

Research Article

Economic Benefit Analysis of Medical Tourism Industry Based on Markov Model

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To study the impact of the medical Tourism Industry on regional economic performance, a Markov prediction method was proposed. An improved Markov chain combination forecasting method was established by analyzing the economy of healthcare tourism industry through Markov chain forecasting method and various processing methods for economic results of different years. The research results show that healthcare tourism industry service is a new and highly potential tourism product service. It can generate significant economic and social benefits. The value and market size of healthcare tourism industry is analyzed and studied by using Markov model to explore the complementary roles of Medical and Tourism, which helps to predict the development of market size and benefits. The model results are also analyzed and calculated. The benefits and scale of the development of the healthcare tourism industry are evaluated by combining the actual data situation and development conditions in each year.

1. Introduction

Medical treatment and tourism have many related cross scopes. Its integrated development will drive the development of many related industries and produce huge economic and social benefits. It is expected that the construction and scale development of the Medical and health tourism will help to enhance the value and income of the whole medical and health tourism, and then promote the economic growth of the whole region. The theoretical research on the Health care tourism industry chain is basically blank. This paper constructs an assessment of the economic benefits of medical tourism in Shanghai based on the tourism and medical industry chains, taking into account the actual situation in Shanghai. [1–5] Social network analysis of Health care tourism industry as Chinas economic center city, Shanghai plays the role of tourism center in the regional tourism industry of the Yangtze River Delta. It is not only the gateway hub of Chinas outbound tourism, but also the source market with the most consumption potential in

China. In the medical field, Shanghai has internationally advanced treatment technology, affordable medical service prices and traditional medical and health care projects and technologies with Chinese characteristics. If the tourism industry and medical industry can be effectively integrated, it will create huge economic benefits for Shanghai. Shanghai has formed a complete medical industry chain and tourism industry chain. The industrial value chain networks of medical industry and tourism industry are shown in Figure 1, respectively.

Figure 1 demonstrates that the healthcare tourism industry combines healthcare and tourism, and the number of nodes, the scale of relationships and the value chain network of the healthcare tourism industry in its industrial value chain are much larger than those of the healthcare and tourism industries, and are not a simple superposition of the two. Therefore, there are more industries related to the medical tourism industry. And the influence on the related industries is stronger and wider in scope. However, the density of Health care tourism industry is less than that of

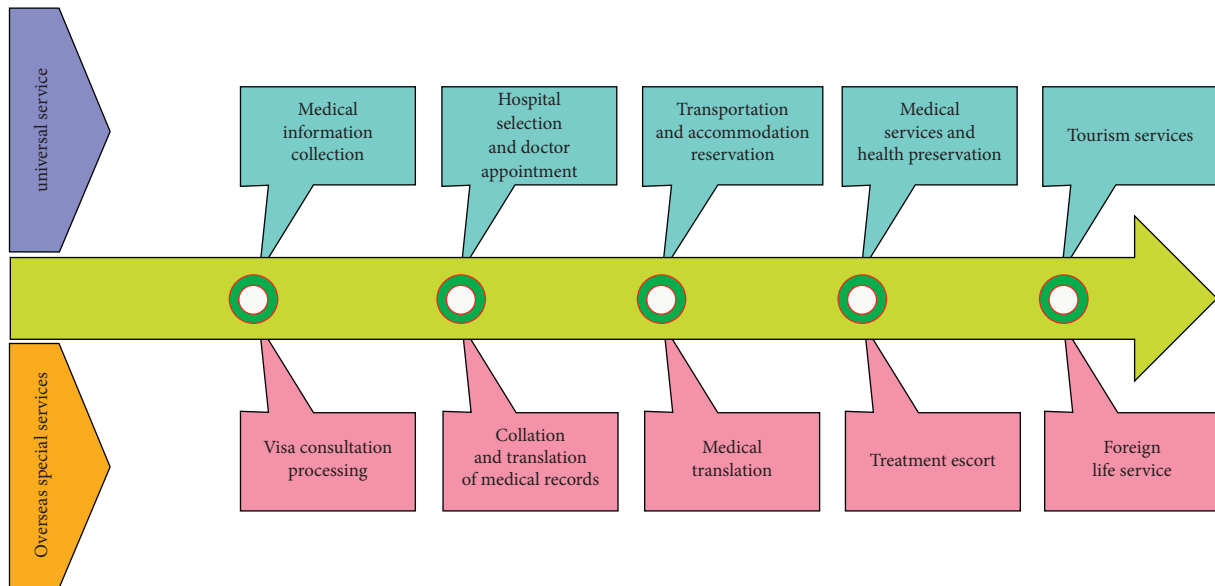


FIGURE 1: Medical and tourism industry chain.

the medical and tourism industries. Because the scale of correlation is larger, but the cross range is larger and higher. Health care tourism industry does not directly strengthen the relationship between medical related industries and tourism-related industries. Hospitals are in a relatively important position, except for patients, and have the highest relative centrality of social networks at 0.8333, i.e., they have more power in the industry as a whole. In the tourism industry, besides tourists, travel agencies have the highest relative centrality of 0.75. In the Health care tourism industry, besides Health care tourism industry consumers, hospitals, the Shanghai Medical tourism Products & Promotion Platform (SHMTPPP), and tourist attractions have the highest relative centrality of 0.75. The relative centrality of the industry is 0.5625, 0.4375, and 0.3125, respectively. The synergy between medical and tourism industry can break through the boundary of traditional tourism industry, take Health care tourism industry activities as the core, integrate Health care tourism industry services, and expand and extend the traditional medical and tourism industry chain. The synergy of Health care tourism industry is mainly reflected in many aspects. According to the form of synergy, synergy is mainly reflected in the sales field, and in the relationship level according to the synergistic effect. According to the relationship between resources, the synergy effect is reflected in the sharing and complementation of resources between the two parties. As shown in Table 1.

As seen in Table 1, the complementary and synergistic nature of healthcare and tourism creates the value of synergy. The combination of supply and demand and value attributes of the medical and tourism industries allows the medical tourism industry to better leverage synergies between tourism companies and hospitals in order to add value and respond to the needs of medical tourists as quickly as possible. This is reflected not only in the synergy between tourism companies due to business cooperation, but also in the synergy between departments within the company due to

changes in external partnerships. On this basis, this paper provides an in-depth study of the probability of impact on the economic efficiency of the medical tourism industry through Markov models to understand the impact on economic efficiency [6–8].

2. Markov Model

2.1. Markov Process. Many things happen that have nothing to do with previous cases or experiences. For example, the first coin flip, whether heads or tails, has no effect on the outcome of the second flip. But there is a temporal order to the first and second coin flips; it is just that this temporal order has no effect on each of these two events. This is the Markov process—“when the present of a process is known, its future does not depend on the past.” In short, you need to know time t , what you are going to do with X , and if it meets the requirements of the formula, you can verify its Markov property. Mm is a classical model that has been invented for 50 years. It has been widely used. But this does not mean that it is not dynamic. Because Mm not only gives you several sets of algorithms, but also an instrumental view of the research problem, helping you to achieve a more flexible mirror transformation from the theoretical to the real world. Here we present a few examples. For example, when a student is in the first class (Class 1), he/she has a 50% chance to attend the second class (Class 2); at the same time, there is also a 50% chance to not listen carefully and go into browsing Facebook. When browsing Facebook, there is a 90% chance to continue browsing in the next moment and a 10% chance to return to the class content. When a student enters the second class (class2), there is an 80% chance of continuing to participate in the third class (Class 3) and also a 20% chance of dropping out (sleeping) due to difficulties in the course. When a student is in class 3, he has a 60% chance of passing the exam and then a 100% chance of dropping out of the course. There is also a 40% chance that he will need to go to

TABLE 1: Industrial value table.

Project	Industrial value	Industrial value increment	Synergistic effect
Medical industry	Va	δVa	-
Tourist industry	Vb	δVb	-
Health care tourism industry	Medical care	Va'	$(Va' - Va) + (\delta Va' - \delta Va)$
	Travel	Vb'	$(Vb' - Vb) + (\delta Vb' - \delta Vb)$

the library to find reference material. Then, depending on his understanding of the class content, he has a 20%, 40% and 40% chance to return to the first, second and third classes to continue his studies [9–15].

The steady state under the action of the transition matrix p is called the Markov chain steady state distribution. There are four conditions for the convergence of the Markov process to the steady state.

The expressions are as follows:

- (1) The number of states is finite
- (2) The transition probabilities are fixed
- (3) Any two states can be transitioned
- (4) And it is not a simple cycle

Markov-stable convergence can also be used to study the process of population transfer between rural and urban areas. In short, forecasting using Markov models is the initial state * state transition matrix n . In linear algebra, it is the eigenvalue decomposition of the matrix. Markovs state transition matrix is such a matrix: if the sum of the row elements of each row is 1, then its eigenvalue must be 1. Here, we still use a very simple weather model to illustrate. It is shown in Figure 2.

According to the nature of D -partition, for all observations before a given time n , we see that the conditional probability distribution of observation x_n is:

$$p(x_n|x_1, \dots, x_{n-1}) = p(x_n|x_{n-1}), \tag{1}$$

p denotes the probability.

In the common first-order Markov chain model, the joint probability distribution of the sequence of n observations is:

$$p(x_1, \dots, x_n) = p(x) \prod_{n=2}^N p(x_n|x_1, \dots, x_{n-1}), \tag{2}$$

x_n is the observed value.

Markov chain: in some applications of this model, the conditional probability distribution $p(x_n|x_{n-1})$ is limited to equality and corresponds to the time series (the data will change over time, but the probability distribution of the generated data remains unchanged). In this way, this model is called Markov modeling. For example, If the conditional probability distribution depends on controllable parameters (parameter values can be determined by a variety of data), the relevant conditional probability distribution will share the same parameter values.

2.2. *Markov Chain Monte Carlo.* Markov process is a kind of stochastic process. Its original model Markov chain was

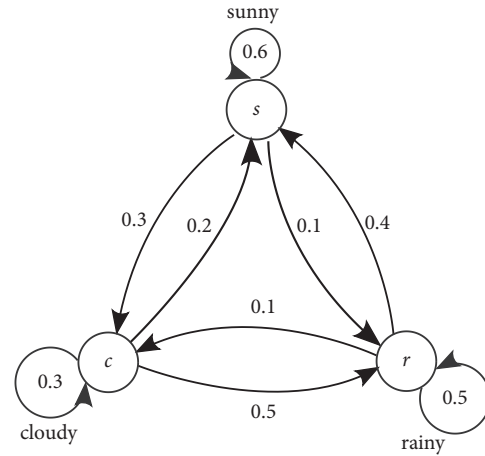


FIGURE 2: Markov usage process.

proposed by Russian mathematician A. A. Markov in 1907. Markov process is an important method to study the state space of discrete event dynamic systems, and its mathematical basis is stochastic process theory. Markov chain Monte Carlo is a sampling method used to solve the problem of random sampling simulation of distribution which is difficult to sample directly. In the basic probability class, we have learned that if a probability distribution function $F(X)$ is known, the random number U subject to uniform distribution is generated by computer and Substitute $F^{-1}(X)$, then $X = F^{-1}(U)$ is a random variable obeying $F(X)$. This method is widely used in the financial field, namely Monte Carlo simulation: calculate the option price by simulating the stock price. Of course, an important assumption of this method is that the probability distribution function is known. However, in many cases, we have no method to obtain the probability distribution and its inverse function, so other means are needed [16–24].

MCMC is usually used to solve high-dimensional integration and optimization problems, which are also the basis of machine learning, physics, statistics, metrology and other fields. The whole process can be further understood by following the steps below. 1. Given two variables x and y , Bayesian statistics mainly needs to calculate the following integrals:

- (a) Normalization, i.e., the denominator of Bayesian estimation:

$$p(x|y) = \frac{p(y|x)p(x)}{\int_x p(y|x')p(x')dx'} \tag{3}$$

- (b) Marginalisation, given the joint posterior distribution $f(x, z)$, is computed:

$$p(x|y) = \int_z p(x, z|y) dz. \quad (4)$$

(c) Expectation

$$E p(x|y)(f(x)) = \int_x f(x) p(x|y) dx. \quad (5)$$

- (1) Variance is also a type of expectation.
- (2) Statistical mechanics, which uses probability theory to summarize the average behavior of a mechanical system. There is a method of calculating normalization constants in computation similar to that used in statistical inference.
- (3) Optimization, minimizing or maximizing the objective function.
- (4) Penalized likelihood model selection with a penalty function is a two-step process in which the parameters are estimated using the maximum likelihood calculated for each model. Then, a penalty term (e.g., AIC, BIC) is used to select the model with better complexity and fit.

Based on the given target probability distribution (of high dimensionality), a sample of independent identical distributions is generated, and using the generated samples a discrete approximation of this distribution can be made, where:

$$pN(x) = \frac{1}{N} \sum_{i=1}^N \delta_{x^{(i)}}(x). \quad (6)$$

N denotes the sample size. Among $\delta_{x^{(i)}}(x)$ is Dirac of x_i δ Function. It is equal to zero at all points except x , and its integral over the whole domain is equal to 1. Is an expression of a continuous function. If expressed by a discrete function, it is

$$pN(x) = \frac{1}{N} \sum_{i=1}^N I\{x = x_i\}. \quad (7)$$

Then we can use this approximate distribution function to calculate various integrals:

$$I(f(x)) = \frac{1}{N} \sum_{i=1}^N f(x). \quad (8)$$

However, many distributions are difficult to sample directly, and some methods need to be used, such as rejection sampling, importance sampling and MCMC. Accept reject sampling is an unknown distribution $p(x)$, but its upper limit can be known. Then select a well sampled distribution function $q(x)$ to satisfy:

$$p(x) \leq Mq(x), \quad M < \infty. \quad (9)$$

Then, the related algorithm calculation is carried out.

The target distribution $p(x)$ of importance sampling, the reference distribution $q(x)$, and $p(x) = w(x)q(x)$, $w(x)$ is called importance weight. For example, to calculate:

$$I(f) = \int f(x) w(x) q(x) dx. \quad (10)$$

The estimation of $I(f)$ can be obtained by generating N independent random quantities subject to $q(x)$, and then according to $w(x)$:

$$I_N(f) = \sum_{i=1}^N f(x) w(x). \quad (11)$$

Discrete approximation:

$$pN(x) = \sum_{i=1}^N \omega(x) \delta_{x^{(i)}}(x). \quad (12)$$

Selecting $q(x)$ to minimize the variance of $f(x)w(x)$ can obtain the optimal reference distribution:

$$q(x) \propto |f(x)| p(x). \quad (13)$$

3. Scale and Development of Health Care Tourism Industry Market

A number of overseas medical and health tourists has exceeded millions every year. It is difficult to determine the exact number and cost of medical and health tourism, one of the reasons is that countries have different definitions of Health care tourism industry. The statistics of some countries include tourists who only go to the spa or get sick locally [25–30].

According to the data of “patients without borders”, the total output value of world medical service was less than 10 billion US dollars in 2000, and the Health care tourism industry market is expanding rapidly at the rate of 25% per year. In 2004, this industry only had us \$40 billion in the world, reached US \$20 billion by 2005, and the total output value of medical value reached US \$100 billion by 2012. In 2013, it was US \$438.6 billion. Its development momentum is amazing. Data from related studies show that the value of medical programs is growing at twice the rate of tourism; the World Health Organization estimates a value of \$678.5 billion in 2016, including more than \$100 billion in Asia. Allied Market Research estimates that the value of the Health care tourism industry in 2016 was US \$61 billion; Laing Buisson, a Health care tourism industry research institution, estimates that the market scale is about US \$12–15 billion, which is much smaller. It is estimated that in 2017, a number of medical tourists will reach 11 million, accounting for 3%–4% of the number of tourists in the world. At present, the income of Health care tourism industry is about 700 billion US dollars, accounting for 15–16% of the total world tourism income, and growing at a rate of 10–20% per year.; It is conservatively estimated that the market share in 2017 will be US \$100 billion, with an annual growth rate of 25%. Transparency market research, a US market research consulting firm, reported that from 2013 to 2019, The compound annual growth rate of global Health care tourism industry will remain at about 10–17.9%. By 2019, the scale of global Health care tourism industry will increase from the current

160 billion yuan to 250 billion yuan. World health organization predicts that to 2020, medical and health-related services will occupy an important position in the industry. The combination of tourism and health-related services will account for 22% of the global GDP. No matter which way you look at it, the healthcare tourism industry has developed into the fastest growing industry in the world. Therefore, the development of this industry can not only promote the development of medical services and tourism, but also lead to the development of other related industries. It can effectively stimulate economic growth. Some data show that the overall size of the global market for the medical and health tourism industry is about \$60 billion, with an annual market consumption of about \$21 billion and an annual growth rate of 10%–20%. And the resources of medical tourism industry are rich and diverse. For China, it has unique advantages in developing Health care tourism industry related services and products, especially in traditional Chinese medicine. Traditional Chinese medicine is not only the most distinctive industry in China, but also a strategic industry vigorously cultivated by the state. It is immeasurable to enhance the brand value. Compared with countries with developed Health care tourism industry, Chinas Health care tourism industry is mainly distributed in areas with advanced medical technology and equipment or rich medical and health care resources, such as other cities. Shanghai has established the first Health care tourism industry in China. Shanghai Hongqiao and Minhang national medical parks have been officially launched and explored to expand the international market, striving to develop international, modern, and diversified characteristic medical and health care services. Taking the opportunity of building an international tourism island, Hainan Province has built a service brand of health island. The international Health care tourism industry pilot area has become a new business card of Hainan. In 2013, Hainan Lecheng became the first pilot area of Health care tourism industry in China; In 2015, Jiangsu province became a pilot area of Health care tourism industry specially approved by the State Council; In 2016, Shangrao, Jiangxi province became a pilot Health care tourism industry zone specially approved by the State Council. At present, the participants in Health care tourism industry mainly include three categories: one is online medical enterprises; The other is traditional overseas medical institutions; There is also a class of online tourism enterprises, such as Ctrip, tuniu, etc. At present, a few first tier cities such as Beijing, Shanghai, and Guangzhou have shown great enthusiasm for the development of Health care tourism industry, actively learn from the experience of international Health care tourism industry developed countries, and some have also begun to formulate relevant policies and measures for the development of Health care tourism industry in the region. At the same time, some tourist cities have also launched Health care tourism industry services. In a word, the combination of medical treatment and tourism in China, on the whole, shows the unique scenery, multielement tourist destination and the diversification of various rare products. In the future, with the expansion of the Health care tourism industry market, we will focus on the areas that take

the lead in development, continuously expand the coverage area, and finally complete the nationwide layout. At this stage, the participants in the Health care tourism industry mainly include three categories: On the one hand, there are online medical products and online groups, such as medical 160, good doctor online, etc; On the other hand, there are traditional medical institutions, such as Shengnuo family, Meiyi society, etc. In addition, Ctrip, tuniu and other online tourism enterprises, including Chunyu international, rely on the communication platform to seize the Health care tourism industry market at home and abroad, radiating a wider consumer group with cost-effective products, ranking first. Several other enterprises, such as Shengnuo family, Han xiangrenhe and Aikang physical examination treasure, focus on other market scales and form the second camp by relying on the PC end and offline business development; Medical 160, micro medicine, good doctor online, etc. Make use of the advantages of mobile Internet to pilot develop some products to form the third camp of Health care tourism industry. According to statistics, the global medical scale soared from less than US \$10 billion in 2000 to 3700 billion yuan in 2017, and maintained an annual growth rate of 20%. It has become an important industry with the fastest growth in the world. With the continuous development of the industry, the medical service level of developing countries has been continuously improved, the service capacity of traditional medical treatment has been continuously enhanced, and the relatively low medical cost has led the passenger flow from developed countries to developing countries. The Health care tourism industry market is divided into North America, Europe, Asia Pacific, South America, the Middle East and Africa according to geographical location. The more mature Health care tourism industry countries (regions) include the United States, Japan, South Korea, Thailand, India, Indonesia, Costa Rica, etc., and Chinas Hong Kong and Taiwan are also developing Health care tourism industry. Chinas Health care tourism industry started late, but the industry has developed rapidly. China is rich in tourism resources, with the improvement of national health awareness. The field of traditional Chinese medicine has traditional technology and broad market. China has unique advantages in developing Health care tourism industry. The government focuses on supporting the development of Health care tourism industry. The planning outline of healthy China released in October 2016 proposes to actively promote the cross integrated development of new health industries, new formats, new modes of tourism, Internet, fitness and leisure, food and so on. In April 2017, the State Council officially announced that in Northeast China, Hubei, Chongqing, Sichuan, Liaoning, Zhejiang, Shaanxi and other seven provinces and cities. In the work deployment of the seven pilot-free trade zones, tourism is regarded as one of the key areas of the construction of free trade zones. Chinese people's health awareness has increased, and medical and health expenditure has increased. A series of problems in modern urban life such as environmental pollution, high pressure and subhealth make people pay more and more attention to the pursuit of a healthy lifestyle. In addition to the usual medical treatment, the development of income and

social environment has made more and more people accept the concept of treating diseases in tourist destinations “treating diseases with diseases and preventing diseases without diseases”. National medical and health expenditure has increased year by year. In 2017, the national per capita consumption expenditure on health care was 145.1 billion yuan, per year increase value of 7.9%. Among them, the per capita consumption expenditure on medical and health care of urban residents is 1814 yuan and that of rural residents is 1056 yuan. As shown in Figure 3:

Figure 3 gives a general idea that there exists a gap of about 50% between rural and urban, developed and under-developed regions in terms of medical consumption. Also the annual growth of medical consumption in urban and rural areas shows an upward trend. This proves that there is still a large market space in the medical field. At the same time, China has a large number of tourism resources, and many citizens choose to travel, vacation and provide for the elderly in the surrounding areas on holidays. Combined with tourism resources, create a variety of Health care tourism industry products with organic combination of high, middle and low-end, integrate and optimize the allocation of relevant resources, and transform from simple sightseeing tourism to a Health care tourism industry integrating leisure, vacation, food, convalescence and elderly care. Health care tourism industry can not only stabilize the health service industry and tourism, but also drive the development of catering, accommodation, shopping, medical device manufacturing, pharmaceutical manufacturing, construction and other related industries, which can effectively stimulate economic vitality. From 2013-2017 although the per capita consumption are growing, the gap between urban and rural areas has not decreased. This also indicates that the urban population is related to the recognition of industries such as healthcare and tourism, but also reflects the economic capacity gap, so in the focus to ensure that in the scale of urban medical tourism to increase the benefits is the focus of the industry.

In terms of product scale, Chunyu international also ranked first, accounting for 26.4% in 2016. The second is shengnuo family, accounting for 12.6%. With the expansion of development space, more enterprises are expected to flow into the Health care tourism industry market, and the product diversity and scale are expected to improve. As shown in Figure 4:

4. Result Analysis

The data of the medical and tourism industry in recent years were compiled and processed, and the trend of Chinas medical tourism market capitalization from 2017-2021 was obtained through Markov model by combining 2017 and 2018 annual statistics. As shown in Figure 5.

The trend of increase in 2019-2020 is very evident from the development of the market funds, in order to further illustrate the development of the market size. In this paper, based on the prediction data, the changes of market scale of Health care tourism industry in different years can be obtained through a variety of processing methods of Markov model in different years. As shown in Figure 6.

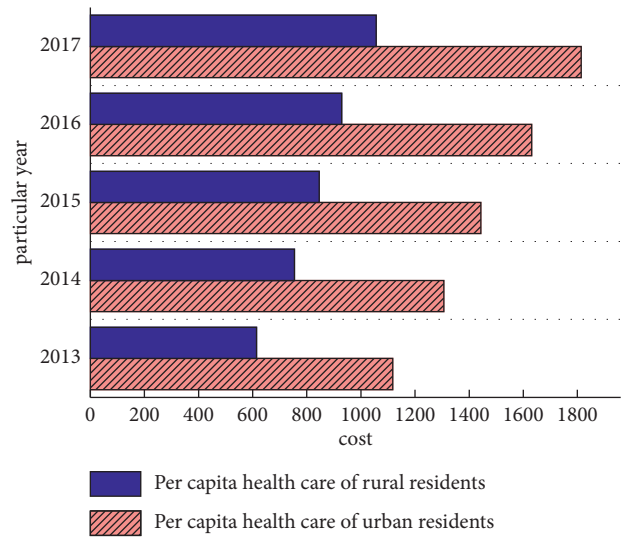


FIGURE 3: Per capita consumption expenditure of medical care in rural and urban areas.

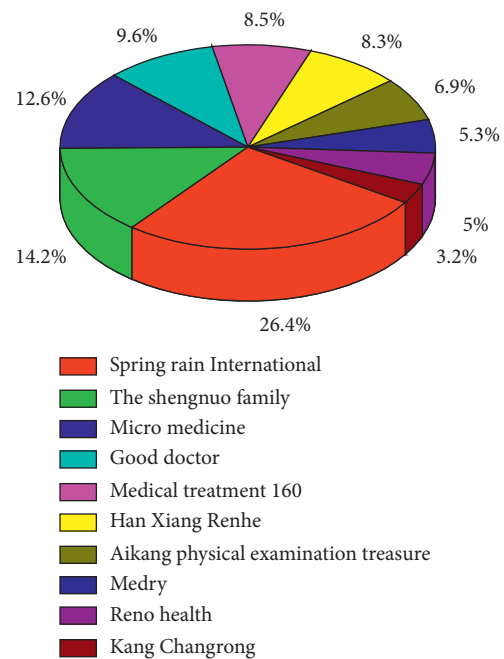


FIGURE 4: Proportion of Health care tourism industry market of enterprises.

Markov chain method is used to sample the economic benefits in different years. Either treatment has a high growth rate in size in 2019-2020 under Markov model. Firstly, it is assumed that the target distribution $p(x)$ is directly processed by normal distribution, as shown in Figure 7:

According to the Markov probability distribution of different years in Figure 7, it can be inferred that with the development of the times, peoples recognition of Health care tourism industry products has gradually increased, which is very obvious in the probability distribution. Through the probability change distribution from 2017 to 2020, it can be

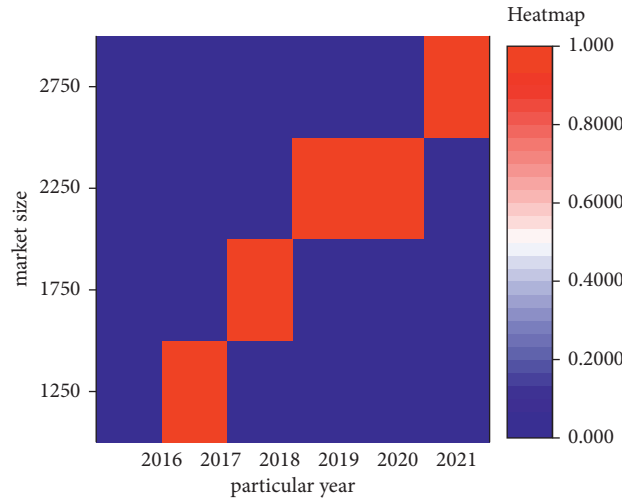


FIGURE 5: Trend of medical industry data.

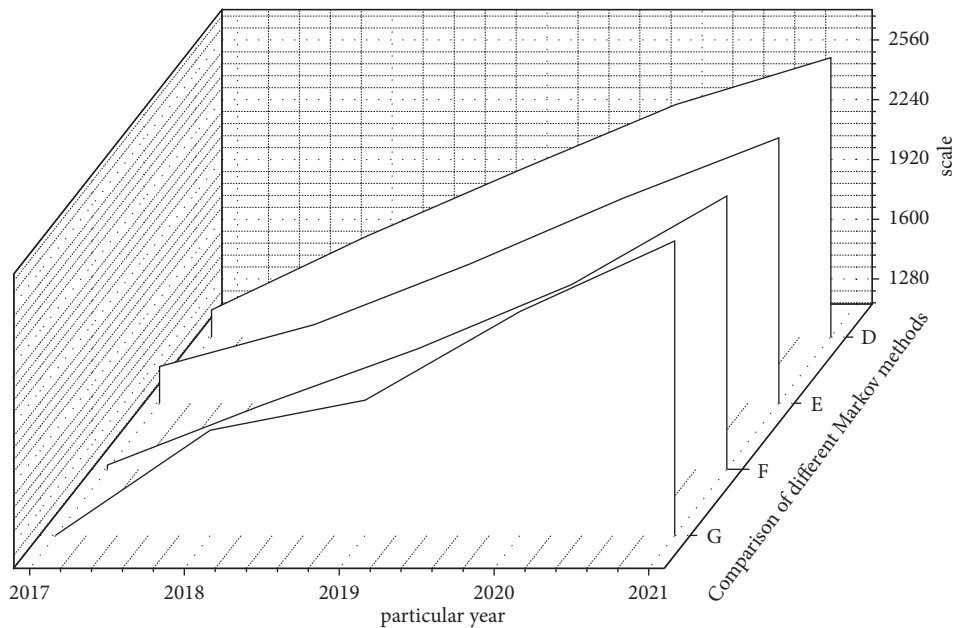


FIGURE 6: Results of various processing methods of Markov model in different years.

seen that the density and frequency increase significantly in 2020. The above shows that peoples interest and activity in participating in Health care tourism industry products have increased. Through the cloud chart of income and annual growth efficiency of different treatment methods under the Markov model from 2017 to 2020, we can further understand the income brought to participating enterprises under the whole market scale. As shown in Figures 8 and 9:

As can be seen in Figures 8 and 9, the revenue profile of the medical tourism industry highlights a peak situation in 2021 under either algorithm analysis. The annual growth rate increases significantly from 12.46% to 17.56% in 2019–2020 and remains high at 20.07 in 2021. The high growth trend of the benefits has been assessed by the growth rates of different models indicate that the medical tourism industry is very economically efficient.

To sum up, we can get the following enlightenment. First, people will choose to treat diseases and travel in better tourist sanatoriums, so that the status of Health care tourism industry will be further improved, consumers will receive better services in the process of Health care tourism industry, and enterprises will pay more attention to the overall protection. Secondly, China will guide enterprises and financial institutions with international competitive advantages to gather, introduce international advanced medical equipment and technology in stages, and gradually form a world-leading Health care tourism industry cluster, combining medical care, health management, rehabilitation, leisure and health care, tourism and sightseeing. Finally, in terms of development relations, the government is the main leader, and relevant enterprises in the Health care tourism industry chain follow up; In terms of development form,

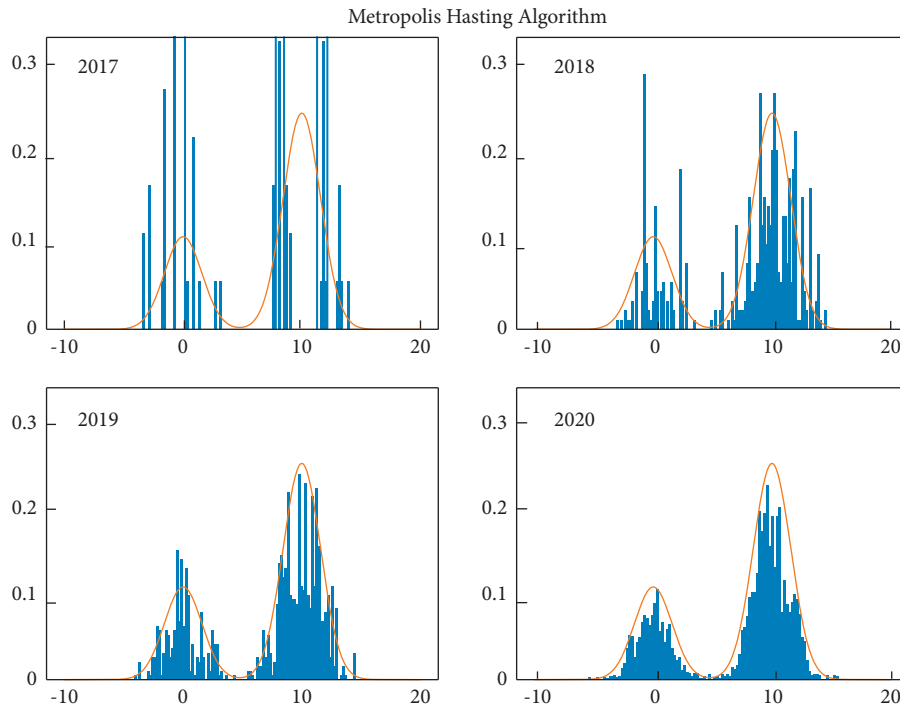


FIGURE 7: Probability statistics of different years.

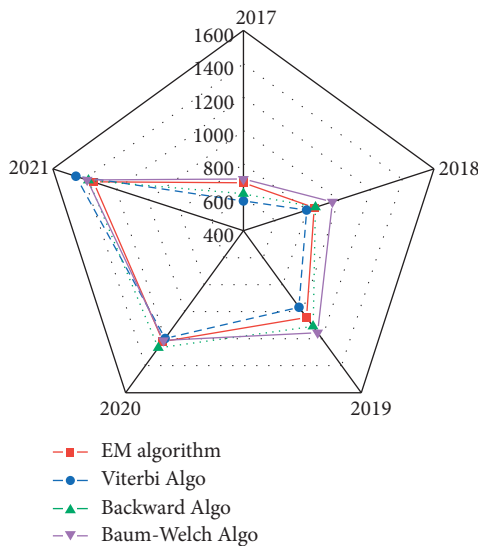


FIGURE 8: Income of Health care tourism industry under different algorithms.

four major forms will be formed, namely, city, town, park and district; In terms of development order, the first stage mainly includes market demand and research and resource promotion, packaging and design of Health care tourism industry products, the second stage is to develop Health care tourism industry supporting facilities and cultivate professional reception teams, and the third stage is to establish Health care tourism industry development fund and regulations and norms related to Health care tourism industry. In this way, the market scale and benefits can grow together for a long time.

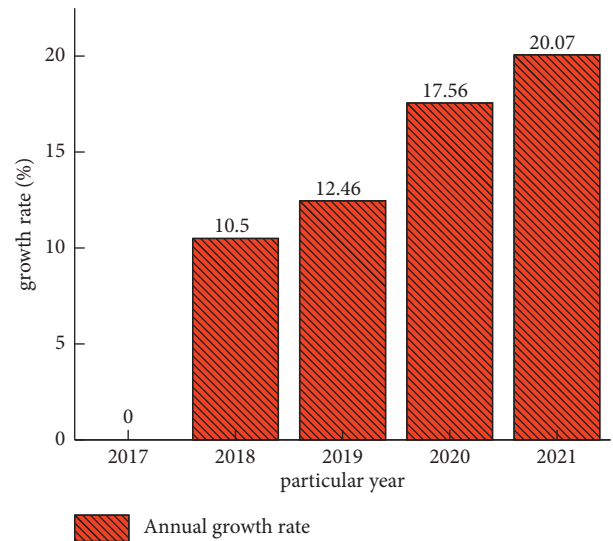


FIGURE 9: Annual growth rate of industry revenue.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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