

## Research Article

# Optimization of Post-Based Merit Salary Based on CPI and University Characteristic Data

Yuan Cao <sup>1</sup> and Qing Cao<sup>2</sup>

<sup>1</sup>*Donghua University, Shanghai 201620, China*

<sup>2</sup>*Shandong University of Science and Technology, Qingdao 266590, China*

Correspondence should be addressed to Yuan Cao; [caoyuan@dhu.edu.cn](mailto:caoyuan@dhu.edu.cn)

Received 6 April 2021; Accepted 11 June 2021; Published 21 June 2021

Academic Editor: Shah Nazir

Copyright © 2021 Yuan Cao and Qing Cao. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

In order to improve the rationality and efficiency of post-based merit salary setting for teaching and research staff in colleges and universities, this paper analyses and discusses the influencing factors and determining principles of post-based merit salary for teaching and research staff in colleges and universities based on the consumer price index (CPI) and the characteristics of colleges and universities. A dynamic and optimal post-based merit salary generation model and its determination method are put forward. The model comprehensively takes changes in price levels into account and the key factors such as the teacher's professional technical level, length of service, and performance appraisal results and can dynamically and intelligently calculate the post-based merit salary of teachers. The test results of the examples prove that the post-based merit salary calculated by the model is objective and reasonable, and it is easy to dynamically adjust according to the changes in social environment and the characteristics of colleges and universities. It can provide a scientific method and useful reference for determining post-based merit salary in colleges and universities.

## 1. Introduction

In order to achieve good pay for good work [1] and to encourage the enthusiasm of the faculty of colleges and universities [2], according to the national salary and income distribution system, all colleges and universities in our country have established a merit salary distribution system that suits their own characteristics [3]. The current merit salary system implemented by colleges and universities divides the salary into four parts: post salary, pay grade salary, merit salary, and allowance [4], while merit salary can be divided into post-based merit salary and rewarding merit salary, and so on. Post-based merit salary is an important component of merit salary. This part mainly reflects post responsibilities and workload matched with the professional technical level of teachers, which not only have an important impact on the income of faculty, but also are a clear response to fairness [5], incentives, and social adaptability [6]. This article researches the optimization methods of post-based merit salary.

The faculty of colleges and universities is divided into four groups: teaching and research staff [7], other specialized technical staff, management staff, and technical workers. Teaching and research staff are the largest group and also contribute the most to the development of colleges and universities. Therefore, this article focuses on researching the post-based merit salary of teaching and research staff (hereinafter, referred to as “teachers”) in colleges and universities and establishes their job performance optimization methods and dynamic adjustment mechanisms based on social development and the university's own characteristic data.

There are several kinds of institutions of higher learning in China, such as teaching and research-oriented universities [8], application-oriented universities, and higher vocational colleges. The construction of teaching and research-oriented universities is the focus of China's higher education construction, and the author has long been engaged in salary management and research in teaching and research-oriented

university. For the above-mentioned reasons, this article mainly discussed the post-based merit salary of teachers in teaching and research-oriented universities. Unless otherwise specified, “university” means teaching and research-oriented university in this article.

The main contributions of this article are summarized as follows:

- (1) This article studies and proposes a model for dynamic optimization that generates the post-based merit salary of university teachers. This model analyses and discusses the influencing factors and determining principles of post-based merit salary for teachers in universities based on CPI and the characteristics of universities and comprehensively takes changes in price levels into account and the key factors such as the teacher’s professional technical level, length of service, and performance appraisal results and can dynamically and intelligently calculate the post-based merit salary of teachers.
- (2) In this article, CPI is introduced as a parameter for the generation model of post-based merit salary. A linkage mechanism for post-based merit salary to rise with the price level is established, which makes post-based merit salary change dynamically with the price level, in order to ensure the income level of the university teachers, guarantee the basic living needs of faculty of college and university, and maintain the salary competitiveness of university.
- (3) In this article, the effectiveness of the generation model of post-based merit salary proposed is tested with the actual information of 8 teachers, and the results are compared with salary data obtained by traditional methods. The test results prove that the dynamic and optimized generation model of post-based merit salary developed in this article is scientifically valid. This model can calculate reasonable post-based merit salary, which provides a useful reference for salary managers of universities.

## 2. Analysis on the Status and Problems of Post-Based Merit Salary of University Teachers by Data

The post-based merit salary of university teachers is a kind of compensation based on the post setting result of the university, which mainly reflects the post responsibilities and basic workload of the teachers. Taking a university in Shanghai as an example, the university adjusted the standard of post-based merit salary once in 2013, 2017, and 2020, respectively. The data of the three adjustments are shown in Table 1. Another example is the post-based merit salary data of a university in Nanjing, as shown in Table 2.

Analysing the current situation of the setting of post-based merit salary of teachers in different universities, it is found that there are several problems as follows:

- (1) Post-based merit salary cannot be adjusted dynamically with the price level. The average increment

TABLE 1: Post-based merit salary of a university in Shanghai in 2013, 2017, and 2020.

Professional and technical level	2013	2017	2020
2	90,000	140,400	151,200
3	82,200	128,400	138,240
4	74,400	110,400	118,920
5	68,400	88,800	96,000
6	64,200	82,800	89,520
7	60,000	76,800	83,040
8	55,200	65,400	70,800
9	51,600	61,200	66,240
10	48,000	57,000	61,800
11	44,400	52,800	57,120
12	43,200	51,000	55,200
13	40,200	47,400	51,240

TABLE 2: Post-based merit salary of a university in Nanjing.

Professional and technical level	Post-based merit salary
2	120,000
3	100,000
4	80,000
5	60,000
6	55,000
7	50,000
8	45,000
9	40,000
10	35,000
11	30,000
12	27,000

speed of post-based merit salary should match with the increment speed of social production efficiency and price increases; that is, salary increment speed needs to be adjusted with the increment speed of per capita GDP and the increment speed of CPI. However, the changes in price levels have not been considered in the current setting of post-based merit salary of many colleges and universities.

- (2) Post-based merit salary structure is relatively simple. China’s public institutions (university is a kind of public institutions in China) began implementing the employee salary system in 1993, implementing the post allowance system in 1999, and established the merit salary system in 2006 [9]. Although many colleges and universities have completed the setting of post-based merit salary, they still use the same way as the original post allowance system. They fail to follow the principle of “focus on efficiency with due consideration given to equity,” “more pay for more work,” and “good pay for good work” [10] in the setting of post-based merit salary.
- (3) The setting of difference between post-based merit salary levels lacks an objective basis, so it is not persuasive. The current difference between the post-based merit salary levels of university teachers is mostly based on the original job allowance salary grade differential multiplied by the corresponding

coefficient, which lacks an objective basis and scientific calculation method.

- (4) The determination method of post-based merit salary is not smart enough. The current determination method of post-based merit salary is mainly through the static table, and this method lacks the ability to change intelligently and dynamically, which makes it difficult for post-based merit salary to keep pace with the times. It also forces universities to manually adjust post-based merit salary rates every few years to keep up with the development of the times, thereby increasing the difficulty of the work.

### 3. The Determining Principle and Function Design of Post-Based Merit Salary of University Teachers

*3.1. The Influencing Factors and Determining Principles of Post-Based Merit Salary of University Teachers.* The salary distribution system for university teachers must not only comply with national policies and relevant regulations but also be affected by the social environment and the specific conditions of the university. Among the four parts of university teachers' salary, the three parts, namely, post salary, pay grade salary, and allowance, must be implemented in strict accordance with national regulations. Only the merit salary part is flexibly determined by the university according to its own situation and social influence. Therefore, in order to promote its own development and progress, every university should make scientific decisions in order to optimize its merit salary distribution plan. The influencing factors and determining principles of university teachers' post-based merit salary are as follows:

- (1) Focus on motivation effect and guarantee internal fairness.

The main distribution principles of post-based merit salary are as follows: "focus on efficiency with due consideration given to equity," "highlight the role of performance," and "good pay for good work." According to these principles, colleges and universities should appropriately widen the income difference between teachers of different positions and levels in order to enhance the incentive of compensation and at the same time should focus on improving internal fairness. Therefore, according to the different job levels of teachers, the salary increase range should be allocated reasonably to balance efficiency and fairness.

- (2) Adjust dynamically according to social development and price changes.

The salary increase mechanism of university teachers must be synchronized with the economic development of the country and the region. Price level increase is an accompanying phenomenon of social and economic development, and the consumer price index (CPI) [11] is constantly changing. Therefore, it is necessary to establish a linkage mechanism in

which merit salary increases with the price level increase to ensure the fundamental living demands of university teachers and help them share social development achievement.

- (3) Reasonably determine the post-based merit salary of teachers according to the situation of the university. When specifically determining the post-based merit salary, each university should make reasonable arrangements according to its own situation, and the following four key factors need to be considered.

Firstly, reasonable income differential: colleges and universities should set up a reasonable income differential between teachers of different post levels. As mentioned above, in the process of determining post-based merit salary, both incentive and balance should be carefully studied and considered, reasonable differences of post-based merit salary should be formed, and efficiency and equity [12] should be balanced as much as possible.

Secondly, being able to link up with job performance assessment and evaluation system [13]: when determining the post-based merit salary, we should fully consider the post and performance appraisal results so that the salary can better reflect the work performance of teachers, better play the role of salary leverage, and reflect the distribution principle of "more pay for more work," "reward the good and fine the bad," and "reward the diligent and punish the lazy."

Thirdly, reasonable growth and flexible and dynamic adjustment: in order to fully stimulate the enthusiasm of teachers, the post-based merit salary of university teachers should have a reasonable growth year by year and can be flexibly and dynamically adjusted according to the specific situation of the university.

Fourthly, the limitation of the total amount of school merit salary: the verification of total post-based merit salary should be related to the overall development level of colleges and universities, and a linkage mechanism should be established to link the total post-based merit salary with the development of colleges and universities and the financial level. The amount of post-based merit salary for teachers (teaching and scientific research staff) is allocated within the total post-based merit salary of the school, and the post-based merit salary for each teacher is reasonably determined within this amount.

*3.2. The Function Design of the Post-Based Merit Salary of the Teachers in Colleges and Universities.* In order to optimize the post-based merit salary of teachers according to the principles of determining the post-based merit salary of teachers in colleges and universities and establish a scientific, dynamic, and intelligent method for determining the post-based merit salary of teachers, the functions of the method are planned and designed as follows:

- (1) Under the same circumstances of other variables, the higher the level of professional and technical posts, the higher the post-based merit salary. The highest level and structure proportion of professional and technical posts shall be determined in accordance with the functions, specifications, affiliations, and professional and technical level of public institutions and in accordance with the current relevant regulations on professional and technical post management and the guiding opinions on post setting management of the industry. In colleges and universities, professional and technical posts are divided into 13 levels, including senior titles, vice-senior titles, intermediate titles, junior titles, and staff titles. Among them, technical levels 1–4 are senior titles, levels 5–7 are vice-senior titles, levels 8–10 are intermediate titles, levels 11–12 are junior titles, and level 13 is staff titles. In particular, the professional technical level 1 is generally academician, and the salary system of academician and other high-level talents is generally planned separately. Therefore, this model does not consider the professional technical level 1 and other high-level talents.
- (2) Under the same circumstances of other variables, the longer the length of service, the higher the post-based merit salary. The length of service reflects the working time of the employees. The post-based merit salary increases with the length of service, which is conducive to maintaining the stability of the employees and meets the needs of the sustainable development of colleges and universities.
- (3) Under the same circumstances of other variables, the better the performance appraisal result is, the higher the post-based merit salary is. Post-based merit salary can reflect the job content and workload. The better the performance appraisal result is, the higher the salary amount is, motivating employees to work hard and improve work efficiency.
- (4) Post-based merit salary should change dynamically with the price level. At present, with the rapid development of society and the continuous improvement of the price level, the adjustment of post-based merit salary is obviously delayed. In order to make up for this deficiency, job performance pay should change dynamically and intelligently with the price level so as to maintain the salary competitiveness of university and attract [14] and retain talents.
- (5) The total amount of post-based merit salary is controllable. Considering the relevant policies of performance pay, the employment cost of colleges and universities, and the actual situation of colleges and universities, the total amount of post-based

merit salary should be designed as a controllable value.

#### 4. Research on the Optimization Model of Post-Based Merit Salary for University Teachers

*4.1. Research on the Method of Determining the Post-Based Merit Salary of University Teachers.* According to the above analysis, we design the post-based merit salary of university teachers according to the dynamic, controllable, and hierarchical principles.

- (1) Determining the grade differential of post-based merit salary hierarchically.

Reasonable salary grade differential design is the key to determine post-based merit salary. To distinguish the difference of post-based merit salary among scientific research personnel with different post levels and service years, we should consider not only fairness but also efficiency and not only incentive effect but also maintaining stability.

According to the work complexity of different post levels and considering the contribution rate of each post to the development of colleges and universities, the difference of post-based merit salary between different post grades should be reasonably drawn. The design adopts three layers: senior titles, vice-senior titles, intermediate and lower titles, and salary grade differentials are set in each level. The specific treatment uses the mathematical model of the salary grade differential in sections and adjusts the gradient flexibly of salary grade differential by adjusting the parameters.

In addition, in order to reflect the factors of “fairness” and “stability” of the sign of employment years, a coefficient related to the employment years should be set when determining the salary grade differential so that the post-based merit salary increases with the service period reasonably.

- (2) Dynamic adjustment of post-based merit salary with the price level.

With the continuous change of national and local price levels, the income of staff should be adjusted accordingly. Although the state advocates the coordination between the salary of staff in public institutions and the development of the national economy, many institutions have not yet done so. On the one hand, Japan’s practice can be used for reference: the Japanese personnel academy investigates the wage level, national standard living expenses, and living price index of employees in private enterprises every year and writes the civil service wage adjustment plan after analysis. The cabinet formulates the wage adjustment bill accordingly and reports it to the parliament for deliberation and implementation.

In order to ensure the income level of the staff in public institutions and maintain the competitiveness of colleges and universities to attract talents, CPI is introduced as a parameter to determine the post-based merit salary of teachers. For specific operations, we can check the CPI index of local urban residents in the previous year published by the national bureau of statistics. If it is accurate to month, we can check the CPI index of local urban residents in the previous month published by the national bureau of statistics to adjust the results of the salary model.

- (3) Determine the total post-based merit salary according to the specific situation of the university and dynamically control it.

The setting of post-based merit salary is important to the performance and development needs of specific universities teaching and scientific research and should be able to make reasonable adjustment according to the post performance. The total amount of post-based merit salary in colleges and universities should be designed as controllable parameters, and colleges and universities can make regular (generally one year) adjustments according to their own specific conditions.

#### 4.2. Dynamic Generation Model of Post-Based Merit Salary for University Teachers

4.2.1. *Basic Generation Model of Post-Based Merit Salary.* According to the determination method and work demand of post-based merit salary of university teachers, this article designs the generation model of post-based merit salary of university teachers, and its basic model is as follows:

$$S_i = \delta \times F \times (1 + \text{CPI}) \times \rho, \tag{1}$$

subject to  $\sum_{i=1}^N S_i < T,$

where  $S_i$  is the annual post-based merit salary of teaching staff and its unit is Yuan;  $\delta$  is the coefficient of salary grade differential and  $\delta \geq 1$ ;  $F$  is post-based merit salary baseline defined as the value of  $S_i$  last year when  $\delta = 1$  and  $\rho = 1$ . CPI is the consumer price index of local urban residents,  $\rho$  is the performance appraisal coefficient of the previous year,  $N$  is the total number of teachers, and  $T$  is the total amount of post-based merit salary with the unit of Yuan.

4.2.2. *Discussion and Parameter Determination of Post-Based Merit Salary Generation Model.* We analyse and discuss the basic model (1) and study the method of determining each parameter as follows (Figure 1).

- (1)  $\delta$  coefficient of salary grade differential is a key parameter in the post-based merit salary generation model, which reflects the impact of the two dimensions of professional technical level and length of service on post-based merit salary.

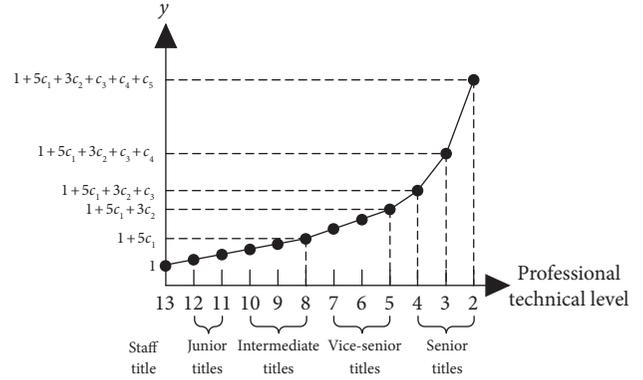


FIGURE 1: Curve of  $y$ , professional technical level parameter.

$$\delta = y + p. \tag{2}$$

Among them,  $y$  is the professional technical level parameter and  $p$  is the length of service parameter. These two parameters, respectively, reflect the influence of the professional technical level and length of service on  $\delta$ , the coefficient of salary grade differential.

We first discuss the method of determining  $y$  the professional technical level parameter. The coefficient of salary grade differential between professional technical levels can be increased in four ways. Firstly, proportional salary grade differential: that is to say, the wages of each professional technical level are increased step by step with the same salary grade differential percentage. It has two characteristics. One is the amount of wage increased by the same percentage, and the salary grade differential is gradually expanded with the absolute amount, but the gap is not very large, and the incentive effect is obvious. The other is that it is convenient for labor cost budgeting and enterprise salary plan formulation. Secondly, the progressive salary grade differential: progressive salary grade differential means that the wages of each grade increase step by step by a progressive percentage. The wage salary grade differential determined in a progressive way has obvious absolute disparity between levels and large income gap. Compared with the proportional salary grade differential, it has a stronger incentive effect on employees and is more suitable for some jobs that need to highlight individual abilities. Thirdly, the regressive salary grade differential: that is, the wage levels are gradually increased in a regressive proportion. The regressive salary grade differential is suitable for jobs that require high labor intensity, small technical differences, and regular upgrades to employees. Fourthly, the irregular salary grade differential: that is to say, the changes in the percentage of the salary grade differential and the absolute amount of the salary grade differential are determined in accordance with the “segmental type” between the wages of each grade. In accordance with

the above-mentioned method of “determining the grade differential of post-based merit salary hierarchically,”  $y$ , the teacher’s professional technical level parameter, should be determined by this method.

Irregular salary grade differential is more flexible than other salary grade differentials in determining methods and is more in line with the law of wage distribution. At the same time, considering that the promotion standards for senior titles are quite different from those of intermediate, junior, and staff titles, it is not advisable to choose a unified salary grade differential. Therefore, the irregular gradation method is used to set the salary differential coefficient in the post-based merit salary generation model, and the coefficients of salary grade differential are set as three sectional salary grade differentials, which are staff to intermediate titles, vice-senior titles, and senior titles. From staff titles to junior titles to intermediate titles, a linear salary grade differential distribution is used, as shown in the following equation:

$$y = -c_1 \times \text{Post} + d, \quad (3)$$

where Post is the corresponding professional technical level,  $c_1$  is the slope of the straight line, which reflects the growth rate of professional technical level parameter with the promotion of professional technical level, and  $d$  is the intercept of the straight line. Set the professional technical level parameter  $y$  of the new employee  $v$  of professional technical level 13 as 1, so there is  $-c_1 \times 13 + d = 1$ , i.e.,  $d = 1 + 13 \times c_1$ . Then, equation (3) is obtained as

$$y = 1 + (13 - \text{Post}) \times c_1. \quad (4)$$

$$y = \begin{cases} 1 + (13 - \text{Post})c_1 + (8 - \text{Post})c_2 + (5 - \text{Post})c_3, & \text{Post} \leq 5, \\ 1 + (13 - \text{Post})c_1 + (8 - \text{Post})c_2, & 5 \leq \text{Post} \leq 8, \\ 1 + (13 - \text{Post})c_1, & \text{Post} \geq 8, \end{cases} \quad (5)$$

where  $c_3 > c_2 > c_1$ . According to the reasons described in Section 3.2, the professional technical level 1 is not considered in the model. A schematic diagram of the professional technical level parameter curve is shown in Figure 1.

In addition to the professional technical level, length of service is also an important factor to be considered in the post-based merit salary generation model. The contribution and return of senior teachers are reflected by the job performance bonus brought by the length of service. The length of the service parameter is determined by the following formula:

$$p = \text{Year} \times \eta \times c_1, \quad (6)$$

When the professional and technical level rises to the vice-senior titles, the grade difference should increase correspondingly due to the improvement of talent level, and the slope of professional technical level parameter is increased to  $c_2$ . Similarly, in the senior titles, the higher the professional technical level is, the more difficult it is to promote, and the talent level rises greatly, and the slope of professional technical level parameter is increased to  $c_3$ . There are three main reasons to consider when setting the three parameters  $c_1$ ,  $c_2$ , and  $c_3$ . Firstly, doctors and masters can get intermediate titles through the orientation of professional and technical level, which is less difficult, so the slopes of intermediate and junior titles are the same and the minimum. Vice-senior is more difficult to promote than intermediate, while senior is more difficult than vice-senior, and the return should be more abundant, so the slope gradually increases. Secondly, from the perspective of performance appraisal, the higher the level of professional and technical posts, the higher the performance appraisal requirements, and the salary level should also be improved accordingly, which is in line with the principle of more pay for more work and distribution according to one’s performance. Finally, considering the number of new promotion places each year, the higher the professional and technical level, the fewer the promotion places, which is in line with the pyramid talent structure of colleges and universities, and the salary should be tilted to more senior technical personnel, which has a greater incentive effect on the staff of colleges and universities. So, we finally set  $c_3 > c_2 > c_1$ . From this, we can get  $y$  the professional technical level parameters from staff title 13 to senior title 2 as follows:

where Year is the length of service of the teacher (less than one year is calculated as one year); new employee Year = 1.  $\eta$  is a coefficient that can be set on demand and  $\eta \times c_1$  reflects the growth rate of grade difference coefficient with length of service. Generally, this speed should be far less than the growth rate of professional technical level parameter with professional technical level promotion, so  $\eta$  is usually far less than 1.

- (2)  $F$  is post-based merit salary baseline. The post-based merit salary baseline  $F$  is constant, defined as the value of  $S_i$  with  $\delta = 1$  and  $\rho = 1$  in the previous year. Therefore,  $F$  changes with CPI the year-on-year, as shown in the following equation:

$$F_{\text{the } N\text{th year}} = F_{\text{the } (N-1)\text{th year}} \times (1 + \text{CPI}). \quad (7)$$

When using this model, the value of  $F$  in the first year can be determined in the following ways. Firstly, it can be reasonably estimated and determined according to the salary data of the school in the previous year. Secondly, for special cases, such as the new school, it can be reasonably estimated and determined by referring to the per capita disposable monthly income of local urban residents or the per capita consumption expenditure of local urban residents.

- (3) Consumer price index (CPI) is a relative number reflecting the change trend and range of the price level of goods and services purchased and consumed by residents. It is closely related to people's lives and plays a very important role in the price system of the whole national economy. This index includes not only the prices of all kinds of consumer goods needed by urban and rural residents in daily life but also the prices of various services closely related to people's life, such as water, electricity, transportation, education, and medical care. It can comprehensively reflect various factors of market price changes and their impact on the actual life of residents.

Adding the CPI parameter item into the post-based merit salary generation model is the concrete embodiment of the method of "dynamically adjusting the post-based merit salary with the price level." The purpose is to make the post-based merit salary change with the price level dynamically and keep pace with the development of the national economy so as to ensure the basic living needs of university teachers.

In some exceptional circumstances, such as the COVID-19 epidemic in 2020, there may be sharp changes in CPI. Therefore, we should give CPI a range of values in case of this kind of sharp change happens. Considering recent years' situation, we think when  $\text{CPI} > 3\%$  or  $\text{CPI} \leq 3\%$ , the CPI in the model should be substituted with  $3\%$  or  $-3\%$ , not the true value of CPI.

- (4)  $\rho$  is the performance appraisal coefficient of the previous year. Because the post-based merit salary should reflect the work responsibilities, basic workload, and performance appraisal results, it is closely combined with the performance and demand of teaching and research work in specific universities, and the performance appraisal coefficient  $\rho$  of the previous year can be set to make reasonable adjustment to this situation.  $\rho$  is determined according to the comprehensive evaluation of the workload and performance appraisal results in the previous year and positively related to the comprehensive evaluation results. If the evaluation results are in a regular way,  $\rho$  is taken as 1. Correspondingly, if the evaluation results are higher or lower than the average level, they are taken as greater than 1 or less than 1, respectively. The value can be determined according to the specific performance appraisal results, one value for one person, in principle  $0.7 \leq \rho \leq 1.3$ .

*4.2.3. Dynamic and Optimal Generation Model of Post-Based Merit Salary.* The final generation model of post-based merit salary is established by introducing all the above parameters into the basic model (1). The final model is a dynamic and optimized generation model of the post-based merit salary of university teachers, as shown in the following:

$$S_i = \begin{cases} (1 + (13 - \text{Post})c_1 + (8 - \text{Post})c_2 + (5 - \text{Post})c_3 + \text{Year} \times \eta \times c_1) \times F \times (1 + \text{CPI}) \times \rho, & \text{Post} \leq 5, \\ (1 + (13 - \text{Post})c_1 + (8 - \text{Post})c_2 + \text{Year} \times \eta \times c_1) \times F \times (1 + \text{CPI}) \times \rho, & 5 \leq \text{Post} \leq 8, \\ (1 + (13 - \text{Post})c_1 + \text{Year} \times \eta \times c_1) \times F \times (1 + \text{CPI}) \times \rho, & \text{Post} \geq 8, \end{cases} \quad (8)$$

subject to  $\sum_{i=1}^N S_i < T, \quad c_3 > c_2 > c_1.$

The meaning of each parameter in (8) is the same as those mentioned before, and it will not be repeated. Some parameters are explained as follows.

For the performance appraisal coefficient  $\rho$  in the previous year, the benchmark value is 1. If the performance of the current year is poor, it can be reduced as appropriate, such as 0.95. If the performance is good, it can be increased as appropriate, such as 1.05.  $\eta$  is a parameter used to adjust the influence percentage of the length of service on post-based merit salary.  $1/\eta$  can be understood as the number of years of service required to increase the allowance of a professional technical level.  $c_1 > 0$  refers to the difference of professional technical level parameters between adjacent professional

technical levels in level 13 to level 8. The larger  $c_1$  is, the greater the salary grade differential is.  $c_2 > c_1$  refers to the difference of professional technical level parameters between adjacent professional technical levels in level 8 to level 5.  $c_3 > c_2$  refers to the difference of professional technical level parameters between adjacent position levels in level 5 to level 2.

## 5. Dynamic Optimization Determination Method for Post-Based Merit Salary of University Teachers

*5.1. Determination Method and Optimization Adjustment of Post-Based Merit Salary for University Teachers.*

According to this study, the post-based merit salary of university teachers is calculated and determined according to equation (8) and adjusted dynamically. We should pay attention to the following problems in the specific work.

- (1) Solve the coordination problem between the total amount of post-based merit salary and related parameters in colleges and universities:

In the dynamic optimization model shown in (8), the constraint is the total amount of post-based merit salary of a specific university. However, according to the above research and discussion, each parameter in the equation has its reasonable value range. Therefore, in the specific determination of a year's post-based merit salary, although it can be calculated according to the model, it often needs to be adjusted according to the actual situation of the university, and finally, determine the total post-based merit salary of the university and the value of the relevant parameters.

The specific treatment method of this problem is as follows:

Due to the changes in the social environment and specific situations of colleges and universities each year, the total performance salary of colleges and universities will change every year. For a specific year, the total performance salary is a fixed value. The decision-making staff of colleges and universities cut the total performance salary according to the components of performance salary and determine the total post-based merit salary according to the appropriate proportion; that is, the total post-based merit salary  $T$  discussed in this article is a component of the total performance salary.

In practical work, if the other parts of the total performance salary can be compressed, it can ensure that the value of  $T$  is not less than the total demand of the post-based merit salary calculated by the current model, and all the relevant parameter values do not need to be adjusted adaptively. In this case,  $T$  = the total amount of post-based merit salary calculated by the model.

If, for some reason, the value of  $T$  cannot meet the total demand of post-based merit salary calculated by the current model, then through calculation, the

performance baseline  $F$  of this year will be reduced adaptively. Because  $S$  and  $F$  are related in each position grade model, without changing other parameters, each employee's post-based merit salary  $S$  will decrease accordingly. Thus, the post-based merit salary of all teachers is reduced by equal proportion based on total amount control.

- (2) Reasonably determine the salary grade differential of post-based merit salary according to the current situation of colleges and universities.

The salary differences between different post levels are adjusted by parameters  $c_1, c_2, c_3$ , in which  $c_3 > c_2 > c_1$ . Although it can reasonably widen the difference in post-based merit salary between different post levels, there are still two problems: the values of  $c_1, c_2, c_3$  and the gap between three parameters. These two problems still need to be solved through experience and analysis in practical work.

The recommended approach to this problem is that the values of  $c_1, c_2, c_3$  are determined comprehensively according to the proportion of the teachers of each post level among the full-time teachers in the university in the current year and the performance appraisal requirements for teachers of each post level in the current year. Meanwhile, there is secondary management in colleges and universities. The management institutions of secondary colleges can adjust  $c_1, c_2, c_3$  to meet the requirements of the staff structure and performance appraisal of the college according to the personnel structure of their respective colleges.

*5.2. Case Analysis on the Determination of Post-Based Merit Salary of University Teachers.* Taking the actual situation of a university in Shanghai as an example, this article analyses the feasibility and effectiveness of the proposed optimization method of post-based merit salary.

*5.2.1. Parameter Setting.* Through investigation, the CPI of cities and towns in 2019 is 2.9%. Combined with the actual situation of a university in Shanghai, set  $F_{2019} = 40,000$ ,  $\rho = [0.8, 1, 1.2]$ ,  $\eta = 0.25$ ,  $c_1 = 0.13$ ,  $c_2 = 0.22$ ,  $c_3 = 0.31$ . These parameters are brought into equation (8), and the model is transformed into the following:

$$S_i = \begin{cases} (6 - 0.66 \times \text{Post} + 0.0325 \times \text{Year}) \times 41160 \times \rho, & 2 \leq \text{Post} \leq 5, \\ (4.45 - 0.35 \times \text{Post} + 0.0325 \times \text{Year}) \times 41160 \times \rho, & 5 \leq \text{Post} \leq 8, \\ (2.69 - 0.13 \times \text{Post} + 0.0325 \times \text{Year}) \times 41160 \times \rho, & \text{Post} \geq 8, \end{cases} \quad (9)$$

subject to  $\sum_{i=1}^N S_i < T$ .

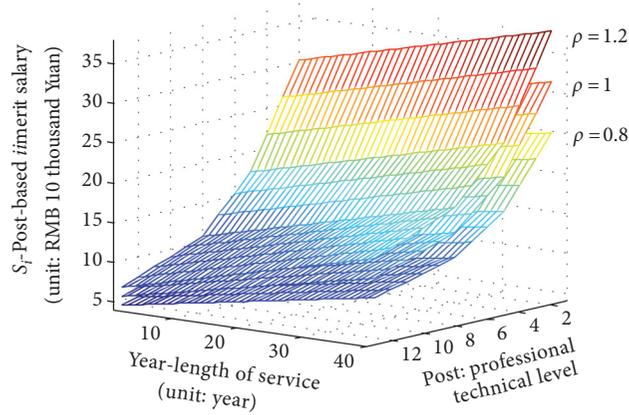


FIGURE 2: Example simulation results of post-based merit salary generation model.

TABLE 3: Test sample group.

No.	Year	Professional technical level	Length of service	Performance appraisal result	Post-based merit salary by our model	Current post-based merit salary
A	B	C	D	E	F	G
1	2020	10 (intermediate)	8 year	1	67,914	73,800
2	2020	7 (vice-senior)	8 year	1	93,022	95,040
3	2020	7 (vice-senior)	15 year	1	102,386	95,040
4	2020	7 (vice-senior)	15 year	0.9	92,147	85,536
5	2020	7 (vice-senior)	15 year	1.1	112,624	95,040
6	2020	5 (vice-senior)	15 year	1	131,198	108,000
7	2020	4 (senior)	15 year	1	158,363	130,920
8	2019	4 (senior)	15 year	1	153,900	130,920

5.2.2. *Calculation Results.* Simulate the equation (9) model with MATLAB, and draw the mesh image of post-based merit salary, as shown in Figure 2.

It can be seen from Figure 2 that the post- and performance-based salaries generated by this model can set reasonable differences with the increase of post level, the differences of level 13 to level 8 are balanced, and the differences of level 8 to level 5 and level 5 to level 2 are appropriately improved. At the same post level, the coefficient of gradation also rises to a certain extent as the length of service increases. Meanwhile, the results of job appraisal also have a certain range of influence on post-based merit salary.

In order to more specifically observe the running results of the model, we take 8 teachers' samples for testing, and the results are shown in Table 3. Among them, column *F* is the post-based merit salary value of each teacher obtained by this model, and column *G* is the current post-based merit salary of corresponding teachers in a university in Shanghai.

By analysing the results of column *F*, we can see the rules of post-based merit salary of this model: from teachers 1 and 2 and teachers 3, 6, and 7, the higher the post level, the higher the post-based merit salary of teachers with the same length of service and the same performance appraisal results. From teachers 2 and 3, it can be seen that the longer the length of service, the higher the post-based merit salary of teachers with the same post level and performance appraisal results. From teachers 3, 4, and 5, we can see that the better the performance appraisal results, the higher the post-based merit salary. From teachers 7 and 8, it can be seen that the

post-based merit salary of teachers with the same post level, length of service, and performance appraisal results dynamically change with the CPI year by year.

Analysing the results of column *G*, we can see the current law of post-based merit salary. Teachers 3, 6, and 7 show that the higher the post level, the higher the post-based merit salary. Teachers 2 and 3 show that the length of service has no effect on post-based merit salary. From teachers 3, 4, and 5, it can be seen that, compared with teachers with average performance appraisal results, teachers with poor performance appraisal results have post-based merit salary, but teachers with good performance appraisal results have no increase in post-based merit salary. From teachers 7 and 8, it can be seen that post-based merit salary does not change dynamically with the CPI year by year.

In summary, the test results prove that compared with the current post-based merit salary system of a university in Shanghai, the dynamic and optimized generation model of post-based merit salary developed in this article is reasonable and effective, and it can reflect the teachers' own post level, length of service, and performance appraisal results. Furthermore, the post-based merit salary generated by this model can also change dynamically with the price level.

5.3. *Model Improvement and Problem Discussion.* Although the method and optimization model of university teachers' post-based merit salary proposed in this article satisfactorily solve the problems in the current salary system

such as single structure and cannot be adjusted dynamically according to price changes, it still needs to be gradually improved in the application. Related issues and their solutions are discussed as follows.

The difficulty of the determination method and dynamic generation model of university teachers' post-based merit salary is the unity of its realistic rationality, social influence, and intelligent optimization. On the premise of studying and putting forward the dynamic generation model of post-based merit salary, the difficulty is transformed into the problem of reasonable determination of each parameter in the model. As mentioned above, although this article puts forward the principles and methods of parameter determination, it still needs discussion, research, and specific determination by relevant leaders. In the practical work, due to the need for different departments in colleges and universities to complete the work, there is a gap in mutual coordination, resulting in the actual effect being often difficult to achieve the satisfaction of teachers and the real sense of optimization. This problem still needs to be solved by the effective cooperation of different departments in colleges and universities.

## 6. Conclusion

Based on the consumer price index and the characteristics of colleges and universities, this article analyses and discusses the influencing factors and determination principles of post-based merit salary for teaching and scientific research personnel in colleges and universities, and studies its dynamic and optimal generation model and determination method.

- (1) The grade differential of post-based merit salary for university teaching and scientific research personnel should be determined at different levels and should be dynamically adjusted according to the price level. At the same time, the total post-based merit salary should be determined according to the specific conditions of the university, and it should be dynamically controllable.
- (2) The dynamic and optimized generation model of post-based merit salary for teaching and scientific research personnel established in this article can truly reflect the various elements of post-based merit salary through simulation experiments and case analysis. The amount of post-based merit salary is reasonably adjusted according to the post level of the teacher, the length of service, and the result of performance appraisal and can change dynamically according to the level of social consumption. This model not only conforms to the principle of giving priority to efficiency and giving consideration to fairness but also increases the competitiveness of universities in attracting talents. Therefore, the post-based merit salary optimization model and method proposed in this article is an innovation in this field, which can be flexibly applied according to the actual situation of different universities.

- (3) The model and method proposed in this article leave room for further research in its parameter determination methods, which should be solved in practice and further research.

## 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.

## Acknowledgments

This work was supported in part by the Project of the Humanities and Social Sciences on Young Fund of the Ministry of Education in China (Research on Swarm Intelligence Collaborative Robust Optimization Scheduling for High-Dimensional Dynamic Decision-Making System, no. 20YJCZH052) and 2020 Donghua University Higher Education Planning Special Topic Project (Research on Performance Wage Distribution Method Based on the Sense of Pay Fairness, no. 206-99-0243030).

## References

- [1] W. Jones, R. Haslam, and C. Haslam, "What is a 'good' job? modelling job quality for blue collar workers," *Ergonomics*, vol. 60, no. 1, pp. 1–22, 2016.
- [2] S. Rahayuningsih, "The influence of compensation and work environment towards teacher's job satisfaction," *SHAHIH Journal of Islamicate Multidisciplinary*, vol. 2, no. 2, pp. 157–169, 2017.
- [3] X. Hu, "Research on performance pay policy for college teachers in China: logical evolution, theoretical framework and future development," *Journal of National Academy of Education Administration*, no. 1, pp. 89–95, 2020.
- [4] X. Liu, "Difficulties and countermeasures of performance pay reform in public institutions," *Party School of the Central Committee of the Chinese Communist Party*, vol. 23, no. 1, pp. 30–34, 2019.
- [5] M. Mihai, P. Constanța, T. Ana-Maria, and T. Valerica, "Modelling discrete choice variables in assessment of teaching staff work satisfaction," *PloS One*, vol. 10, no. 4, Article ID e0115735, 2015.
- [6] Y.-M. He, Yu-L. Pei, B. Ran, J. Kang, and Y.-T. Song, "Analysis on the higher education sustainability in China based on the comparison between universities in China and America," *Sustainability*, vol. 12, 2020.
- [7] G. Rodriguez, C. Zhou, and M. Carrio, "Creativity in biomedical education: senior teaching and research staff's conceptualization and implications for pedagogy development," *International Journal of Engineering Education*, vol. 33, no. 1, pp. 30–43, 2017.
- [8] J. Arsenault, J. Boustani, J. Talbot, R. Gonzales, and K. Manaugh, "The environmental footprint of academic and student mobility in a large research-oriented university," *Environmental Research Letters*, vol. 14, no. 9, Article ID 095001, 2019.

- [9] W. Zhen, “Exploration of the reform of the performance-related pay system in institutions in the new era,” *Value Engineering*, vol. 37, no. 22, pp. 111-112, 2018.
- [10] G. Yan, “The trajectory, problems and future of academic appointment system reform,” *China Higher Education Research*, no. 10, pp. 1-9+19, 2019.
- [11] G. A. Sarantitis, T. Papadimitriou, and P. Gogas, “A network analysis of the United Kingdom’s consumer price index,” *Computational Economics*, vol. 51, no. 2, pp. 173-193, 2018.
- [12] A. Cohn, E. Fehr, and L. Goette, “Fair wages and effort provision: combining evidence from a choice experiment and a field experiment,” *Management Science*, vol. 61, no. 8, pp. 1777-1794, 2015.
- [13] C. R. Sánchez, D. Díaz-Cabrera, E. H. Fernaud, Does effectiveness in performance appraisal improve with rater training,” *PLoS One*, vol. 14, no. 9, pp. 1-20, 2019.
- [14] C. Björn, M. Lindberg, and D. Rissén, “Significant factors for work attractiveness and how these differ from the current work situation among operating department nurses,” *Journal of Clinical Nursing*, vol. 25, no. 1-2, pp. 109-116, 2016.