



ACL: a Mathematical Model for Assessing the Level of Higher Education in the World Based on Multimodal Data

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ACL :A mathematical model for assessing the level of higher education in the world based on multimodal data

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“The quality of high education is vital to the development of the country” President Obama said in a public speech . As we all know, high education is an important part of further improving the level of civic education beyond secondary education. Therefore, every country attaches great importance to high education and has established its own unique high education mechanism. For a country, a sustainable higher education system can undoubtedly play a positive role in promoting the country’ s economic development and the cultivation of advanced talents. Therefore, in order to judge whether a country’ s high education is healthy and recyclable, we have established a brand-new evaluation system, and based on our evaluation of the high education level of each country, we have put forward some suggestions for improvement.

To this end, we make the following main contributions:

- Here, we set up the ACL [1] (Ability, Crowd, Level) model, in this model, we select eight indicators which is showed below to evaluate the health of higher education. The eight indicators inculde: the number of paper (ACL1), the amount of money spent on each college student as a percentage of GDP per capita (ACL2), the teacher-student ratio(ACL3),GPI-tertiary education(ACL4),gross-enrollment-ratio-in-tertiary-education (ACL5), share-of-students-studying-abroad ,proportion of people with higher education (ACL7), the comprehensive strength of graduates in different countries (ACL8).

- Then,We use fuzzy comprehensive evaluation method (FCEM) to evaluate ACL8 and get the score of each country in this item. Then, Entropy weight method (EWM) and analytic hierarchy process are used to calculate the weight of the eight indicators. After normalizing the eight indicators of each country, the comprehensive score and the indication’s score is calculated, which is used to evaluate the health of higher education of each country. we decided to use the UK as an example to improve it with the ACL model

- Thereafter, We have put forward some suggestions on the lower indicators of British higher education, that is, by improving the lower indicators of the UK in the ACL model to reach a healthy and cyclical level. in particular ,We use the Grey-Verhulst model. The predicted value of the next five years is brought into our model for scoring, and then the predicted value of the policy impact is obtained through our policy impact on specific indicators for evaluating the adjustment growth rate, and the evaluation value is brought into the evaluation system to verify whether our policy is feasible and the effect after implementation.

- Finally, we conducted an in-depth analysis and sensitivity analysis of the ACL model, and carefully considered the feasibility of the UK's policy guidelines to ensure the health and recyclability of the higher education system and we summarize the suggestions made according to the current development characteristics of the UK after Brexit, and focus on the suggestions made and the future development situation.

Keyword: ACL(Ability, Crowd, Level) model, EWM,AHP, Grey-Verhulst ,fuzzy comprehensive evaluation method

Contents

1 INTRODUCTION	2
1.1 BACKGROUND	2
1.2 OUR WORK.....	2
2 SYMBOL TABLE AND ASSUMPTIONS.....	3
2.1 SYMBOL TABLE	3
2.2 ASSUMPTIONS.....	4
3 ASSESSING THE HEALTH OF HIGHER EDUCATION	4
3.1 INDICATOR SELECTION	4
3.2 MODEL BUILDING	6
3.2.2 Model 2: Entropy Weight Method (EWM)	7
3.2.3 Model 3: Analytic Hierarchy Process (AHP).....	8
4. UNITED KINGDOM: HIGHER EDUCATION TO BE BETTER.....	11
4.1 WHY WE CHOOSE UNITED KINGDOM.....	11
4.2 POLICY: FOR A HEALTHY AND RECYCLABLE HIGHER EDUCATION SYSTEM	12
4.2.1 Low enrollment due to high tuition	12
4.2.2 Reasonable allocation of higher education funds.....	12
4.2.3 Male to female ratio	15
5. IMPACTS FOR ACHIEVING SUCH LEVELS.....	17
5.1 THE IMPACT OF HUMAN INTERVENTION	17
5.2 POLICY FEASIBILITY VERIFICATION.....	18
5.2.1 modeling principle of multidimensional grey model GM (1, N).....	18
5.3 ANALYSIS OF THE RESULT	20
6. EQUITY ISSUES	21
6.2 SENSITIVITY ANALYSIS	22
7. STRENGTHS AND WEAKNESSES.....	23
7.1 STRENGTHS.....	23
7.2 WEAKNESSES	23
REFERENCES.....	24

1 Introduction

1.1 Background

In today's fast-developing globalization trend, economic globalization, the flow of knowledge, and the competition for highly educated talents are mutually reinforcing and intrinsically linked. Peter D. Eckel of the American Education Council and Harbin University of Pennsylvania Professor Matthew Hartley believes in his thesis that it is particularly important to establish a healthy and recyclable higher education system in order to cultivate talents who can adapt to the global working environment and have excellent comprehensive qualities. Therefore, we hope to make the current higher education system even better, Improve, establish a higher education level evaluation model and improvement plan based on multiple dimensions.

1.2 Our work

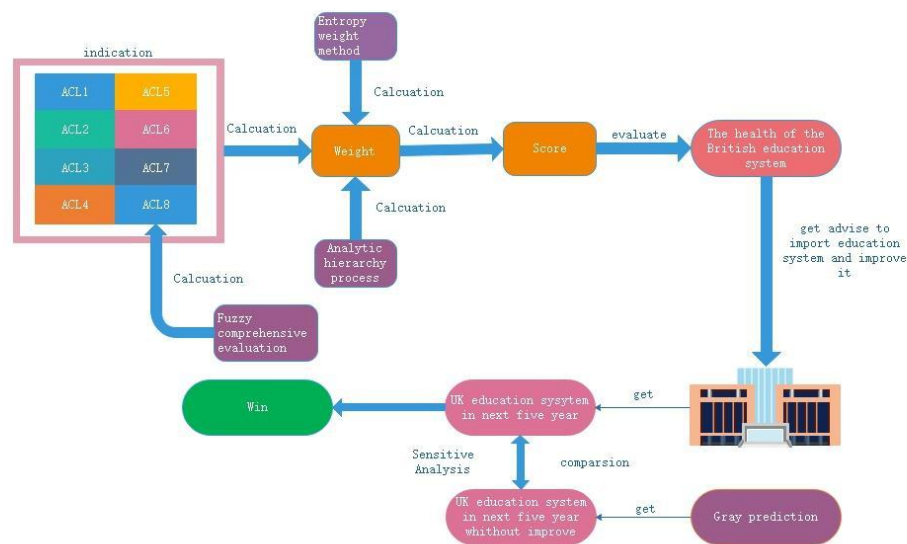


Figure [1]

First, we propose the ACL model, which is established a higher education level evaluation model based on multiple indicators. Specifically, ACL model considers whether a country's higher education system is healthy and sustainable from three perspectives. And scored the higher education system of each country in an ideal way.

Then, We apply the ACL model to a number of countries and ranked 27 of them. We decided to use the UK as an example to improve it with the ACL model.

Thereafter, We have put forward some suggestions on the lower indicators of British higher education, that is, by improving the lower indicators of the UK in the ACL model to reach a healthy and cyclical level in particular. We use the Grey-Verhulst model. The predicted value of the next five years is brought into our model for scoring, and then the predicted value of the policy impact is obtained through our policy impact on specific indicators for evaluating the adjustment growth rate, and the evaluation value is brought into the evaluation system to verify whether our policy is feasible. And the effect after implementation.

Finally, we conduct an in-depth analysis and sensitivity analysis of the ACL model, and carefully considered the feasibility of the UK's policy guidelines to ensure the health and recyclability of the higher education system. And we summarize the suggestions made according to the current development characteristics of the UK after Brexit, and focus on the suggestions made and the future development situation

2 symbol Table and Assumptions

2.1 symbol Table

Symbol	Definition
ACL1	The number of paper
ACL2	The amount of money spent on each college student as a percentage of GDP per capita
ACL3	the teacher-student ratio
ACL4	GPI-tertiary-education
ACL5	gross-enrollment-ratio-in-tertiary-education
ACL6	Share-of-students-studying-abroad
ACL7	Proportion of people with higher education
ACL8	The comprehensive strength of graduates in different countries
U	Factor set
V	Comment set
R	Fuzzy evaluation results
w _j	Weight of index I
S	Comprehensive score of Higher Education
x ⁽⁰⁾	the original data series of UK from 2010 to 2018

2.2 Assumptions

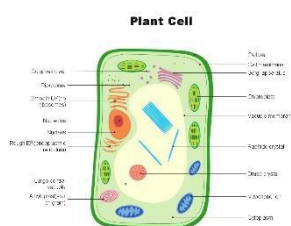
- We assume that all the data we get are correct
- We assume that the higher education indicators of 27 countries selected by us can reflect the higher education level of all countries in the world
- We assume that COVID-19 will not affect the effectiveness of our recommendations.

3 Assessing the health of higher education

3.1 Indicator selection

Considering we have to assess the health of any nation's system of higher education. we set up the ALC model, in this model, we select eight indicators and use the Entropy Weight Method (EWM) , Analytic Hierarchy Process (AHP) and fuzzy comprehensive evaluation(FCE) to build the model for evaluating the health of higher education.

1, The number of paper (ACL1)



The main purpose of higher education is to cultivate scientific and technological talents. Therefore, an important indicator of the health of higher education in a country is whether it can produce a large number of scientific and technological talents for the society. we use the number of papers to quantitatively measure the contribution of a country's higher education for the development of science and technology.

2, The amount of money spent on each college student as a percentage of GDP per capita (ACL2)

The more money a country spends on each college student, the more importance it attaches to higher education. However, bigger is not always better. The bigger indicator also reflects another phenomenon which is very difficult to support a person to go to college for



ordinary family, so it is also an intermediate index.

3, the teacher-student ratio (ACL3)



whether the higher education can train outstanding students, another key factor is the teacher-student ratio, teacher training is very important to students. The higher teacher-student ratio means that teachers can give students more guidance

4. GPI-tertiary-education(ACL4)

Ratio of female to male net enrolment ratio for tertiary education. It is calculated by dividing the female value for the indicator by the male value for the indicator. In some country the girl go to the University is not easy. The index reflects whether higher education in this country is equal for men and women .



5. gross-enrollment-ratio-in-tertiary-education (ACL5)



This index reflects the popularization level of higher education. In the past, only the elite could receive higher education. The larger the index, the higher the quality of the people, which means that more and more people have the opportunity to change their class status through education.

6, Share-of-students-studying-abroad (ACL6)

The higher education level of a country is, the more international students it attracts. Therefore, the number of international students in a country can be used to evaluate the education level of a country



7, Proportion of people with higher education (ACL7)



The proportion of higher education in the total population reflects the history of higher education in this country. The longer the history of higher education in a country is, the more mature the system of higher education is, and vice versa

8, The comprehensive strength of graduates in different countries (ACL8)

We invited some parents of students to evaluate the education in our country, and got the corresponding scores by using the fuzzy comprehensive evaluation method

3.2 Model building

We have collected eight indicators from 24 countries, covering developed countries, developing countries and backward countries, covering five continents and four oceans, which can basically represent the higher education level of all countries in the world. We use the fuzzy comprehensive evaluation method to evaluate the comprehensive ability of graduates receiving higher education. Such evaluation often requires comprehensive consideration of multiple indicator factors, using the existing comprehensive quality evaluation system of students, and combining with the characteristic indicators of international training. Evaluation; At the same time, appropriate consideration should be given to the rationality and stability of the evaluation system design.

3.2.1 Model 1: Fuzzy comprehensive evaluation method (FCEM)

We use the fuzzy comprehensive evaluation method to evaluate the comprehensive ability of graduates receiving higher education. Such evaluation often requires comprehensive consideration of multiple indicator factors, using the existing comprehensive quality evaluation system of students, and combining with the characteristic indicators of international training. Evaluation; At the same time, appropriate consideration should be given to the rationality and stability of the evaluation system design.

We build an analytic hierarchy process model, using 15 indicators to analyze the ability of graduates in a country and get the weight of the corresponding indicators

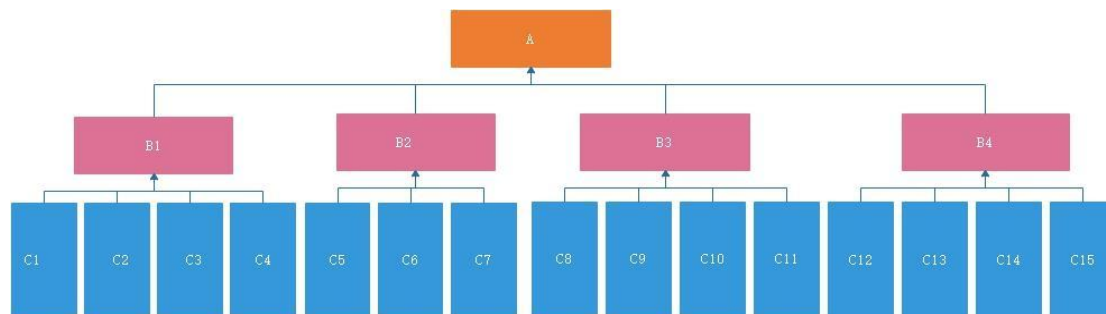


Figure [2]

Table [1]

A(1 st indices)	B(2 nd indices)	C(3 rd indices)
	Sense of Worth(B1)	Citizens' moral consciousness(C1) international competition consciousness(C2) social responsibility consciousness(C3)

The comprehensive ability Of graduates in Different countries(A)		innovation and exploration consciousness(C4)
	Potential Quality(B2)	professional learning ability(C5) theory application ability(C6) team cooperation ability(C7)
	Knowledge And skill(B3)	foreign language basic skills(C8) cultural knowledge reserve(C9) interpersonal skills(C10)
		international communication ability(C11) organizational leadership(C12)
	Practical Innovation Ability(B4)	independent thinking ability(C13) critical innovation ability(C14) psychological endurance ability(C15)

We use the “yaaph” software and get the weigh of 15 indication ω_i (i from 1 to 15).Let

$$U = \{\omega_1, \omega_2, \omega_3, \omega_4, \omega_5, \omega_6, \omega_7, \omega_8, \omega_9, \omega_{10}, \omega_{11}, \omega_{12}, \omega_{13}, \omega_{14}, \omega_{15},\} \quad (1)$$

Comment are very good v_1 ,good v_2 ,average v_3 ,poor v_4 ,very poor v_5 .Let

$$V = \{v_1, v_2, v_3, v_4, v_5\} \quad (2)$$

We calculate the matrix synthesis by formula:

$$R = U \cdot V \quad (3)$$

We take evaluation with the largest value as the comprehensive result.

3.2.2 Model 2: Entropy Weight Method (EWM)[2]

Data preprocessing

When we study the eight indicators, we learn that they should be divided into two types (the big types and the middle type). The bigger types which mean the bigger the indicator is (such as ALC1,ALC3,ALC5,ALC6,ALC7,ALC8), the bigger the score is. The middle type which mean the more intermediate the indicator is, bigger the score is (such as ALC2, ALC4).

For the big type:

$$b_{ij} = \frac{a_{ij} - a_{min}}{a_{max} - a_{min}} \quad (4)$$

For the middle type:

$$b_{ij} = \frac{|a_{ij} - a_{best}|}{a_{max} - a_{best}} \quad (5)$$

The a_{ij} and b_{ij} mean the initial value and normalized value of item j about the i country, a_{\min} and a_{\max} represent the minimum and maximum value of item j in all country, a_{best} mean the value is the best for middle indicator.

Weight calculation

Firstly, we calculate the probability j index about the i country, soon we get the probability matrix

$$p_{ij} = \frac{b_{ij}}{\sum_{i=1}^n b_{ij}} \quad (6)$$

Secondly, According to Canon and his information theory, the more uncertain the information is, the greater the corresponding entropy is. The calculation formula of information entropy is as follows:

$$H_j = -\ln(n)^{-1} \sum_{i=1}^n p_{ij} \ln(p_{ij}) \quad (7)$$

Thirdly, we define the information utility value. The larger the information utility value is, the more information is. We normalize the information utility value to get the index weight.

$$\omega_j^1 = \frac{1-H_j}{n-\sum_j^1 H_j} \quad (8)$$

3.2.3 Model 3: Analytic Hierarchy Process (AHP)[3]

Correction of weight

If variation of the index If variation of the index is bigger, the corresponding index weight is bigger. Among the eight indexes, the weight of the number of papers is the biggest. we calculate that its weight is close to 0.35. This seems unreasonable. In order to eliminate the unreasonable weight which influence the result of evaluation, we use the analytic hierarchy process to calculate the weight ω_j^2 . The final weight score is

$$\omega_j = \omega_j^1 + \omega_j^2 \quad (9)$$

Establishment of hierarchical structure

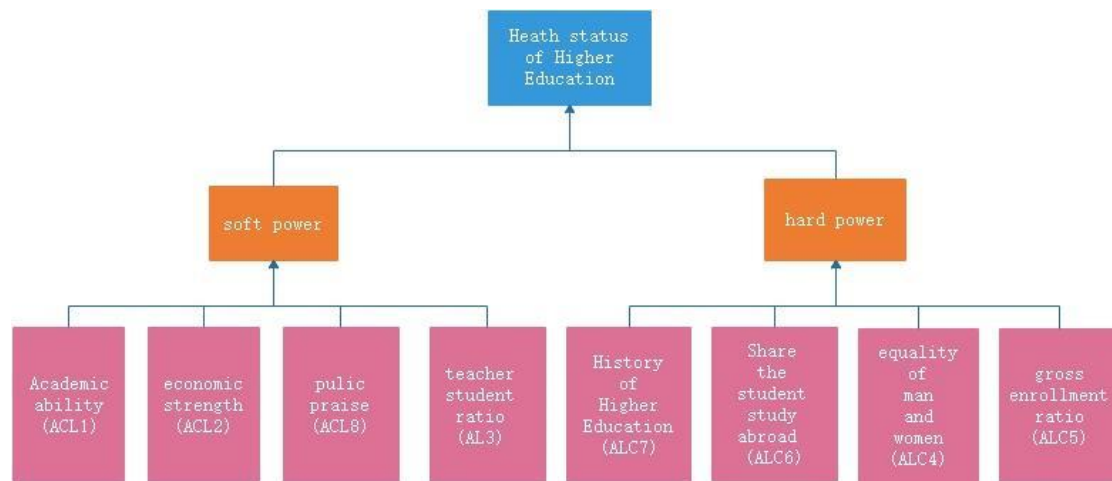


Figure [3]

Constructing judgement matrix

1, Scheme layer

We establish the initial Comparative Matrix for soft power and hard power by comparing the importance of eight items

	ALC2	ALC1	ALC8	ALC3
ALC2	1	4/3	2	4
ALC1	3/4	1	3/2	3
ALC8	1/2	2/3	1	1/2
ALC3	1/4	1/3	2	1

Table [2]

	ALC5	ALC4	ALC7	ALC6
ALC5	1	4/3	2	4
ALC4	3/4	1	3/2	3
ALC7	1/2	2/3	1	1/2
ALC6	1/4	1/3	2	1

Table [3]

2, Criteria layer

Here we think that soft power and hard power are equally important so we get the Comparative Matrix in show below

Table[4]

	Soft power	Hard power
Soft power	1	1
Hard power	1	1

The consistency checking

Using the sum-product method to find the largest eigenvalue γ_{max} and the eigenvector of the comparison

$$\gamma_{max} = \frac{1}{n} \sum_{i=1}^n \frac{(M\omega)_i}{\omega_i} \tag{10}$$

Calculate the CI :

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{11}$$

Calculate the CR :

$$CR = \frac{CI}{RI} \tag{12}$$

The values of RI show below:

Table[5]

n	1	2	3	4	5	6	7	8	9
R1	0	0	0.58	0.9	1.12	1.24	1.31	1.41	1.45

When $CR < 0.10$, the results have great consistency and the results are acceptable

We calculate the weigh about $\omega_j^1 \omega_j^2$ and get the values of ω_j by using Matlab software show below

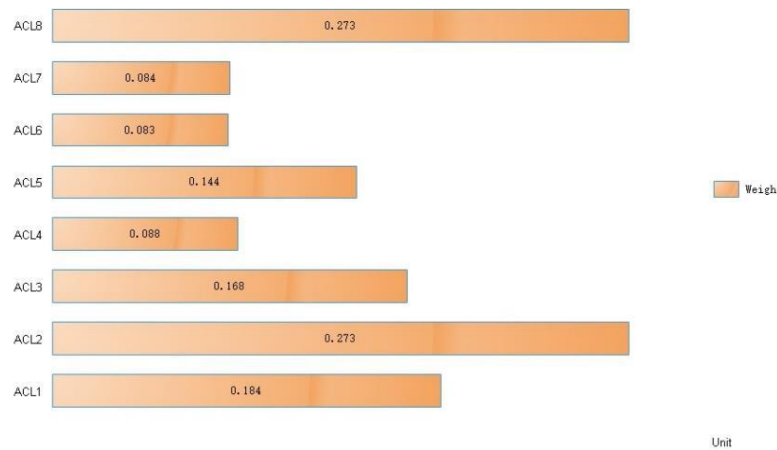


Figure [4]: The weight of indicator

we use the formula show below and get the scores of 27 country[4]

$$S_i = \sum_{j=0}^8 100 * b_{ij} * \omega_j \tag{13}$$

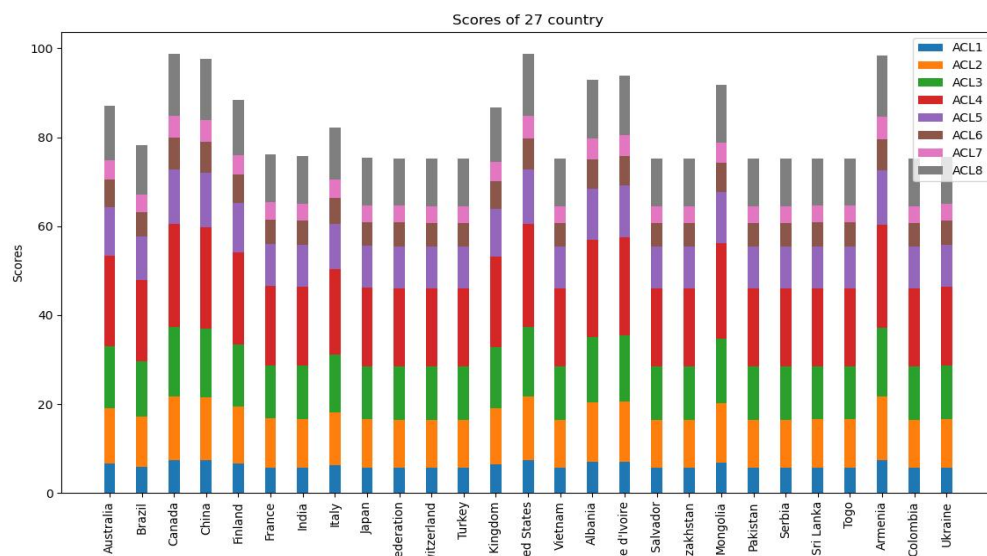


Figure [5]

4. United Kingdom: higher education to be better

4.1 Why we choose United Kingdom

We applied the above model to multiple countries to evaluate them and got their higher education health scores. Among them, we found a special country through the chart: the United Kingdom. The academic level of the UK (academic achievements including: number of patents, number of papers and number of citations) is among the best in the world. The number of international students studying in the UK is even among the best. The government also has ample funding for university construction, but the UK accepts higher education. The number of students in the country is very small (43 in the ranking countries) and the ratio of male to female students is seriously imbalanced, and the number of females is higher than that of males (gender parity index 5.6); such a deviation is extremely unhealthy. Therefore, we decided to conduct research on the British higher education system in order to make the higher education system more perfect and give policy recommendations.

4.2 Policy:For a healthy and recyclable higher education system

4.2.1Low enrollment due to high tuition[5]

The Second World War accelerated the decline of Britain. "Britain's overseas investment has decreased by a quarter, and its foreign debt has increased by 3 billion pounds. It has become a debtor country." Faced with such a challenge, the Conservative Party and the Labour Party reached a consensus. The first "welfare state". Providing the public with free education as a public service is one of the hallmarks of the welfare state. However, in September 2010, the British Parliament passed a bill to increase the maximum tuition fee for universities from £3,000 to £9,000, which will be implemented in 2012.

We believe that a better plan to solve this problem is to implement a "study before pay" policy and implement differentiated fees. The policy stipulates that tuition fees shall be paid by the government in the form of loans. Students do not need to pay tuition in advance. The starting point for loan repayment has been raised from the graduate's annual income of £15,000 to £21,000. The repayment period was extended to 30 years. Different amounts of loans and living allowances are set for the family residence, study time, loan purpose, the nature of the selected major, and the type of school. We advocate expanding the size of UK higher education institutions, thanks to our policy of postponing tuition payments,

4.2.2Reasonable allocation of higher education funds[6]

In the "Dearing Report" promulgated by the United Kingdom (The Dearing Report), the National Higher Education Commission and other Education Investigation Commissions have made the latest definition of "higher education", pointing out that the scope of higher education is: 0 (1) Non-compulsory education. That is to receive any stage of education after the compulsory education stage in the UK. (2) Adult education. That is, higher education, continuing education and adult education received after 18 years old in the UK. (3) Education above high school level. That is to say, all British education that meets or exceeds the third level of national education (that is, higher than A-level and the National Advanced Vocational Qualifications (GNVQ)). @And the "Dearing Report" defines higher education as a broad higher education, mainly Refers to post-secondary education, covering general higher education, continuing education, adult education, training education and special education. However, the British higher education studied in this article refers to higher education in a narrow sense, which refers specifically to general higher education, that is, the British higher education institutions and The education of students by multi-technical colleges. The United Kingdom (the United Kingdom

Kingdom) is composed of four parts: England (England), Scotland (Scotland), Wales (Welsh) and Northern Ireland (Northern Ireland), but the United Kingdom Of colleges and universities are mainly concentrated in England. The development of higher education began in England and then expanded to Scotland, Wales and Northern Ireland. According to statistics, the United Kingdom has a total of 169 universities and colleges, of which 132 are located in England. Therefore, this The research content of the paper is mainly aimed at the market-oriented reform of the allocation of financial resources for higher education in England. However, if there are differences in different regions and in some specific research content, higher education in several other regions will also be mentioned. The market-oriented reform of the allocation of financial resources. In short, the main body of higher education in the UK in this article is higher education in England, but if necessary, it will involve the allocation of financial resources of relevant higher education institutions in other regions of the UK

My suggestion for this is to establish a Higher Education Fund Committee and the review committee is to allocate funds to higher education institutions. The Higher Education Fund Committee is a non-governmental public executive department initiated by the British Ministry of Education to allocate higher education financial resources to higher education institutions, To promote high-quality teaching and research development.

The procedures and models of the allocation of financial resources for higher education in the UK mainly have five characteristics: (1) Transparency. The procedures and methods for the allocation of higher education financial resources are clear and open, and all data used in the allocation can be searched and audited. (2) Predictability. The methods and parameters of higher education financial resource allocation can be predicted, so that in emergencies, can respond in time and take emergency measures to ensure the timely allocation of financial resources. (3) Fairness. The government and the Higher Education Fund Committee have a sufficient and detailed understanding of the specific conditions of all higher education institutions. Because of the differences in the conditions and specific needs of each university, there is also a certain difference in the allocation of financial resources. Opposite sex. (4) High efficiency. The clear division of responsibilities among higher education institutions, the fixed allocation of financial resources, the calculation method and the accountability system, effectively ensure the efficiency of the allocation. (5) Flexibility. Its financial resource allocation model has a strong rigidity, while also leaving a certain degree of flexibility. This flexibility is specifically used to respond to external policies and the strategic needs of higher education fund members' own development policies.

In order to calculate the amount of funds for high-cost subjects. Its calculation formula is as follows:

Expenses for high-cost subjects = subject subsidy ratio by group × number of full-time students × conversion factor

The first step is to determine the allocation amount of each group in the Research Excellence Framework (ResearchExcelFramework, REF). Among them,

the first stage is based on the quality characteristics of each sub-configuration module in the research excellence framework to determine the weight, the second stage is based on the number and quality of each sub-configuration module group in a proportional distribution, and the quality level of the group weight is to reflect different subjects

relative cost of the research; then the total funding is allocated to each evaluation team and each higher education institution. The flowchart is as follows:

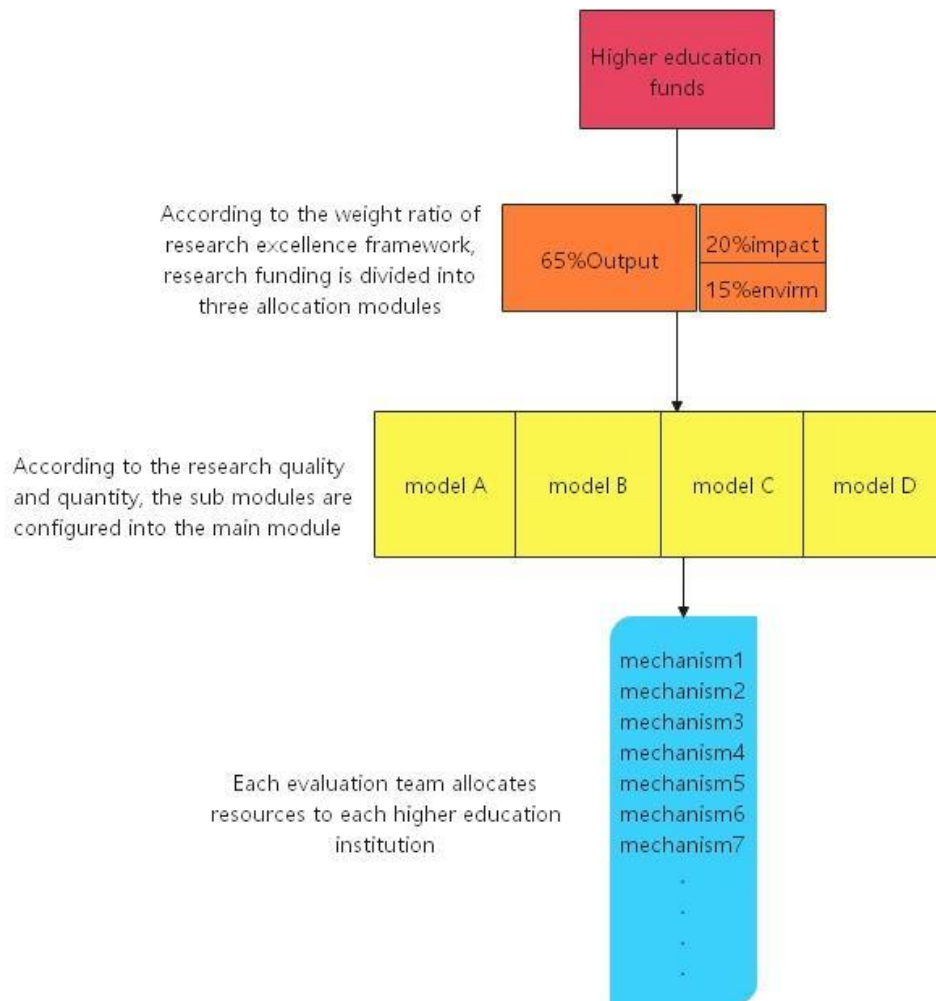


Figure [6]

Review Committee The British Higher Education Quality Assurance Agency has introduced performance management theory in the allocation of financial resources, and is committed to guaranteeing and evaluating the standards and quality of British higher education.

4.2.3 Male to female ratio [7]

Generally speaking, the gender gap in British higher education admission opportunities has shown a narrowing trend, and the degree of gender equality has been greatly improved. The situation where boys had far more opportunities than girls in the past has been reversed. Now, whether undergraduate or graduate, the disadvantaged position of boys is becoming more and more obvious. As a result, the current situation of more women than men in higher education has become a new problem. Therefore, at this stage, in addition to considering the fairness of opportunities for girls in higher education, it is also necessary to pay attention to the situation that boys are in a disadvantaged position in obtaining higher education opportunities, and to analyze the reasons for the reversal of male gender opportunities. The reasons for the obvious advantage of women's opportunities in higher education can be traced back to the compulsory education stage in contemporary Britain. A large number of studies have confirmed that generally, there is no difference between the sexes in terms of intelligence, but both sexes have their own strengths. Girls have more advantages in literacy and language expression, while boys have better abilities in spatial and math tests. The compulsory learning, literacy and language skills are usually the basis and medium of learning various subjects, so girls are more likely to achieve good academic results. With the enactment of the "Education Reform Act of 1988", the United Kingdom has implemented a unified curriculum and unified quality monitoring of key sections in the compulsory education stage, and all students have to take the unified examination. [2] And in terms of school education, curriculum design, teaching implementation and academic evaluation all adopt a uniform and gender-free approach. These characteristics of elementary education are more suitable for girls, so that their performance is usually better than boys in all aspects. Judging from the results of taking the GCSE and A-level examinations in recent years, girls have always maintained an advantage in academic performance. For example, in 2007, 65% of girls reached 5+ A *-C GCSE or equivalent, compared with 55.8% of boys. Girls are also more likely to continue full-time education at age 16 (82% of girls and 72% of boys). Girls have a higher chance of reaching A level than boys, and the higher the test level, the higher the proportion of girls and the higher the test pass rate than boys[9].

Establish a number of higher education institutions focusing on science and engineering majors to expand the number of enrollment for men.

Research find that Men are both dumber and smarter than women. Using several different measures of intelligence including IQ and SAT scores, more men are found in the high and low tails. Women . The proportion of women with intermediate achievement is more than men. The fact is showed below[8].

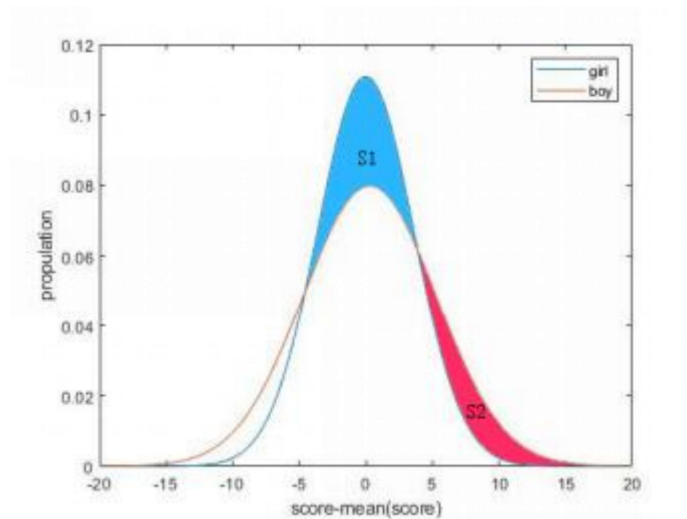


Figure [7]

We think that when the number of university students is relatively small, the passing line is higher. At this time, the male students are in the majority. With the increase of the number of university students, the passing line decreases year by year. At this time, the university gradually are the female in majority

We draw the picture to show the relationship about Female than men (y) and gross-enrollment-ratio-in-tertiary-education(x).

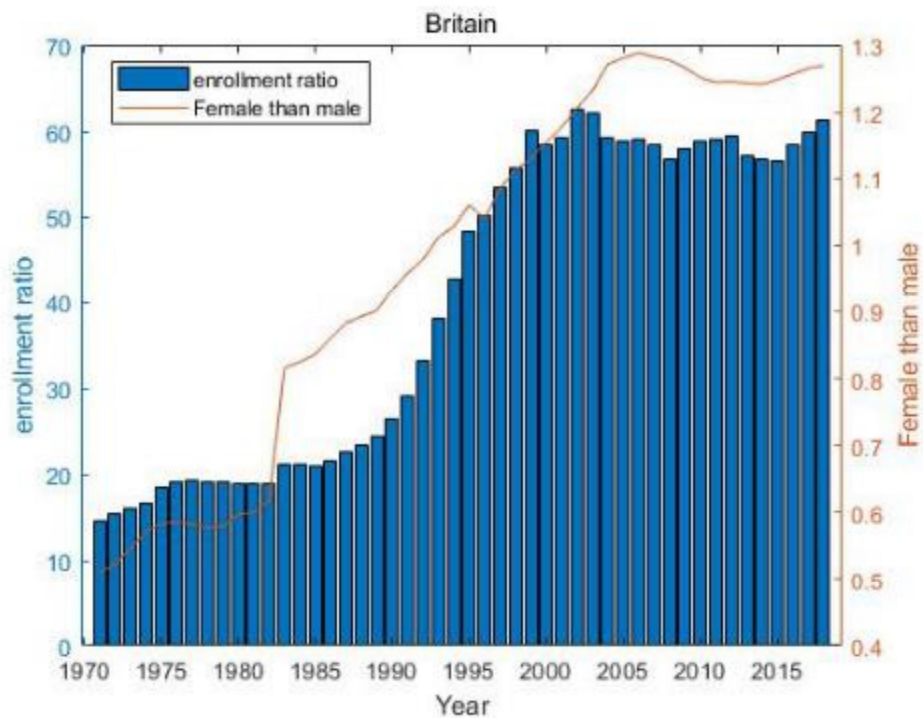


Figure [8]

We analyze the female male enrollment ratio and the higher education enrollment rate in the UK, and find that they have positive correlation between them.

The Pearson correlation coefficient (R^2) is equal to 0.94 and $p < 0.01$.

We use linear regression to fit the two variables and get the linear relationship about y and x. (Adjusted R-Squared 0.896, p-value = 1.77e-24)

$$y = 64.161x - 22.681 \quad (15)$$

We can know that the linear relationship is not strictly tenable. With the increase of enrollment' s ratio, boys with poor performance will have the opportunity to enter the University which will decline the ratio of Female than male in the University.

5. Impacts for achieving such levels

5.1 The impact of human intervention

We take the UK as the research target, through the data of the British National Bureau of statistics and the world bank, as well as the relevant reports on the development of education in the UK, and put forward countermeasures for the healthy development of education in the United States, which can be roughly divided into the following three categories

- Intervention 1: The government should set up reasonable tuition fees to find a balance point, and grant after enrollment
- Intervention 2: 2022.---My suggestion for this is to establish a Higher Education Fund Committee and the review committee is to allocate funds to higher education institutions
- Intervention 3: 2023 - set up a polytechnic college, which is more inclined to admit male students (because male students have slightly stronger thinking in science than female students), so as to improve the number of male students‘
- Intervention 4: 2024 - find the balance between the number of students enrolled and the ratio of men to women



Figure [9]

We analyzed the impact of these interventions on our model as shown in the table below :

Table [6]

intervention	Impact indicators
Intervention 1	Enrollment rate
Intervention 2	Enrollment rate Teacher student ratio
Intervention 3	gender parity index (GPI) Enrollment rate
Intervention 4	gender parity index (GPI)

5.2 Policy feasibility verification

Here, we use grey prediction to predict the original 7 data, and finally bring them into the model for solution to get the predicted value which is not interfered by our suggestions. Then we carry out prediction on the 8 data after our policy intervention and bring them into the evaluation model for scoring, and compare the results to verify the feasibility of the model

5.2.1 modeling principle of multidimensional grey model GM (1, N)

Gray system seeks its change rule through the arrangement of original data, which is a way to explore the realistic state of data, namely the production of grey

sequence. The multi-dimensional grey model GM (1, N) is a multi-dimensional grey model with first-order n variables. The behavior factor x_1 is affected by n-1 action factor x_i

We define it $x^{(0)}$ is the original data series of UK from 2010 to 2018

$$x^{(0)} = x_1^{(0)}, x_2^{(0)}, \dots, x_n^{(0)} \quad (16)$$

And then we get the whitened equation:

$$\frac{dx^{(0)}}{dt} + ax^{(0)} = b \quad (17)$$

$X^{(1)}$ is the cumulative generating operation sequence of $X^{(0)}$.

Then we use the least square method (OLS) to obtain parameters a and b as:

$$\hat{a} = (B^T B)^{-1} B^T Y \quad (18)$$

among

$$B = \begin{bmatrix} -z_2^{(1)} & 1 \\ -z_3^{(1)} & 1 \\ \dots & \dots \\ -z_n^{(1)} & 1 \end{bmatrix} \quad Y = \begin{bmatrix} -x_2^{(0)} \\ -x_3^{(0)} \\ \dots \\ -x_n^{(0)} \end{bmatrix} \quad (19)$$

$$z_k^{(1)} = 0.5 (x_k^{(1)} + x_{k-1}^{(1)}) \quad (20)$$

The respective time response sequence of the model is:

$$\hat{x}_{k+1}^{(1)} = \left(x^{(0)}(1) - \frac{b}{a} \right) e^{-ak} + \frac{b}{a} \quad k = 1, 2, 3 \dots n \quad (21)$$

We can get to $\hat{x}_{k+1}^{(1)}$ and then we can subtract to get to $\hat{x}^{(0)}$

$$\hat{x}_k^{(0)} = \hat{x}_k^{(1)} - \hat{x}_{k-1}^{(1)} \quad (22)$$

To test the model, we define the grey prediction sequence as:

$$\hat{x}^{(0)} = \{ \hat{x}_1^{(0)}, \hat{x}_2^{(0)}, \hat{x}_3^{(0)} \dots \hat{x}_n^{(0)} \} \quad (23)$$

Residuals can be obtained:

$$e = x^0 - \hat{x}^0, k=1, 2, \dots, n \quad (24)$$

5.3 Analysis of the Result

Assuming that there is no government policy intervention, we forecast seven education evaluation indicators in the UK through grey prediction, and the predicted values in the next five years are shown in the table below

Table [8]

year	ACL5	ACL2	ACL6	ACL4	ACL3	ACL1
2021	60.425433 3	23.7643203 7	1.07750034 3	1.24170005 3	15.359 58	99144. 92
2022	60.732547 8	31.5719299 3	1.00680700 5	1.24882996 1	14.899 43	984520 .1
2023	61.765347 5	35.9362716 7	1.15985001 1	1.25672996 1.26531004	14.863 89	99428. 13
2024	60.934675 3	37.7475013 7	1.17775003 4	1.26531004 9	14.559 58	95680. 09
2025	61.896745 4	35.6332283	1.16080700 5	1.26930999 8	13.954 41	99716. 02

Through the analysis of the impact of policies on the indicators, we will increase the predicted growth rates of the gross enrollment rate, the percentage of higher education expenditure in government expenditure by 3% and 5% respectively, and the number of gender equality is closer to one. The predicted values of the indicators affected by policies are shown in the figure below

Table [9]

year	ACL5	ACL2	ACL6	ACL4	ACL3	ACL1
2021	60.5254333 2	27.3443503 2	1.07750034 3	1.14170005 3	15.659 58	99150.92
2022	60.9325478 3	32.7519329 3	1.00680700 5	1.14882996 1	15.899 43	985520.1
2023	61.9653475 7	36.0062816 7	1.15985001 1	1.15672996 1.16531004	15.963 89	99528.13
2024	61.9346753 7	38.5475621 7	1.17775003 4	1.16531004 9	16.059 58	95780.09
2025	62.1967454	38.2332283	1.16080700 5	1.06930999 8	14.954 41	99916.02

More clearly observe the effect of the impact through the chart

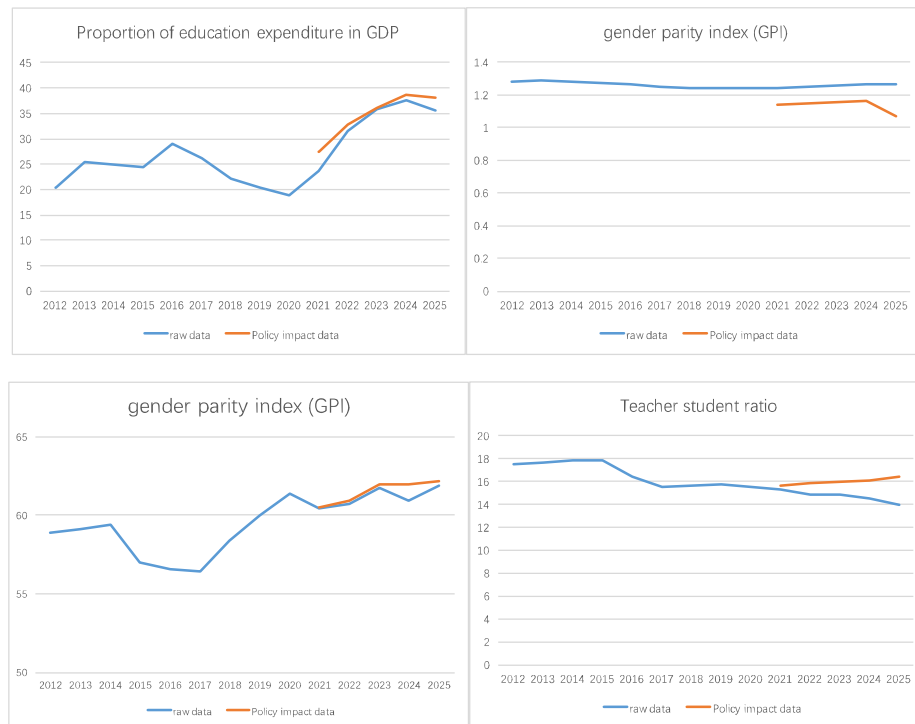


Figure [10]

The comprehensive scores of the two groups are 74.49258324 and 77.56348223 respectively, which shows that our policy recommendations are effective. In an ideal situation, our policy can achieve the desired effect and realize our ideal blueprint.

In the early stage of implementation, our policy will help children from ordinary families have more opportunities to receive higher education. However, the fact is that the government expenditure is a big problem. Students and teachers in the transitional stage of higher education can get better resources, while the proportion of boys in higher education will increase appropriately. But in fact, the policy will cause widespread social controversy, and the possibility of implementation needs to be considered. In the later stage of implementation, the health index of education in the UK has increased significantly, the proportion of social talents has become more coordinated, the proportion of teachers and students has been balanced, the academic environment has become better, and the overall level of education has been greatly improved.

6. Equity Issues

6.1 An improved approach

The accountability system can be used when supervising higher education institutions, which mainly includes the following three points.

First, through cost accounting, the use of funds for universities can be made transparent. The Higher Education Fund Committee published a report on the

“Transparency Review of Higher Education Funds” from 1998 to 1999, established a joint steering group for cost accounting and pricing, and designed a cost transparent accounting algorithm. In this way, the dialogue and exchanges with the university are strengthened, which not only meets the accountability requirements of the university, but also facilitates its development.

Second, through teaching and research quality assessment activities, university stakeholders can obtain quality information. Burton Clark proposed three main forces that influence the higher education system: the state, the market, and academic authority. Under the influence of academic authority, the quality of higher education in the UK is generally controlled internally by universities. Since the 1970s, state and market intervention has gradually strengthened. The government no longer trusts the internal quality assurance of universities and began to build and improve a new assurance system.

Third, through the performance management of colleges and universities, the public and stakeholders can obtain performance information. Performance management was introduced into the management of colleges and universities, began to pay attention to the results and output of college education, and through the quantitative evaluation of the results of colleges and universities and all aspects of school work, it provided an effective means for colleges to understand their own school benefits and status.

6.2 Sensitivity analysis

In task 5, we use grey prediction to get the specific values of the UK enrollment rate, GPI and the number of papers from 2021 to 2025 without implementing any policies. After using our policy to improve the British higher education system, we find that the situation of English higher education has been greatly improved than before. But the reality is changing so much that we can't predict the future. Here, we draw the confidence intervals of three indicators: GPI and the number of papers and the Enrollment rate from 2021 to 2025 without implementing any policy. Confidence intervals represent possible future changes. It is found that although our proposed improvement measures can't exceed the best results in the future in some area. However, in most cases, especially considering the impact of COVID-19 on British education, our model has significantly improved the British education system.

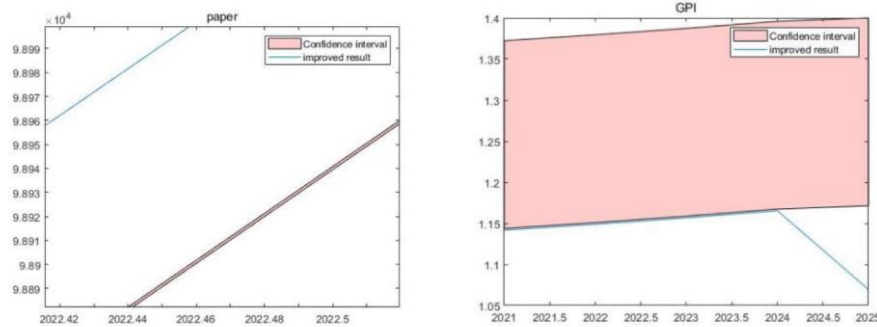


Figure [11]

7. Strengths and Weaknesses

7.1 strengths

- We use 27 countries with different development status to build the model, which makes the model more universal
- We use AHP and entropy weight method to calculate the weight of each index, making the weight more reasonable
- For qualitative indicators such as (ALC8), we use fuzzy comprehensive evaluation method to define it to make the indicator more reasonable

7.2Weaknesses

- AHP is a semi quantitative method, and the determination of weight is influenced by personal subjective concept.
- The information entropy of ACL1 is relatively large, which leads to its weight far greater than other indicators.

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