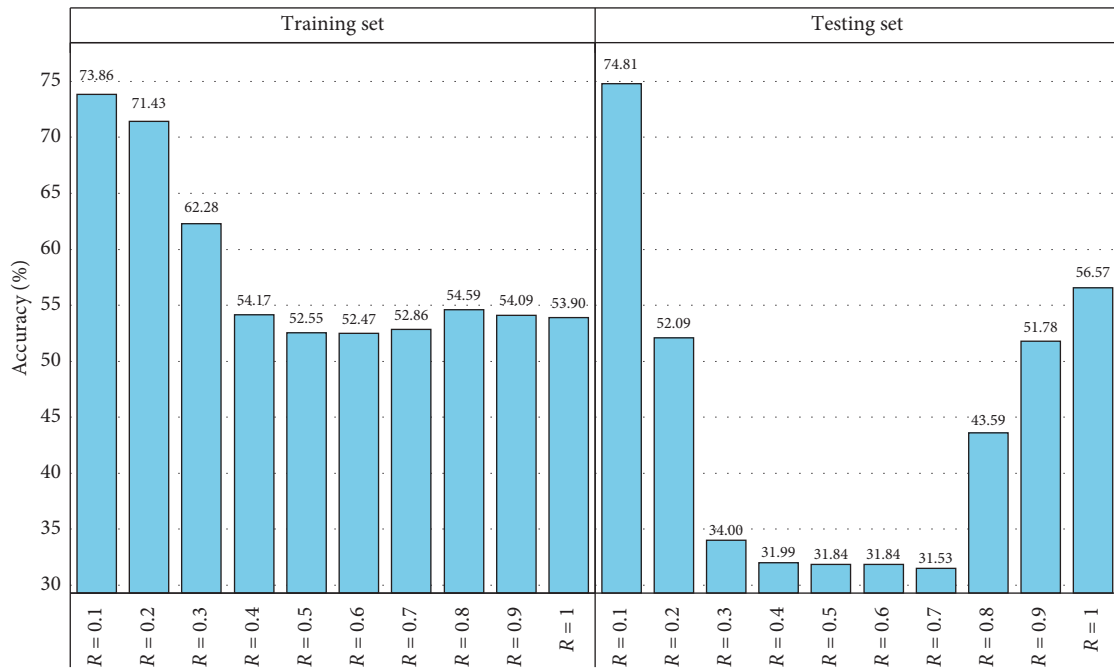


FIGURE 3: Results of the GM (0, N) and FGM (0, N) models: choice of continuing studying.

TABLE 3: Results of coefficient of variables: choice of continuing studying.

Coefficient	r = 0.1	r = 0.2	r = 0.3	r = 0.4	r = 0.5	r = 0.6	r = 0.7	r = 0.8	r = 0.9	r = 1
Constant	-0.858	-0.618	-0.792	-1.292	-2.216	-3.717	-5.998	-9.358	-14.301	-21.701
Town	0.095	0.096	0.127	0.185	0.266	0.361	0.465	0.570	0.666	0.748
SES	-0.092	-0.176	-0.291	-0.423	-0.534	-0.593	-0.600	-0.571	-0.525	-0.475
GPA	0.171	0.105	0.088	0.076	0.061	0.043	0.024	0.006	-0.011	-0.024
Gender	0.019	-0.022	-0.018	0.005	0.035	0.058	0.066	0.058	0.039	0.014

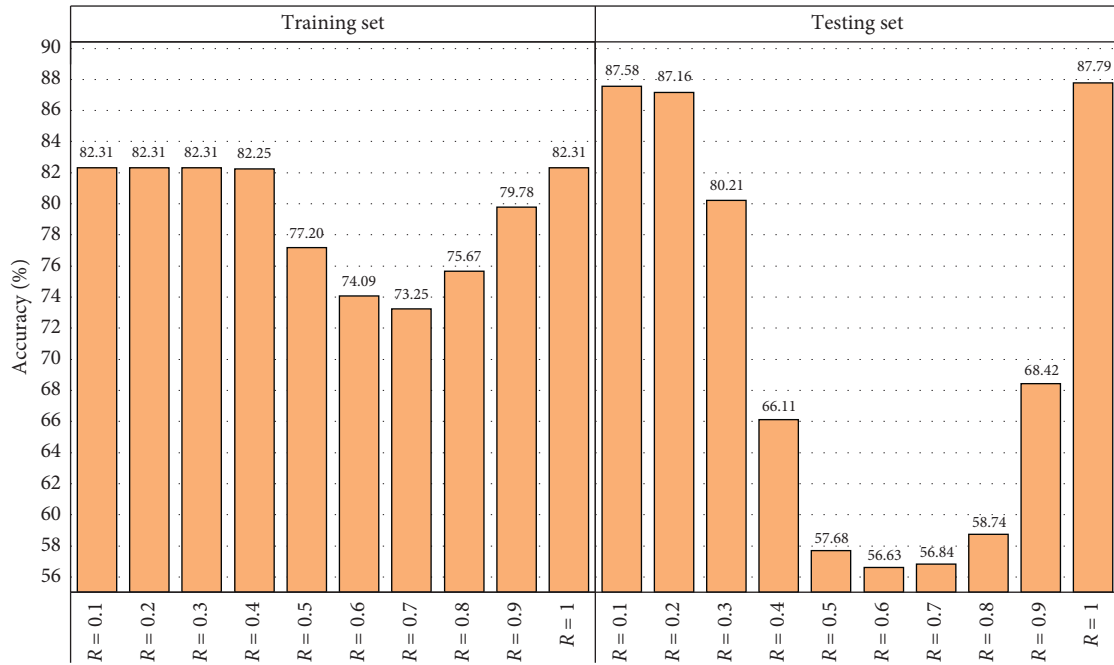


FIGURE 4: Results of the GM (0, N) and FGM (0, N) models: choice of working in state-owned enterprises.

TABLE 4: Results of coefficient of variables: choice of working in state-owned enterprises.

Coefficient	$r = 0.1$	$r = 0.2$	$r = 0.3$	$r = 0.4$	$r = 0.5$	$r = 0.6$	$r = 0.7$	$r = 0.8$	$r = 0.9$	$r = 1$
Constant	-0.200	-0.315	-0.508	-0.901	-1.642	-2.919	-4.916	-7.780	-11.627	-16.632
Town	0.072	0.064	0.055	0.049	0.043	0.036	0.027	0.019	0.011	0.005
SES	-0.038	-0.061	-0.096	-0.143	-0.187	-0.209	-0.197	-0.151	-0.081	-0.003
GPA	0.035	0.043	0.049	0.050	0.046	0.047	0.064	0.097	0.137	0.173
Gender	0.002	0.025	0.066	0.126	0.192	0.248	0.279	0.279	0.253	0.212

graduates with higher GPA and from an urban household are more likely to continue studying. Secondly, SES shows the negative influence. And, the reason may be that graduates with worse SES may choose to work aiming at weakening the family’s stress.

**4.3. Influential Factors for Fresh Graduate’s Career Choice of Working in State-Owned Enterprises.** This section selects the whole dataset except the graduates with choice of continuing studying. Eventually, we get specific information of 2374 graduates (male: 35% and female: 65%), and average GPA is 3.64. Similarly, this paper sets the output number of 16.6% of the whole dataset (choice of working in state-owned enterprises) as 1 and the others as 0.

Based on the information shown in Figure 4, we find that, in the training set, there are five models with the accuracy of 82%. However, after considering the results of the testing set, we find that the performance of two fractional models ( $r = 0.1$  and  $0.2$ ) and the traditional model is much better than the others. Due to the similar performance of these three models, we choose to take advantage of all these three models to explore the effect of factors on the graduate’s choice of working in state-owned enterprises.

As we can see in Table 4, results obtained from the GM (0, N) model are similar with those of the other two fractional models, which indicates the robustness. And, there are also two conclusions: on one hand, gender and GPA make the contribution to the choice of working in state-owned enterprises, which means males with higher GPA are more likely to make this choice. On the other hand, the effect of SES can diversely affect this action.

**4.4. Influential Factors for Fresh Graduate’s Career Choice of Working in Private Enterprises.** The dataset used in this section is similar to that in Section 4.2. The only difference is that the output variable in this section is whether the students choose to work in private enterprises. After calculation, nearly 62% of the whole students take this action and we set the output number as 1.

Based on the information shown in Figure 5, we find the training-set accuracy of all the FGM (0, N) models is higher than the accuracy of the traditional model. Among them, the model with the fractional order ( $r = 0.1$ ) has the best performance, while the testing-set accuracy of all the FGM (0, N) models is 59.68%, which may be caused by the fact that we set the situations of predictions more than 0.5 as 1 and

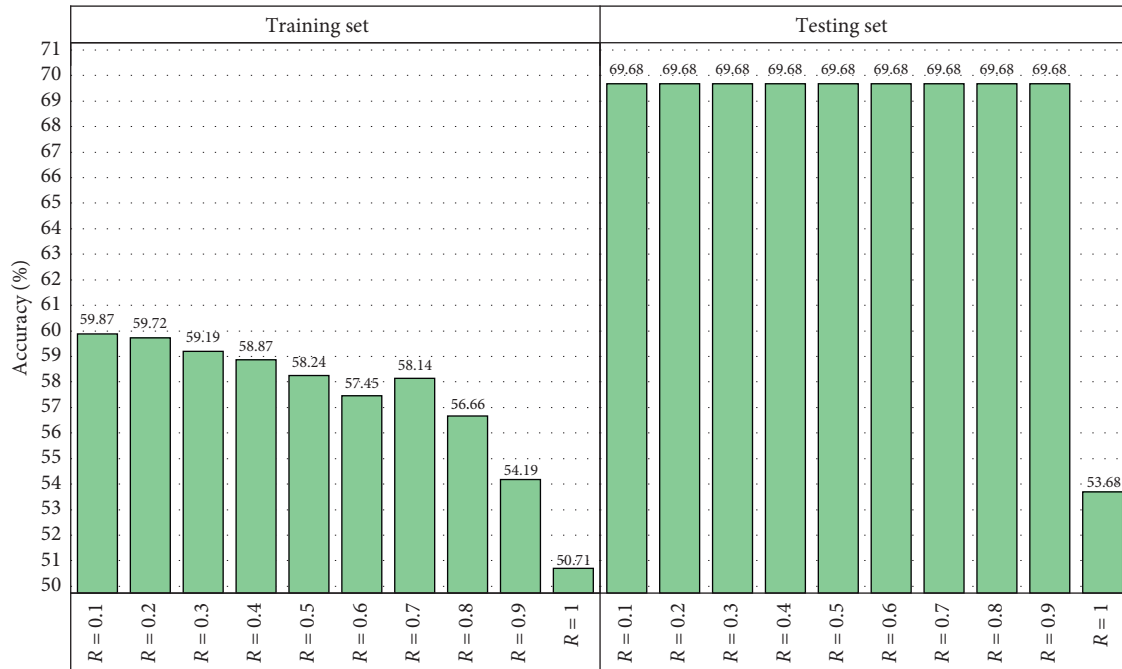


FIGURE 5: Results of the GM (0, N) and FGM (0, N) models: choice of working in private enterprises.

TABLE 5: Results of coefficient of variables: choice of working in private enterprises.

Coefficient	r = 0.1	r = 0.2	r = 0.3	r = 0.4	r = 0.5	r = 0.6	r = 0.7	r = 0.8	r = 0.9	r = 1
Constant	0.696	0.254	0.171	0.301	0.742	1.707	3.471	6.277	10.248	15.366
Town	0.052	0.109	0.103	0.088	0.075	0.065	0.059	0.056	0.054	0.054
SES	0.108	0.175	0.256	0.347	0.431	0.494	0.523	0.511	0.463	0.394
GPA	0.009	0.072	0.135	0.208	0.291	0.377	0.450	0.498	0.522	0.530
Gender	0.121	0.205	0.248	0.256	0.224	0.170	0.119	0.093	0.100	0.134

the predictions less than 0.5 as 0 and most of the predictions are around 0.5. Comprehensively comparing the performance of models, this paper sets the training-set accuracy equaling to 58.5% as the standard and chooses results of the fractional models with the fractional orders ranging from 0.1 to 0.4 to make the following analysis.

The results, as shown in Table 5, indicate that all the four factors show the positive effect on this behavior. Among these four factors, SES and gender are the most influential ones, followed by GPA. After comparing the results from the fractional models with the fraction order ranging from 0.1 to 0.4, we propose that the robustness of the results has been tested.

### 5. Conclusion and Suggestions

In order to confirm student’s needs and provide suitable help, this paper builds the GM (0, N) models to forecast graduate’s career choices. The career choices contain three parts, including continuing studying, working in state-owned enterprises, and working in private enterprises. And, GPA, SES, gender, and whether the student comes from an urban household or not are four input variables. More importantly, in order to increase the accuracy of models, we

firstly combine the traditional GM (0, N) model with the fractional order and propose the FGM (0, N) model.

However, we are surprised to find that the accuracy of some models is almost 60% and the accuracy of the fractional models in previous studies is more than 90%. After reading some related studies, this paper thinks that the most possible reason is the effect of COVID-19. This epidemic has an impact on the career choice of some fresh graduates. And, the effect may also be affected by other factors. Thus, the accuracy of some models is still small.

From the above analysis, we can mainly get the following conclusions:

Firstly, after making the statistical description of the data, we find that most of the graduates are more likely to work instead of continuing studying. And, working in private enterprises is their first choice. Besides, there are still many students with financial problems, which may strongly affect their behavior.

Secondly, based on the empirical studies, we propose that, in most of times, the performance of the FGM (0, N) models is better than the traditional one. However, there is no doubt that, in some cases, the accuracy of the GM (0, N) model is also very good, even higher than that of the fractional ones.



Thirdly, GPA, gender, and town show the positive effect on all the three choices. Among these three factors, GPA is the most influential factor for the choices of continuing studying and working in state-owned enterprises.

Fourthly, the effect of SES changes in forecasting graduate's different choices: while forecasting the choice of continuing studying and working in state-owned enterprises, SES shows the negative effect. However, SES makes the diverse contribution in forecasting the choice of working in private enterprises.

Thus, based on the above conclusions, we propose the following suggestions: for the male students with higher GPA and from an urban household, schools should set up more theoretical courses and some modules about how to be better suitable for the work in state-owned enterprises. For the students with bad family socioeconomic status, schools setting up more practical courses can be better.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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