

# The evaluation system and development strategies for a country's higher education

## Summary

Higher education determines the future development potential of a country. At this stage, the diverse and complex education systems of various countries make people more concern about how to evaluate higher education of a nation in a unified standard. The article establishes an evaluation system to score higher education system of a nation, and formulates sustainable policies to help the nation further improve its own higher education.

In the first part, we construct our evaluation model based on the TOPSIS method. After quantifying the various evaluation indicators from the education aspect, we select five evaluation indicators, which are the most representative, to examine the education system. First, the data is transformed into the maximal values to obtain the feature matrix. Second, we standardize the matrix and calculate the relative distance between the optimal solution and the worst solution. Finally, we can get the score by calculating the similarity to the worst condition. The model we construct gives scores for the 10 countries. Among them, Britain, Japan, the United States and other developed countries get high scores. We notice that as a developing country, Indian score is 50% lower than that of the United Kingdom. We provide a reasonable explanation for the scores of Indian five indicators based on the state of India.

In the second part, we formulate a set of sustainable development policies to improve higher education of India. In our first model, Indian performance in the five indicators we select is much lower than the two developed country: the United States and the United Kingdom. We have formulated five innovative policies based on the specific national conditions of India to improve these five aspects. Inspired by the natural water cycle, the five policies we propose build five cycles between Indian fast-developing economy and a healthy higher education system. The five policies have improved the gender ratio, higher education awareness, education funding, education internationalization and private higher education system. Those improvements will enhance the five indicators in our first evaluation model. To be further, the talents cultivated by those improvements will help India to accelerate economic growth. The economic improvement means that there will be more government budgets to continue supporting the five policies which we have formulated. This forms a virtuous cycle and ensures our policy to be sustainable.

In the last part, we look forward to the prospects of the policies we proposed. In the current world environment where the pandemic is raging, the effective implementation of policies is still very difficult, and the actual effects are probably difficult to live up to our expectations. So there is still a long way for our policy implementation to go.

**Keywords:** higher education;TOPSIS;India; cycle system

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# 1 Introduction

## 1.1 Background

*“Ensuring quality in higher education is one of the most important things we can do for future generations.”*  
—Ron Lewis

What is higher education? When a group of youth who are curious about the world and tirelessly about the light of truth gathers at Plato Academy studying philosophy with great concentration, it is the germination of higher education. Today, from elite education to mass education for which we are still working hard, intellectuals emerging from higher education have become the solid pillars of this society, and the flame of scientific research it burns illuminates the forward direction of the times. Higher education is undoubtedly the driving force of society. However, the outbreak of coronavirus pandemic in 2020 has drawn a few cracks in the fixed model. This also drives us to constantly think about: what model and change will be more suitable to the changing world and will play a greater role.

## 1.2 Statement of the problem

The problem aims to make us develop and verify a model or a set of models so that people who use the model can more conveniently and accurately assess the health of higher education in any nations, and apply the model to several nations to evaluate higher education of these systems.

First, we notice that the main evaluation target of the system we will construct is whether the nations higher education system is healthy and sustainable, instead of the brilliant research findings and high quality educational resources it has at this time. Abundant research achievements and premium educational resources is important, but it is not a necessary and sufficient condition for an education system to be healthy and sustainable. We believe that a higher education system to be healthy and sustainable is the result of multiple effects, which are obviously gray. Therefore, when evaluating it, we should try to choose relatively representative evaluating indicators. While the model is required to be applicable to any nation and region, the selection criteria should grasp the problem from a more macro perspective eliminating the interference of regional factors as much as possible.

On the current social situation, we do not have a relatively uniform standard to depict an absolutely healthy and sustainable educational system. We can only find a relatively better higher education system based on the existing data and the reality as the standard, which makes us only get the criteria based on the comparison among the countries participating in the judgment. And it is difficult for us to know which nation has a healthy and sustainable higher education system before it is verified. In that case we abandon the use of deep learning or machine learning methods for the lack of reliable data samples to train the model. After synthesizing the characteristics of the above problems, we decided to use the TOPSIS scoring model to solve the problems.

## 1.3 Our work

In order to construct a model that can be used to assess the health of any nation's higher education system, we have established an entire feedback loop for analysis. The core point of the entire loop is the selection of evaluation indexes, and what we do is based on the selected indexes, through the

formulation of policies to affect the specific values of indicators. The changes of indicators will give feedback to the society. Such kind of feedback will be manifested through its impact on the national economy, which will once again affect the policy formulation.

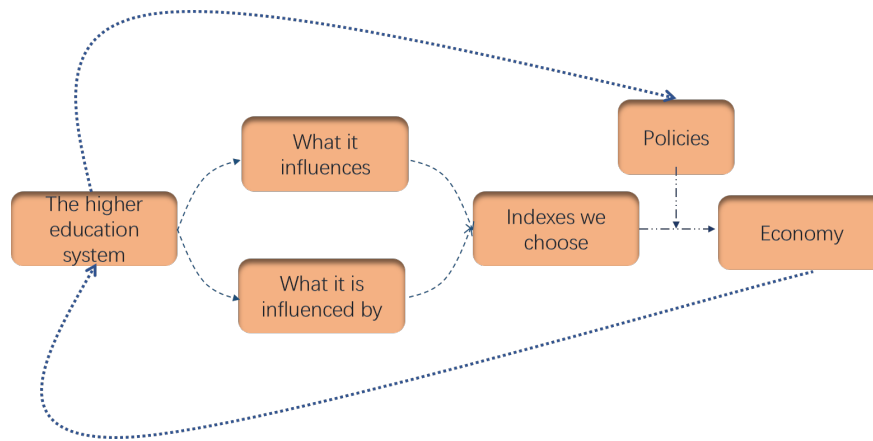


Figure 1: The mind map

## 2 Base model analysis

### 2.1 Notations

Symbol	Description
PEG	The proportion of total expenditure on higher education to GDP
RMF	The ratio of males to females in higher education including teachers and students
PIE	Proportion of international students in higher education
PP	Proportion of the population with higher education
PER	Private school enrolment rate

### 2.2 Parameter selection

- PEG: Through the indicator of the proportion of total expenditure on education in higher education to GDP, we can get to know the input scale and intensity of the local government in higher education, but we also notice that the indicator does not mean “the bigger, the better” toward a nation. On the contrary, in the case of sufficient education funding, the lower the indicator, the more prosperous private education will be. According to the interpretation of UNESCO, *This indicator should not be considered a unit cost, since it only includes what the government spends, and not total spending per student (including household contributions). Since it is a simple division of total government expenditure by the number of students at a given level, whether they attend public or private institutions, in countries where private provision and/or funding of education is higher the average amount per student will appear lower.*
- RMF: The parameter represents whether males and females enjoy equal opportunities and rights in the higher education system. In the earlier era, men chances of receiving education

were much more than females. On the one hand, it is a violation of females right to be educated. On the other hand, it also wastes a considerable part of social resources, because this situation would inevitably lead to the sparse educated population, and make the progress of human society relatively slow. On the premise that both males and females could fully enjoy education and engage in higher education and scientific research, the sustainability and health of higher education in the nation can be well guaranteed.

- **PIE:**The proportion of international students in higher education can fully reflect the strong strength of the nation's higher education. Only relatively high-quality educational resources can attract more international students to study in places far away from their hometowns. Besides, the number of international students can indicate the closeness of cooperation and connections in the nation's higher education worldwide. We can foresee that there are countries with considerable influence in the field of higher education all over the world, which obviously have better educational resources and world structure. While cultivating international students, it is also a process to absorb fresh blood and enrich themselves, connecting with the world to obtain resources and enlarging effects.
- **PP:** The parameter of the proportion of the population with higher education can also be an important indicator of the model. For a country, with a large number of highly educated population can not only reflect that the country has a solid basic education, it can also show that the country has more higher educational institutions and teaching staffs, and an aspect reflect the countrys investment in higher education ,which will affect the national quality and development potential .It is an appropriate embodiment of the comprehensive strength of a nations higher education.
- **PER:**To a certain extent, the private school enrolment rate can reflect the development level of private education in the country. Private education means more accurate positioning, more market-oriented, and more competitive elite education. There is a current policy to developing private education vigorously in many developing countries . However, compared to PEG, PER, representing the private investment in higher education, has always had a relatively high proportion in areas with more developed education.

## 2.3 Model building

After analyzing the data we have, we decide to use the TOPSIS method[1] to score various indicators, and then get a final score.

### 2.3.1 Parametric classification

Based on the above analysis, it can be seen that for PEG, the smaller its value, the better the development of higher education in the country. It is called a monotonically decreasing index, and its optimal solution is the minimum value in the data. RMF and PIE need to be stable within a certain range, so they are called interval indexes. As for PP and PER, the larger the value, the better the development of higher education in the region, which is called monotonically increasing indexes.

Index	Classification
PEG	monotonically decreasing index
RMF	interval index
PIE	interval index
PP	monotonically increasing index
PER	monotonically increasing index

### 2.3.2 Data preprocessing

We need to process the above indexes and convert all of them into monotonically increasing indexes to facilitate our calculation of scores.

For the minimal index,

$$x_i = \max - x_i \quad (1)$$

For the interval indexes, we set [a,b] as the best division, then

$$M = \max\{a - \min\{x_i\}, \max\{x_i\} - b\} \quad (2)$$

and convert them through:

$$\hat{x}_i = \begin{cases} 1 - \frac{a - x_i}{M} & x_i \leq a \\ 1 & a < x_i < b \\ 1 - \frac{x_i - b}{M} & x_i \geq b \end{cases}$$

### 2.3.3 Normalisation

Standardize the above indexes to further eliminate the interference of abnormal data and increase the stability and reliability of the data. Take the standardized matrix as Z, then

$$Z_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}^2} \quad (3)$$

### 2.3.4 Score

The standardized matrix contains all monotonically increasing indexes. Therefore, the optimization solution vector can be formed by taking out the maximum values of each indicator, and the vector formed by the minimum values is the most inferior solution vector. Then, according to

$$\frac{z_i - z_{\min}}{(z_{\max} - z_i) + (z_i - z_{\min})}$$

$$d_i^+ = \sqrt{\sum_{j=1}^m (z_j^+ - z_{ij})^2}$$

$$d_i^- = \sqrt{\sum_{j=1}^m (z_j^- - z_{ij})^2} \quad (4)$$

Calculate the distance from each index vector to the optimal solution and the worst solution and calculate the final score by the following formula:

$$S_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad (5)$$

### 3 Our model Toward 10 countries

We apply the model to the 10 countries including the United States, the United Kingdom, and Turkey and so on for analysis. The model mainly uses six indicators mentioned above as benchmarks to initially measure the education development of a country, and uses the TOPSIS method to score, and finally obtains the results as follows: Judging from the data extracted from the calculation

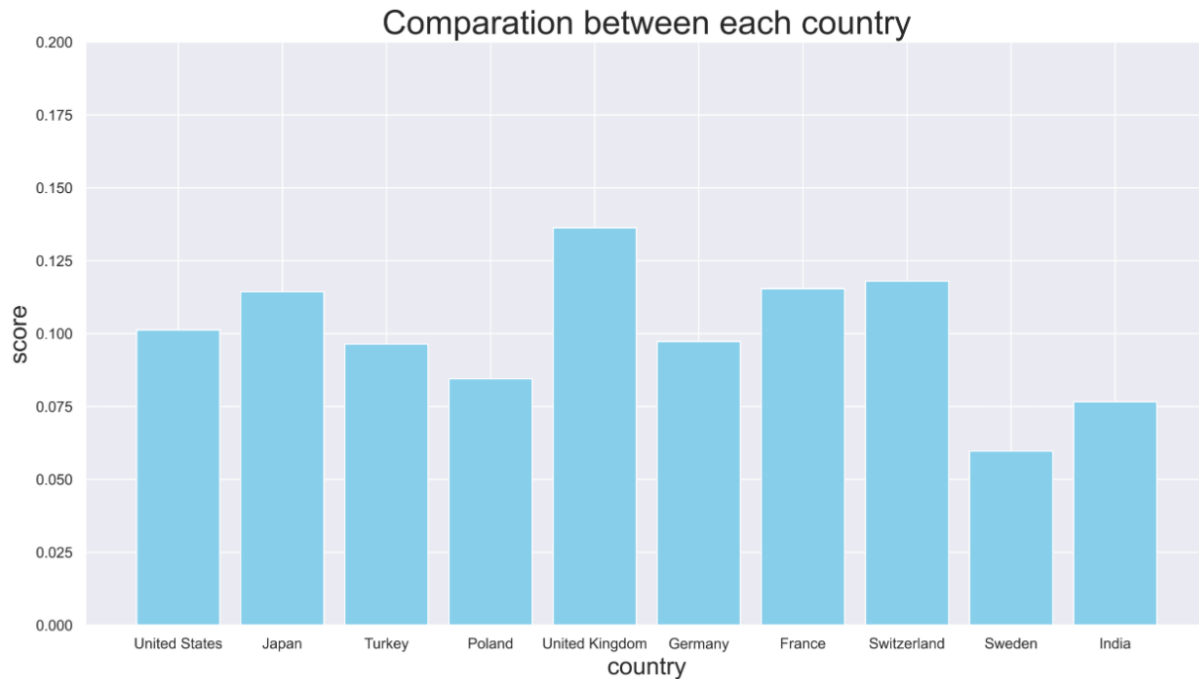


Figure 2: Comparison among ten countries

results of the above model, the first place in the final score belongs to the United Kingdom, which has a good score of 0.137. Similarly, it also has a good score in the internal evaluation of various data. It achieves the highest score in the *private education enrollment rate* ( *private education enrollment rate* is a maximal index, so full marks only mean that it has the highest score in the same category, and it does not mean it is perfect). The second, third and fourth places are Switzerland, France and Japan respectively. Japan also has outstanding scores in various indicators without obvious shortcomings. It is worth mentioning that although the United States ranks the fifth in the sample data, it is undeniable that the United States has strong scientific research capabilities and fruitful results.

The bottom two places are Sweden and India, with scores of 0.06 and 0.08, which is a pity. Both countries have low scores on a number of indicators. For example, India scores 0 points and 4.16 points respectively in the *proportion of the population with higher education* and *proportion*

*of international students in higher education* . To a certain extent, it also reflects the national conditions of India. Indias situation is special and there are many contradictions that are difficult to reconcile, so we decide to choose India for a more detailed analysis.

## **4 The nation we choose—India**

### **4.1 Background analysis of India**

Take basic education as an example. The right to education in India is that children aged 6-14 must receive education in school. However, according to data in 2010, the average number of years of education per capita in India is 4.4 years, far below the 8 year requirement. The high dropout rate means that nearly half of school-age children cannot complete compulsory education, which leads to a greatly low proportion of the number of people who can complete higher education successfully, and the literacy rate of women in India is not high.

There may be many reasons , such as the influence of the caste system, the limitation of economic strength, or the governmental insufficient investment in education (Although the enrollment rate of private education is one of the important standards for measuring the development of education in a region, for less developed education regions, the government still needs to have sufficient investment to maintain the overall balance of social education development). In addition, Indian society has strong gender discrimination. The numerous rape cases that are common in reports prove it. As far as basic education is concerned, due to the traditional concept of man is superior to woman and the effect of religion, girls account for 40% of the total number of students in elementary school. , but it is difficult to complete the statutory 8-year basic education.

And from Indian low proportion of international students in higher education (lowest score) and the rate of studying abroad (high score), we can see that even though Indian higher education has cultivated many elites, it is difficult to retain talent, not matter whether to come into the educational circle to improve the quality of education or develop domestic science and technology. It is difficult to introduce foreign talent as well. It is undeniable that there are indeed many Indian elites who choose Silicon Valley instead of returning to their homeland. This shows that Indian attractiveness to its own youth elites is weak.

However, India has emerged as the fastest growing major economy in the world and is expected to be one of the top three economic powers in the world over the next 10-15 years. Indian GDP (at constant 2011-12 prices) was estimated at Rs. 33.14 trillion (US\$ 452.74 billion) for the second quarter of FY2020-21, against Rs. 35.84 trillion (US\$ 489.62 billion) in the second quarter of FY2019-20. It is estimated to surpass USA to become the second largest economy in terms of purchasing power parity (PPP) by 2040 as per a report by PricewaterhouseCoopers.[2]

The economy of India is characterized as a middle income developing market economy. It is the world's fifth-largest economy by nominal GDP and the third-largest by purchasing power parity (PPP). According to the International Monetary Fund (IMF), on a per capita income basis, India ranked 142nd by GDP (nominal) and 124th by GDP (PPP) in 2020. From independence in 1947 until 1991, successive governments promoted protectionist economic policies with extensive state intervention and economic regulation, which is characterized as dirigisme, in the form of the License Raj. The end of the Cold War and an acute balance of payments crisis in 1991 led to the



adoption of a broad economic liberalization in India. Since the start of the 21st century, annual average GDP growth has been 6% to 7%, and from 2014 to 2018, India was the world's fastest growing major economy, surpassing China. Historically, India was the largest economy in the world for most of the two millennia from the 1st until 19th century[3]

## 4.2 The vision to India

We hope that through the policies we will formulate, we can help India to realize a policy that takes economic development as the driving force and the five policies as a guide to achieve:

- Healthy higher education investment
- Equality rights for higher education between male and female
- Higher education Popularization
- Higher education Internationalization
- Higher education Elitism through private institutions

These five achievements can help India accelerate economic growth through their respective feedback methods and finally establish a healthy and circular education system.

## 4.3 Our model toward India

According to the data we acquire[7], we apply the model on India, Through calculation, we get an

Index	PEG	RMF	PIE	PP	PER
Scores	0.0000	0.2953	0.4043	0.1033	0.3657

Figure 3: Scores of India

awful result of 0.076643, which is the second to last.

# 5 Policies development

Based on the above data, we can conclude that India, as the second largest developing country in the world, possesses vigorous economic vitality and continues to maintain rapid economic growing speed. This feature provides a good prerequisite for our next education policies.

## 5.1 Policies

There will be five pieces of policies, as follows:

- Increase the capital investment in higher education, build a sound higher education management system, and at the same time create a better academic exchange environment

- Formulate enrollment standards for higher education schools, compulsorily require higher education institutions to control the ratio of men to women which must meet the minimum standards set by the state ,and provide more financial assistance to female students receiving higher education
- A series of policies should be introduced to provide a certain percentage of living allowances for international students who come to study in the country , and a certain percentage of tuition fee reductions for outstanding middle school graduates who choose to continue their studies in the country.
- Introduce the meaning of higher education to the people across the country through various channels, and encourage more students to choose to continue to complete higher education.
- Encourage the construction of private schools to help children from families with a certain economic foundation to enjoy elite higher education in the home country.

## 5.2 Feasibility and effectiveness evaluation

The five policies we have established are based on the ability of the Indian government to provide sufficient funds to participate in the investment in education. Through the recent and future economic status of India introduced above, we find that India, as a developing country, can sustain rapid economic growth in the near future and in the coming decades, which means that the annual budget of the Indian government should have maintained the same rapid growth. The Indian government is fully capable of devoting a part of the annual budget increase to in education investment.

### 5.2.1 Health of higher education verification

For policy 1, If the Indian government increase its investment in higher education. In a short time, the PEG parameter will not drop to the level of the United Kingdom or the United States. It will

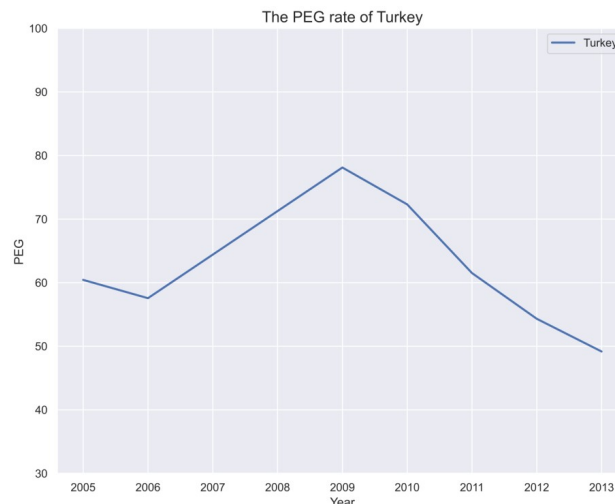


Figure 4: The PEG rate change in Turkey

even cause a small increase in the PEG parameter (this is not what we expect). But in the long run, with the increase in higher education funding, the quality of the advanced talents cultivated will make a big leap. When these talents complete their studies and enter society, the value they create for the country and society will be multiplied.

The experience of Turkey, which is also a developing country, illustrates this point well. The PEG change curve of Turkey from 2005 to 2013 well reflects the impact of the increase in education investment on PEG parameters (the Turkish government started a huge education reform from 2005. There were a series of reform policies including increasing investment in education)

For policy 2, The Indian government needs to amend the Education Act to require every higher education institution to control the enrollment ratio of male to female students each year above the bottom line. Here we use Japan, which performs well in model evaluation, as an example:

On October 14, 2018, a group of women filed a lawsuit against Santa Mariana University School of Medicine in Kawasaki City, Kanagawa Prefecture, southern Tokyo, which also exposed structural discrimination against women. They were rejected after taking the entrance examination from 2015 to 2018, and demanded a total of 16.84 million yen in compensation. The plaintiff said at a press conference: "There is no excuse that we should not be discriminated against because we are women." A third-party investigation committee investigated the admission practices of the medical school and found that the university manipulated test procedures for men, some of which were determined based on application forms and documents based on score distribution. Women score lower at the same level. But the university denies discrimination. Following the 2018 scandal caused by the gender bias admission scandal of Tokyo Medical University and Juntendo University, the Ministry of Education conducted an investigation and found that 10 universities discriminated against applicants based on gender. Women sued some of these universities.[5]

Japan, as a country with historically unequal treatment to women in education, pays special attention to safeguarding the right of female students to receive higher education, and enforces such issues through the government and other state authorities. The same method can be applied to India. The second policy we formulate will ensure that the ratio of male to female students in higher education will not be lower than a minimum bottom line, and control RMF will not be far below the expected health value, thereby ensuring the health of the system. The state's education funds also need to be devoted a portion to provide financial support specifically for female students receiving higher education. It will ensure that women receiving higher education will not give up their studies halfway due to financial difficulties, and will ensure the graduation rate of female higher education talents.

For policy 3, the Indian government has to allocate part of the education funds to subsidize international students. The initiative will attract international students from all over the world to India for higher education, increase the parameter PIE ratio, and thus improve the health of education system. For talents with exceptional performance in some poor countries, sufficiently favorable subsidy conditions will gather these ones in higher education institutions in India, so that higher education in India can integrate more foreign cultures and ideas, thereby colliding more sparks and further enhance the students' creative ability and help students open a broader vision.

The Indian government can use part of the education funds for publicity, and help the Indian people to better understand what higher education is and what higher education is doing through

social media platforms (such as Youtube, Tiktok, Twitter), and finally give what benefits higher education can bring to students. These can be popularized by formal higher education documentaries made by the country showing on various platforms

For policy 4 ,the Indian government can use part of the education funds for publicity, and help the Indian people to better understand what higher education is and what higher education is doing through social media platforms (such as Youtube, Tiktok, Twitter), and finally give what benefits higher education can bring to students. These can be popularized by formal higher education documentaries made by the country showing on various platforms Here we give an example of higher education in the United States. Every university will launch a variety of promotional videos every year to introduce its advantages and characteristics of higher education to the general public. At the same time, the United States has also shot many documentaries, in which experts and scholars are invited to analyze the benefits of higher education. Such measures have improved the public's understanding of higher education, so that those who have not received higher education have a yearning for higher education, attract more people to receive higher education, and ultimately increase the proportion of higher education for the whole people, thereby increasing the health of the system.

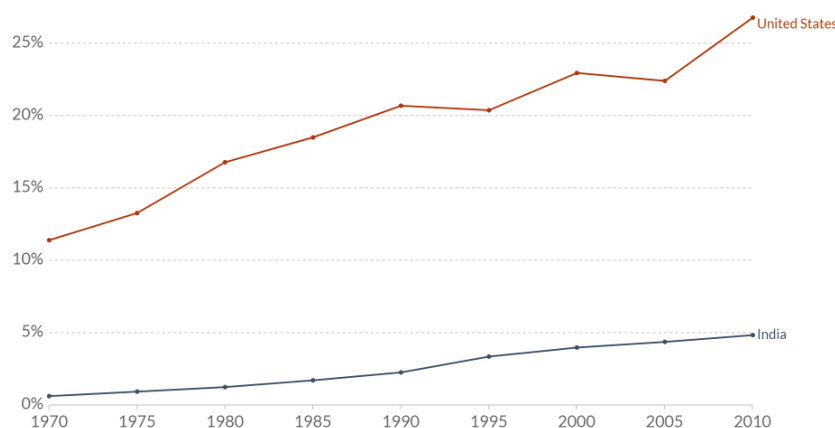


Figure 5: PP in the United States

For policy 5,the government can take out a portion of education funds to encourage the development of private schools. Due to the limited capacity of the government in a short period of time, it is impossible to quickly establish a large number of higher education institutions, so policies can be formulated to encourage the establishment of private higher education institutions. Thus, the scale of national higher education institutions can be rapidly expanded in a short time, and more outstanding higher education talents can be cultivated. This move will increase the PER parameters and help Indian education system to maintain better health.

### 5.2.2 Implementation timetable

### 5.2.3 Sustainability assessment

For policy 1,the improvement of the PEG coefficient can ensure that the quality of higher education talents cultivated by the country in the future will continue to rise. After entering the society,

Policy	Time	Concrete measure
Policy 1	2020-2030	Increase education funding by 10% every year
Policy 2	2020-2022	Amend the Education Act to make it mandatory that the ratio of male to female enrollment in higher education schools should not be less than 0.8
Policy 3	2025-2030	After basically solving the domestic problems of educational inequality, 5% of the education funds should be invested every year to establish two types of scholarships 1. Encourage international students to study in India 2. Encourage outstanding Indian students to continue their higher education in India
Policy 4	2020-2030	Spend 2% of the annual education funds to carry out higher education introduction lectures and other publicity activities to popularize higher education to the people
Policy 5	2020-2030	3% of the education budget should be used to support the construction of private schools, and subsidies are provided according to the size of the school

Figure 6: Time-table

these high-quality and advanced talents can accelerate the development of the industries so that India will develop its own economy rapidly, thereby continuing to ensure the prerequisites for the implementation of policy one, provide sufficient financial support for policy one. In this theory the first cycle promotion chain will be established.

For policy 2, the improvement of the RMF coefficient can ensure that higher education in India is more equitable, and help the country find those female who also have great talents. Moreover, that will improving the quality of higher education, and at the same time allowing more women to have equal social resources and Educational rights comparing to male. Recently, women can make a positive effect on cooperation in the workplace. A study on gender composition of the team in the workplace found that cooperation between professionals in the operating room tends to increase with a rising proportion of women in clinical team.[6]The participation of women has enhanced various industries to increase the efficiency of cooperation. Eventually, under the joint efforts of women and men, Indian economic development will keep in a higher speed. This also guarantees the prerequisite for the implementation of policy two, and provides sufficient financial support for policy two. The second cycle promotion chain will be established.

For policy 3 , the improvement of the PIE coefficient can help India to rapidly increase internationalization of higher education. This will also bring more diversified logical thinking into the Indian education system. At the same time, the internationalization of education will attract more investment funds from overseas. Research shows that investment companies are more likely to communicate with entrepreneurs from their home countries and the cooperation rate will be much higher than that of entrepreneurs from other countries. This will help Indian economic

growth rate to reach a new level. It also guarantees the prerequisite for the implementation of policy three, and provides sufficient financial support for policy three. The third cycle promotion chain will be established.

For policy 4, the improvement of the PP coefficient can ensure that the total number of higher education talents trained by the country in the future will continue to rise. By the time these graduates entering the society, their high-quality and advanced talents can improve the educational background of the employees of Indian companies, which will help the industries to develop faster, and directly help India to develop the economy rapidly. The government budget is increasing year by year, thus continuing to ensure the implementation of the fourth policy. Sufficient financial support from the government will be provided to persist the fourth policy. The fourth cycle promotion chain will be established.

For policy 5, the improvement of the PAR coefficient can ensure that the government release the pressure on the issue of rapid development of higher education. The government's limited funds are far from enough to support the rapidly expanding student scale in a short period of time. The implementation of Policy 5 can use various forces from society to jointly develop education in order to help the government save a large part of its budget. The model we built before finds that the UK's PER coefficient remains at 100 all the year round, while Japan also maintains around 80. The following are the research data:

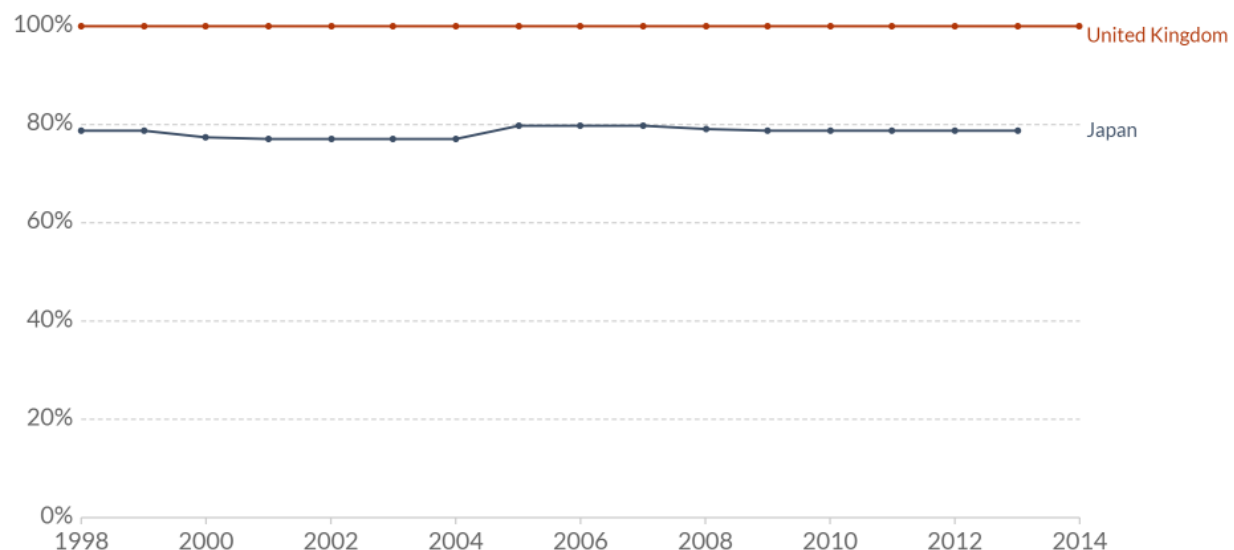


Figure 7: PER in UK and Japan

On the other side, Parental wealth is found to have a very strong positive correlation with children's degree-level qualification attainment at age 25. This correlation is stronger at below-the-median wealth levels and remains strong after controlling for a wide range of confounding family characteristics. There is also evidence of a positive correlation between parental wealth and children's employment probability and earnings. However, for both labor market outcomes the parental wealth gradient is rather weak and for the employment outcome the effect is largely mediated by children's education.[4] These comments show that elite families hope that their

offspring can get better elite education, and private higher education institutions can meet this demand. In this way, those students who graduated from private higher education institutions are more likely to make a big career with the help of their own family resources, thereby promoting the development of India. The result is that the GDP rate will continue to keep rising to ensure the prerequisites for the implementation of policy five. In other words, this will provide policy five sufficient financial support. The fifth cycle promotion chain will be established.

According to the five policies we have formulated, we can find that for each policy, we can improve the five parameter indicators we previously select, and for these five parameter indicators, they can generate a certain feedback effect on economic growth, thus five cycles formed, which accelerate the country's economic development and at the same time ensure the rapid and effective implementation of policies, which proves that the policies we formulate are very sustainable.

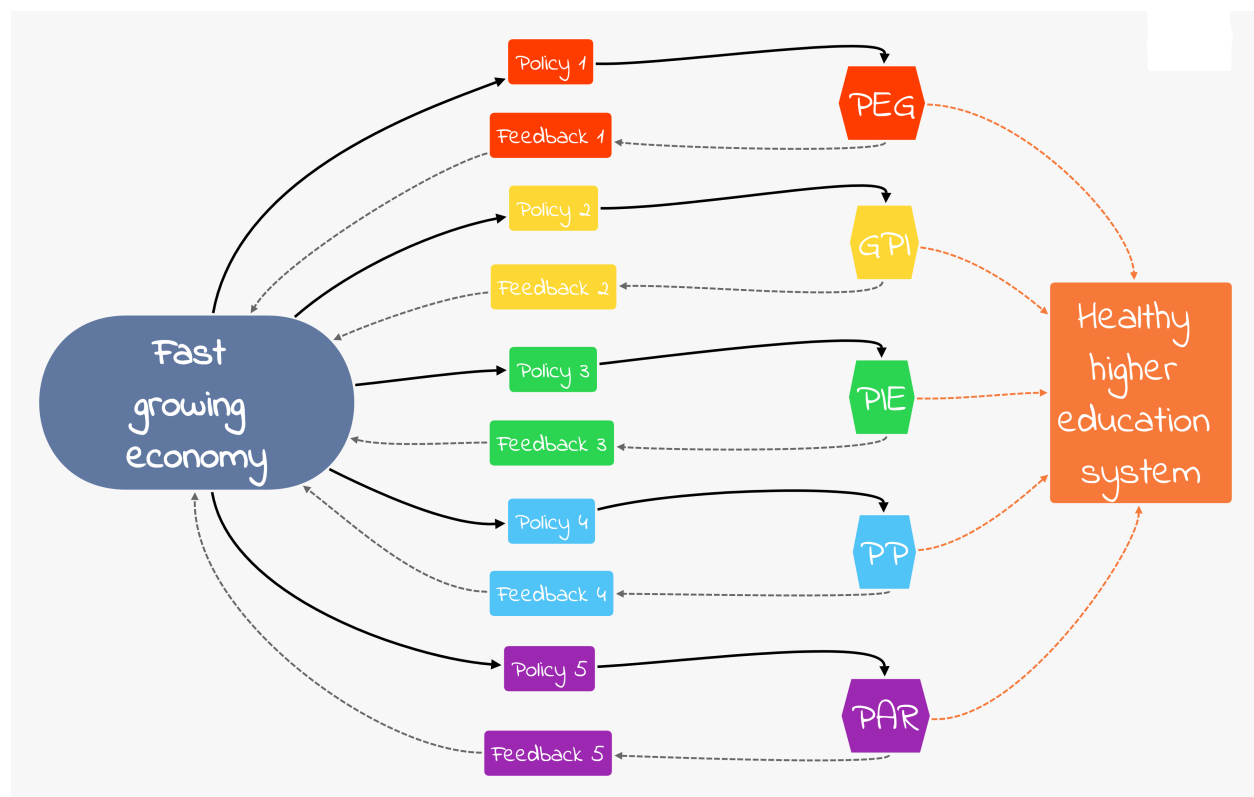


Figure 8: The policy-making loop

## 6 Effects on the real world

It takes a long time to adjust the reality of higher education to what we expect. At the beginning of the implementation of the policy, the situation will not immediately develop in a good direction. For example, when the government increases funding for higher education, the PEG may not fall as we wish. If the GDP remains unchanged, the PEG will increase instead. After the revision of the education regulations on the ratio of males to females, the education situation of female students will not improve all at once. It is very likely that even due to the rebound of the conception of conservatism, the female enrollment rate will drop to a low point, then gradually rise, and the

whole change will radiate from the city to the countryside; the international student policy will not improve the status of international students in India at the beginning. Only when the conditions in India have improved, this indicator will be greatly improved.

For example, only after the society's respect for women increases showing as the rising gender ratio, more outstanding female international students will be willing to come here. In the final state of the implementation of the policies, whether Indian students receive higher education depends entirely on their own wishes. As long as they have the desire to continue their education, they can get help from the government in a timely manner even if they are restricted by the funding situation; whether they are men or women, In the city or in the countryside, they all have the right to be educated on an equal footing; public and private colleges and universities are blooming, forming a healthy competition, and foreign students and domestic students have their own and peaceful academic exchanges, and cultivate a series of talents to participate in national construction. Among them, a benign closed loop will be formed from the investment of the national economy in education to the return of education talents to the economy.

However, we have to admit that the reality is complicated. There are too many factors that may affect the country's higher education. Not everything could proceed in the direction we expected. In terms of the ratio of male and female students enrolling, gender discrimination in India is very serious, especially In rural areas, it is difficult for many women and even their own lives to be guaranteed, not to mention the issue of education, and the huge gap between urban and rural areas makes it very difficult to implement reforms in rural areas. And because of the deep-rooted influence of cultural traditions, etc., it is very difficult to change the status quo overnight. It takes a long time for the development of society and the progress of people's thinking, and therefore it requires the unremitting efforts of several generations.

## 7 Model evaluation and further discussion

### 7.1 Strengths

The advantages of the model are that its structure is relatively simple, the selected indicators are relatively typical, and have a certain degree of generality. The *proportion of the population with higher education* is a relatively intuitive indicator, which is a comprehensive reflection of higher education investment, the scale of higher education, and the people's right to education. It can reflect the benefits and effects of higher education and even basic education to some extent. While *the proportion of total expenditure on higher education to GDP* and *private school enrollment rate* reflect the state's investment in education from both the governmental and the private aspects; the comparison of the number of domestic and international students can reflect the status and influence of the country's higher education quality in the world; the ratio of male to females in higher education including teachers and students reflects the equality of the right to education for men and women in the country.

In the conception of the model, we try to reduce the preset components in the model, but split them into various indicators, and analyze its representativeness and relevance to higher education through literature and various data. We firstly select the number of universities some countries have in the top 600 THE rankings as a basis to roughly verify the relevance of each indicator to the education situation, and then draw conclusions.



## **7.2 Weakness**

But our model also has some problems. Due to its relatively simple selection of indicators, some deviations to the expectations will inevitably occur in the forecast results. In addition, there are quite a lot of factors to be talk about in the country's higher education, and they are interconnected. So it is a very complex gray model. We can only choose as representative indicators as possible as evaluation criteria and judgment basis.

## **7.3 Improvement in the future**

In order to make the model fit the reality better, we could collect data for a longer period of time and from more countries for processing. Similarly, we could take more indicators into the model's consideration, For example because of the impact of coronavirus pandemic in the world today, many schools are unable to conduct face-to-face courses. If they do not have the conditions for online courses, they will not be able to complete the teaching tasks. Therefore, the proportion of online courses can be considered as an indicator to measure the elasticity of the countrys higher education when coming across some sudden situations.

## References

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## 8 Appendix

some more text **Input Python source:**

---

```
#!/usr/bin/env python
# coding: utf-8

#min_scoring
def dataDirection_1(datas):
    return np.max(datas)-datas

#mid_scoring
def dataDirection_2(datas, x_best):
    temp_datas = datas - x_best
    M = np.max(abs(temp_datas))
    answer_datas = 1 - abs(datas - x_best) / M
    return answer_datas

#period_scoring
def dataDirection_3(datas, x_min, x_max):
    M = max(x_min - np.min(datas), np.max(datas) - x_max)
    answer_list = []
    for i in datas:
        if(i < x_min):
            answer_list.append(1 - (x_min-i) /M)
        elif( x_min <= i <= x_max):
            answer_list.append(1)
        else:
            answer_list.append(1 - (i - x_max)/M)
    return np.array(answer_list)

#matrix_standard
def temp2(datas):
    K = np.power(np.sum(pow(datas,2),axis =1),0.5)
    for i in range(0,K.size):
        for j in range(0,datas[i].size):
            datas[i,j] = datas[i,j] / K[i]
    return datas

#normalized
def temp3(answer2):
    list_max = np.array([np.max(answer2[0,:]),np.max(answer2[1,:]),np.max(answer2[2,:]),np
    list_min = np.array([np.min(answer2[0,:]),np.min(answer2[1,:]),np.min(answer2[2,:]),np
    max_list = []
    min_list = []
    answer_list=[]
    for k in range(0,np.size(answer2,axis = 1)):
        max_sum = 0
        min_sum = 0
        for q in range(0,4):
            max_sum += np.power(answer2[q,k]-list_max[q],2)
            min_sum += np.power(answer2[q,k]-list_min[q],2)
        max_list.append(pow(max_sum,0.5))
        min_list.append(pow(min_sum,0.5))
```

```
answer_list.append(min_list[k]/ (min_list[k] + max_list[k]))
max_sum = 0
min_sum = 0
answer = np.array(answer_list)
return (answer / np.sum(answer))
#GDP_rating
year=[]
country=['United States','Japan','Turkey',
'Poland','United Kingdom',
'Germany',
'France',
'Switzerland','Sweden','India']
average=[]
rate_score=[]

for i in range(2005,2015):
year.append(str(i))

#calculate the average rate between 2005 and 2015
for temp in country:
rate=df_gdp_rate[((df_gdp_rate["Entity"]).isin([temp]))&(df_gdp_rate["Year"].isin(year))]
average.append(rate["Government expenditure per student, tertiary (% of GDP per capita)"])
gdp_rate_score=dataDirection_1(average)
gdp_rate_score

#visualize
x=[0,1,2,3,4,5,6,7,8,9]
plt.figure(figsize=(15, 8), dpi=800)
plt.bar(x,answer3,color='skyblue',tick_label = country,label='Accuary')
plt.ylabel('score',fontsize='18')
plt.xlabel('country',fontsize='18')
plt.title('Comparation between each country',fontsize='25')
plt.ylim(0,0.2)
plt.show()
sns.set(style='darkgrid')
plt.show()
```

---