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An Evaluation Model of Tuition Fee in Higher Education

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Abstract

This paper surveys evaluation and pricing of tuition fee from two perspectives: society and school. We use the optimization theory in fuzzy mathematics and operations research to establish the evaluation model based on overall society and school satisfaction degree; Taking maximum overall Satisfaction degree as our goal and all factors of comprehensive tuition fee evaluation as the restriction, we establish the optimization model of tuition fee pricing to get the tuition standard in higher education. Then we classify disciplines according to the specific reality and calculate the grades and reference prices in disciplines of three schools in Guangdong Province, China. We further obtain the reference tuition fee in other provinces using the regional conversion coefficient. At last we give our directions for tuition fee pricing of higher education.

Index Terms: Standard education cultivation cost; model; evaluation of tuition fee standard; establishment of tuition fee standard

1. Introduction

Since the founding of P.R.China, higher education has experienced the transition from "free education" to "charge system" and tuition fee has been rising as universities keep expanding the enrollment scale. However, since education investment has not increased in the same pace with the tuition fee, actual proportion of individual pay to higher education has been increasing steadily. After the establishment of charge system, average tuition fee in colleges and universities has rocketed from 800 Yuan to 5000 Yuan between the year 1995 and 2009.

Indeed, charge system can alleviate the financial pressure of fund shortage and promote higher education development in China. But in the era of educational popularization, the growth of tuition fee has exceeded the ability-to-pay for an ordinary family. Especially after 2007, since the increasing price, the rising wealth gap between rich and poor and the international financial crisis have made the economy worse, people pay more

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attention to these questions: whether the current tuition fee standard is reasonable and if not, what kind of standard should be established.

The issue is discussed in Ji Qiuying and Lin Jian's literatures [2] and Hua Cuncai's literature [3] and [4]. And Tian Wenyi proposed that tuition fee should be priced by analyzing three main fators "university-family-society" in "*A High Education Tuition Pricing Model based on Multiple Perspectives*".

This paper surveys evaluation and pricing of tuition fee from two perspectives—society and school. We use the optimization theory in fuzzy mathematics and operations research to establish the evaluation model based on overall society and school satisfaction degree; Taking Maximum overall Satisfaction degree as our goal and all factors of comprehensive tuition fee evaluation as the restriction, we establish the optimization model of tuition fee pricing to get the tuition standard in higher education.

2. description of overall society satisfaction degree

Due to different ability-to-bear and uneven school level between cities and town, we shall establish the evaluation model of overall satisfaction degree of tuition fee to assess tuition fee. Overall satisfaction degree of tuition fee consists of two parts: society satisfaction degree and school satisfaction degree.

As for society satisfaction degree, we should analyze it from two aspects—family satisfaction degree and satisfaction degree of urban-rural gap. The ability-to-pay can be divided into the ability-to-pay of town and ability-to-pay of city. Then by introducing the regional juvenile fostering index and investigating the influence of discipline profitability on ability-to-pay, we obtain overall family ability-to-bear and satisfaction degree.

Society satisfaction degree U_p consists of family satisfaction degree μ and satisfaction degree of urban-rural gap φ. Thus society satisfaction degree can be obtained by the weight sum of family satisfaction degree and satisfaction degree of urban-rural gap.

$$U_p = \lambda_1 \cdot \mu + \lambda_2 \cdot \varphi, \ \lambda_1 + \lambda_2 = 1 \tag{1}$$

In the formula, μ is family satisfaction degree, φ is satisfaction degree of urban-rural gap, λ_1 and λ_2 are weight values. When $\lambda_1 > \lambda_2$, we pay more attention to family satisfaction degree; when $\lambda_2 > \lambda_1$, we pay more attention to satisfaction degree of urban-rural gap; when $\lambda_1 = \lambda_2$, it means we pay equal attention to both of them. In the following, we will describe family satisfaction degree μ and satisfaction degree of urban-rural gap φ.

A.   Description of family satisfaction degree μ

Family satisfaction degree μ is influenced by different factors such as income level, saving level, family burden and discipline profitability. In the following we will obtain family satisfaction degree by analyzing these factors.

1)   Influencing factor of regional Juvenile fostering index

Regional juvenile fostering index is the young and middle aged-workforce ratio. It is the description index of family burden and also one of influencing social factors for ability-to-pay of family. In order to describe the gap between regional juvenile fostering index and the national average level, we take the difference value between regional juvenile fostering index and social average juvenile fostering index into account. When the difference value is positive, it means the family burden exceeds the social average level so that the ability-to-pay is relatively low, and vice versa.

Regional juvenile fostering index is introduced when we try to describe the influencing factor of fostering index. We assume that national general Juvenile fostering index is 1 and get the formula as follows:

$$f^k = 1 - (f_d^k - f_a^k) \tag{2}$$

In the formula, f^k is the influencing factor of regional Juvenile fostering index, f_d^k is regional juvenile

fostering index, $f_a^{\ k}$ is social average juvenile fostering index.

2) The ability-to-pay for tuition fee

We discuss the relationship between tuition fee, urban income and rural income according to the average income, expenditure and family number. Then we calculate the ability-to-pay of urban-rural family by the following formula. The ability-to-pay of next year = annual average family income $\times 15\%$ + average family saving at the end of year $\times 20\%$

Considering that the change of juvenile fostering index has an influence on the willingness-to-pay and ability-to-pay of family, we put forward a new calculation method for the ability-to-pay. In order to discribe urban-rural gap in ability-to-pay better and get a more reasonable tuition standard, we divide the ability-to-pay into the ability-to-pay of town and the ability-to-pay of city. That is,

$$P_a^{\ k} = (15\% \cdot E_a^{\ k} + 20\% \cdot S_a^{\ k}) \cdot f^{\ k} \qquad (3)$$

In the formula, $P_a^{\ k}$ is the ability-to-pay, $E_a^{\ k}$ is the family income, S_a^k is the saving, f^k is regional juvenile fostering index, when K=1, it stands for the situation in urban areas. When K=2, it stands for the situation in rural areas.

3) The ability-to-bear for tuition fee

The tuition fee-paying ability ratio is the proportion of tuition fee to the ability-to-pay and reciprocal can be used to describe the acceptability of tuition fee .The ability-to-bear is in direct ratio with the ability-to-pay while in reverse ration with tuition fee and the higher the ability-to-bear is, the more fee a family can bear.

Firstly, we describe the tuition fee-paying ability ratio p^k and obtain its value by dividing tuition fee T by ability-to-pay $P_a^{\ k}$ .That is,

$$p^k = T \big/ P_a^{\ k} \qquad (4)$$

Then, we get the ability-to-bear t^k which is the reciprocal of the tuition fee –paying ability ratio. That is,

$$t^k = P_a^{\ k} \big/ T \qquad (5)$$

where p^k is the tuition fee-paying ability ratio. T is tuition fee, $P_a^{\ k}$ is the ability-to-pay, t^k is the ability-to-bear.

4) Comprehensive ability-to-bear for tuition fee

Comprehensive ability-to-bear for tuition fee is the family's acceptable tuition fee after considering social and personal benefit from higher education. It can measure the final ability-to-bear of family which shows the tendency influence of the income on comprehensive ability-to-bear. The higher the income is, the higher the willingness-to-pay is, and vice versa. Comprehensive ability-to-bear for tuition fee $t_c^{\ k}$ is decided by the ability-to-bear t^k and difference factor of subject profits α_j.

$$t_c^{\ k} = t^k \cdot \alpha_j \qquad (6)$$

In the formula, α_j is difference factor of subject profits, $t_c^{\ k}$ is comprehensive ability-to-bear for tuition fee.

5) Satisfaction degree of family

According to the psychological research, sensitivity to dissatisfaction is much higher than sensitivity to satisfaction. Through the analysis of this issue we know that when comprehensive ability-to-bear for tuition fee

is a decimal people are extremely dissatisfied and satisfaction degree is 0. When comprehensive ability-to-bear is more than that decimal, the severe change of satisfaction degree smooth down until it reaches a certain number and satisfaction degree is closed to 1.

According to the discussion above, we establish a high T-shape curve to describe the function of satisfaction degree change caused by comprehensive ability-to-bear in the following,

$$\mu^{k}(x) = \begin{cases} 0, & x < \beta \\ 1 - e^{-\alpha(x-\beta)} & x \geq \beta \end{cases} \tag{7}$$

In the formula, α, β are undetermined constants, x is comprehensive ability-to-bear of family for tuition fee.
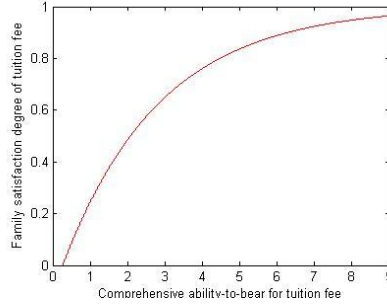

Figure 1. Function of family satisfaction degree of tuition fee

By calculation we know that the ability-to-bear of family for art school is 8.6899 which is the largest number in comparison. We assume satisfaction degree of family is 0.96 and obtain that the ability-to-bear of family for teacher training school in Guizhou is 0.39735, which is the smallest number in comparison. Then we assume the ability-to-bear of family is 0.05 and obtain that $\alpha=0.38198$, $\beta=0.26307$. After putting the number into the function, we can get the following formula.

$$\mu^{k}(x) = \begin{cases} 0, & x < 0.26307 \\ 1 - e^{-0.38198(x-0.26307)} & x \geq 0.26307 \end{cases} \tag{8}$$

Then we can obtain satisfaction degree of urban-rural family.

B. *Description of satisfaction degree of urban-rural gap*

The imbalance in the ability-to-bear of urban-rural family for tuition fee is one influencing factor for satisfaction degree. Thus urban-rural gap should be taken into account in tuition fee pricing so that all people can afford it and educational equity can be promoted. We use the ability-to-bear of family t_c^{k} to calculate the variance and obtain the degree of urban-rural gap to calculate satisfaction degree of urban-rural gap. The variance should be as small as possible in actual analysis. Mean value of the ability-to-bear of urban-rural family and variance of urban-rural gap are calculated in the following formula.

$$\overline{x} = \sum t_i^{k} \Big/ n \tag{9}$$

$$\sigma^{2} = \sum (t_i^{k} - \overline{x})^{2} \Big/ (n-1) \tag{10}$$

The wider the urban-rural gap is, that is, the bigger the variance of urban-rural gap is, and the lower resident

satisfaction degree is. While the narrower the gap is, the higher resident satisfaction degree is. In fact, when the gap is wide enough, residents are quite unsatisfied and satisfaction degree is 0. When the gap is narrow enough, residents are quite satisfied and resident satisfaction degree is 1.

According to the discussion above, we establish the parabolic distributed function $\varphi(x)$ to describe satisfaction degree of urban-rural gap.

$$\varphi(x) = \begin{cases} 1, & x < a \\ \left(\dfrac{b-x}{b-a}\right)^2, & a \leq x \leq b \\ 0, & x > b \end{cases} \tag{11}$$

In the formula, α, β are undetermined constants, x is the variance of urban-rural gap. Using the urban-rural gap in Guizhou and Shanghai, we obtain $a=0.00346$, $b=1.7345$. Then we can get the following formula

$$\varphi(x) = \begin{cases} 1, & x < 0.00346 \\ \left(\dfrac{1.7345 - x}{1.7345 - 0.00346}\right)^2, & 0.00346 \leq x \leq 1.7345 \\ 0, & x > 1.7345 \end{cases} \tag{12}$$

Satisfaction degree of urban-rural gap can be obtained by calculation.

3. description of school satisfaction degree of tuition fee

The world generally use the average education cultivation cost (AECC) ratio to price tuition fee and the tuition and fees-average education cultivation cost ratio is generally about 20%. For example, although the tuition fee-income ratio varies in different American public colleges and universities, the average tuition fee - average teaching cost ratio is 25%.[7]Likewise, In China, Article 55 of *Temporary Act of tuition fee management of higher institutions* rules that "the average tuition fee - average education cultivation cost ratio cannot surpass 25%.[8] Here we use the tuition fee T and average education cultivation cost C_a to describe tuition fee-cost ratio. That is,

$$t = T / C_a \tag{13}$$

As policy rules that the average tuition fee - average education cultivation cost ratio cannot exceed 25%, the closer the school reaches the value, the bigger the school satisfaction degree of tuition fee is. Change of satisfaction degree is demonstrated as high normal distribution.

$$U_s(x) = \begin{cases} 0, & x < \beta \\ 1 - e^{-\left(\frac{x-\beta}{\alpha}\right)^2} & x \geq \beta \end{cases} \tag{14}$$

In the formula, α, β are undetermined constants, x is tuition fee-cost ratio. Considering the restrictive policy, we assume that tuition fee-cost ratio is 0.25 and satisfaction degree is 0.95 and thus we obtain relatively reasonable coefficients $\alpha=0.13295$, $\beta=0.019890$. Putting them into the function we get the following formula.

$$U_s(x) = \begin{cases} 0, & x < 0.019890 \\ 1 - e^{-\left(\frac{x-0.019890}{0.13295}\right)^2} & x \geq 0.019890 \end{cases} \tag{15}$$

School satisfaction degree of tuition fee can be obtained by calculation.

4. Evaluation model of overall satisfaction degree of tuition fee

According to different importance in society and school satisfaction degrees, we obtain overall satisfaction degree of tuition fee by the weight sum of two parts. That is,

$$U_g = a \times U_p + b \times U_s \tag{16}$$

In the formula, a, b are affecting weights of overall satisfaction degree of tuition fee that affected by society and school satisfaction degree of tuition fee. Here we assume they have equal importance that both are 0.5.

We converse overall urban-rural satisfaction degree of tuition fee $\overline{U_g^1}$ and $\overline{U_g^2}$ based on urban-rural ratio $(a':b')$. Then we obtain national overall satisfaction degree of tuition fee $\overline{U_g}$. As for overall satisfaction degree, we consider the commonality and sociality of higher education and assume overall national satisfaction degree of tuition fee $\overline{U_g}$ is 0.9. Then we obtain overall satisfaction degree grade *Mark* after comparing national overall satisfaction degree of tuition fee in one subject with the standard value. The greater the *Mark* is, the better it means.

$$Mark = \left(\overline{U_g} \Big/ \overline{U} \right) \times 100 \tag{17}$$

In the formula, *Mark* is overall satisfaction degree grade, $\overline{U_g}$ is national overall satisfaction degree of tuition fee, $\overline{U}$ is national overall satisfaction degree of standard tuition fee.

5. Model solution

In the caculation, colleges and universities can be categorized according to three aspects: location, school level, subjects. We discuss the situation in three key colleges and universities in Guangdong Province: finance and economics major in Jinan University, sciences and engineering major in South China University of Technology and arts major in Xinghai Conservatory of Music. First we should acquire values like the standard student number and the present tuition fee, and then we can get education cultivation cost through the calculation model of education cultivation. After evaluating two tuition fee numbers, we use the model of tuition fee pricing to calculate the optimized reference price.

A. Category classification

Time, location, school level and subjects all have effects on the education cultivation cost. Specifically speaking, China has the dual structure where economic gap exits in different region. Colleges and universities are also different due to different economic level, price level and location; Different school level (national key university or ordinary university, private college or independent institute ,second vocational college or higher vocational school), different subject training goals and different school running level will make education cultivation cost different. In order to survey tuition fee pricing more objectively and accurately, we categorize it in three aspects:

* location: in which province;
* school level: national key university or ordinary university, private college or independent institute ,second vocational college or higher vocational school
* subjects: Literature and history, science and engineering, agriculture and forestry, medicine, finance and economics, teacher training major or arts.

Science and engineering costs more money due to massive experiments, arts also costs more money than other liberal courses because it needs more teachers and practices. China has special financial funds for teacher training major due to its special characteristic. So we make different analysis according to different disciplines.

B. Data determination

In order to calculate average education cultivation cost, we must obtain the standard student number in one subject. We use the data of undergraduates, postgraduates and doctors from finance and economics in Jinan University (JNU), sciences and engineering in South China University of Technology (SCUT) and arts major in Xinghai Conservatory of Music (XCM) and the conversion coefficient to obtain the respective standard student number.

TABLE I.   STANDARD STUDENT NUMBER IN SUBJECTS OF THREE SCHOOLS IN 2007

Category	Finance and economics in JNU	Sciences and engineering in SCUT	Arts Major in XCM
Undergraduate	4484	18180	4000
Postgraduate	2007	6294	150
Doctor	216	1023	0
Standard student number	7927	29667.8	4225

Source : websites of colleges and universities.

To investigate the situation of satisfaction degree, we need to collect tuition fee in different subjects of the three schools. We obtain the standard tuition fee：4560 Yuan in finance and economics in JNU, 5160 Yuan in sciences and engineering in SCUT and 10000 Yuan in arts major in XCM.

In order to calculate overall ability-to-bear for tuition fee, we collect annual average family income and saving at the end of year in some representative regions. Then we use the regional juvenile fostering index to calculate juvenile fostering influencing factors and obtain the ability-to-pay for tuition fee. The numbers are in the following table Ⅱ.

TABLE II.   ABILITY TO PAY IN REPRESENTATIVE REGIONS IN 2007

Province	Category	Juvenile fostering Influencing factors	Annual average family income	Average family saving at the end of year	Ability-to-pay for tuition fee
Guangdong	city	98.53	53097.9	70621.41	21764.26
	town	98.53	16872.12	70621.41	16410.27
Beijing	city	112.55	65966.13	168193.6	48997.12
	town	112.55	28318.89	168193.6	42641.32
Shanghai	city	114.32	70868.19	141203.8	44437.31
	town	114.32	30433.86	141203.8	37503.63
Shandong	city	103.97	42794.1	36633.18	14291.46
	town	103.97	14956.02	36633.18	9949.97
Gansu	city	95.59	30037.02	21952.04	8503.65
	town	95.59	6986.76	21952.04	5198.59
Guizhou	city	82.34	32035.2	14275.36	6307.53
	town	82.34	7121.97	14275.36	3230.5
Nation	city	100	41357.43	39174.03	14038.42
	town	100	12421.08	39174.03	9697.97

Source : 2008 China Statistical Yearbook

In order to take students' hometowns into account, we select Beijing and Shanghai as representatives of developed provinces, Guizhou and Gansu as the undeveloped provinces. Then we calculate the number after taking the national level and urban-rural gap into account.

We obtain average education cultivation cost in subjects of three schools in 2007: 13367 Yuan in finance and economics in JNU, 14297 Yuan in sciences and engineering in SCUT and 17329 Yuan in arts major in XCM.

We can see from the above result that average education cultivation cost for students in sciences and engineering is higher than that in finance and economics due to higher expense in teaching experimental equipments; while arts major is obviously higher than the other two courses as more teachers and per capita land area are needed.

C. *Evaluation of Present Tuition Fee*

We obtain comprehensive satisfaction degrees in three subjects of three schools using the MATLAB programming calculation. They are in the following table Ⅲ.

TABLE III.   COMPREHENSIVE SATISFACTION DEGREES IN THREE DISCIPLINES OF THREE SCHOOLS

Representative regions	Category	Sciences and engineering in SCUT	Finance and economics in JNU	Art discipline in XCM
Guangdong	*city*	0.8127	0.8311	0.8179
	town	0.7840	0.7983	0.7723
Beijing	*city*	0.9071	0.9216	0.9233
	town	0.9031	0.9138	0.9078
Shanghai	*city*	0.8971	0.9084	0.9074
	town	0.8902	0.8964	0.8861
Shandong	*city*	0.8276	0.8059	0.7584
	town	0.7697	0.7478	0.7067
Gansu	*city*	0.7630	0.7381	0.6948
	town	0.6918	0.6747	0.6445
Guizhou	*city*	0.7223	0.6996	0.6639
	town	0.6431	0.6308	0.6126
Nation	*city*	0.8248	0.8028	0.7558
	town	0.7655	0.7436	0.7035

In the table above, resident satisfaction degrees in Beijing and Shanghai are higher than national average level; While in Gansu and Guizhou, resident satisfaction degrees are lower than national average level.In different subjects, people are quite generally satisfied with the tuition fee of sciences and engineering in SCUT, next is finance and economics in JNU, arts major in XCM gets least satisfaction and it conforms to the fact that present society generally thinks tuition fee in arts major is too expensive.

Using the city-town ratio (4.5:5.5), we converse the satisfaction degree in subjects of schools to obtain overall satisfaction degree. After comparing them with the standard value we can obtain comprehensive grade of tuition fee in the table Ⅳ.

TABLE IV.   NATIONAL COMPREHENSIVE GRADE OF SAMPLE SCHOOLS IN 2007

School and Discipline	Finance and economics in JNU	Sciences and engineering in SCUT	Arts Major in XCM
Tuition fee	0.792185	0.77024	0.727035
Comprehensive grade	88	86	81

Finance and economics in JNU gets the highest score—88 points, but it still doesn't reach 90 points. The score of Xinghai Conservatory of Music is quite low, which conforms to the actual situation.

6. Conclusion and Suggestion

Higher education is crucial to the education of high-quality talents, the improvement of national innovative capabilities and the construction of harmonious society. Therefore we must hold fast to the guiding ideology of scientific development view in order to achieve a healthy and sustainable development in education. Although the stipulation of Cost Sharing Mechanism does make higher education develop faster, some contradictions are exposed in management system especially the contradictions in supply and demand of funds which is the bottleneck for the development of China higher education. Therefore, the government has stipulated the policy of sharing and the policy of cost compensation in which tuition fee plays the most important role. Article 55 of the Temporary Act of tuition fee management of colleges and universities also rules that *"the proportion of average tuition fee to average education cultivation cost cannot surpass 25%"*. However, tuition fee in most universities is higher than the standard value so that it brings heavy burden to the family. Therefore, we propose the following suggestions to improve the rationality of tuition fee in higher education.

- Focus on higher education and increase financial allocation
- Expand fund-raising channels and raise educational funds
- Calculate average education cultivation cost accurately
- Follow the fair principle, Price tuition fee by quality
- Respect public opinion and construct hearing system
- Establish supervision mechanism of tuition receipts and expenditures in colleges and universities
- Improve the subsidization system of poverty students

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