Application of Real Option Theory to Mergers and Acquisitions (M&A) in the Pharmaceutical Industry

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Abstract. As for the mergers and acquisitions (M & A) in the pharmaceutical industry, the patent technology is one of the core values of the enterprise. However, according to the international evaluation criteria, but there are differences over the valuation strategies on the patent technology. Currently, the valuation methods used in the market are mainly cost method, market method and income method. When it comes to the uncertainty and continuity of the M & A, the real option theory can correct the valuation by late adjustment. This paper tends to interpret the real option theory through the simulation of BSM model and binary tree model, and to interpret the application of the gambling agreement to the actual operation of M & A.

1. Introduction
The big health industry is a fast developing industry in the national economy and with the global aging, it will maintain a rapid growth in the next 30 years. In order to expand the market scale and form higher industrial barriers, large pharmaceutical enterprises need to improve the layout of the entire industrial chain. The important means are mergers and acquisitions; for example, Huayuan system, China Resources system, and Fosun system completed the industrial chain integration and scale expansion through mergers and acquisitions.

Mergers and acquisitions can optimize the enterprise's operating income, profit, earnings per share and other indicators, and achieve leapfrog growth in power and scale. Enterprises further expand the market share or form industrial closed loop to enhance competitiveness. In the capital market, the stock price will also give more premiums because of the merger and acquisition issue. Merger and acquisition has become one of the important means to realize enterprise strategy, integrate industry chain and optimize resource allocation. According to the statistics of mergers and acquisitions of a-share listed companies, the average premium rate of merger and acquisition in China keeps rising from 3% in 2010 to 46.3% in 2017: take the pharmaceutical industries for examples, Huarunsanjiu acquired Tianhe pharmaceutical industry at a premium of 1.36 times, which cost 583 million yuan. Xiangxue Pharmacy Company acquired 70% equity of Huqiao Pharmaceutical Industry at a premium of more than 5 times, reaching RMB 448 million. Through mergers and acquisitions of unlisted companies in the same industry, listed pharmaceutical companies can expand the market with the help of the target company, or share the target company's regional and user resources, expand the industrial chain or form a monopoly advantage in the same industry, or even directly set their hands on emerging markets and improve core technologies.

From a large number of empirical studies, one of the main reasons for the failure of merger and acquisition activities is that the valuation of the target enterprise is unreasonable, and there are differences between the two parties. The pharmaceutical industries are characterized by high technical
barriers, high input, long output cycle and relative monopoly. However, the low concentration of China's pharmaceutical industries and the large impact of industrial policies have brought about an opportunity for the merger and reorganization in China's pharmaceutical enterprises. The merger and acquisition of pharmaceutical enterprises is very complex and diversified, including the selection of the target enterprises, the evaluation of their value, as well as the subsequent negotiation game and enterprise integration. Among them, the reasonable valuation of the target enterprise is the key to the success of the merger and acquisition, especially the valuation of core patented technology and related product approvals.

### Table 1. General Procedures and Contents of Enterprise Merger and Acquisition [1].

| The first stage | The second stage | The third stage | The fourth stage |
|-----------------|-----------------|-----------------|------------------|
| research preparation before m&a | m&a valuation | implement m&a | m&a integration |
| clear purpose of m&a; Formulate m&a strategy; select target enterprises | choose valuation methods; assess enterprise value | clear payment method; Negotiations to sign; implement m&a agreement | implement m&a strategy; create synergy |

#### 2. The valuation differences of subdivided pharmaceutical industries in m&a

The pharmaceutical industry includes many subdivided industries, such as medical devices, Chinese medicine preparation, western medicine preparation, drug circulation, Internet medical services, gene testing and treatment, etc. In the pharmaceutical industry m&a, the market valuation of subdivided industries is not the same. For example, in 2016, the PE valuation of unlisted pharmaceutical companies in the capital market was concentrated at 10-20 times; The PE valuation in the secondary market was between 20-80 times after they went public; Among them, the valuation of medical equipment and Internet medical service industry continued to be more than 50 times, while the valuation of western medicine intermediate preparation and drug circulation industry was between 20 and 40 times. Meanwhile, the valuation gap between the primary and secondary markets promoted a large number of listed companies and acquired enterprises to actively participate in mergers and acquisitions and achieve higher returns through asset securitization. The main reason for different valuations in the m&a of subdivided pharmaceutical industries fields is still the differentiated resources such as technology content, patent protection and license scarcity in different fields, among which the valuation of patented technologies is the core.

From the perspective of subdivided pharmaceutical industries, the medical device sector has the largest number of mergers and acquisitions. After Huarun pharmaceutical industry exchanged and sold its Wandong medical stock to a listed company named Yuyue medical, Yuyue medical group achieved an excellent price performance in the secondary market and achieved high returns with the highest increase of 160%. Chutian technology in the medical device industry also acquired Changchun Xinhuatong pharmaceutical equipment co. LTD, which not only increased the market size of domestic pharmaceutical water equipment and the manufacturing capacity of medical and sanitary process equipment, but also promoted the rise of stock price and capital gains. Other pharmaceutical companies with more active M&A business also include Aier Ophthalmology, Luye Pharmaceutical, Dongcheng Pharmaceutical, Jincheng Pharmaceutical, Yuheng Pharmaceutical, Jiashitang Pharmaceutical, Qianshan Pharmaceutical Machinery, etc, which have had multiple mergers and acquisitions. Not only do pharmaceutical companies conduct mergers and acquisitions for their own industrial chain layout, but some Internet technology companies are also following them with their own resources. For example, Neusoft Group, expands its market layout to emerging areas such as smart medicine and Internet medical services through acquisition.

The trend of drug distribution industry is that the concentration of large chain drugstores is getting higher and higher, which forms channel barriers and scale advantages. Independent drugstores are
finding it more and more difficult to survive, and many choose to close down or be integrated. However, with the reform of the national medical system, the acquisition and expansion of the drug distribution industry is not the only way for the brick-and-mortar chain drugstores. Meanwhile, it is also critical to develop the pharmaceutical e-commerce business. In the valuation of enterprises in the drug distribution industry, different from the patented technology of drug enterprises, the scarcity of drug distribution license and the market coverage of physical stores are the core points of valuation.

In the boom of mergers and acquisitions in the pharmaceutical industries, there are fewer and fewer high-qualified pharmaceutical targets with core technologies and good profits in the primary market, and it is more difficult to form the industry mergers and acquisitions dominated by monopoly and thickening profits. From the perspective of enterprise strategic development, it is very important for traditional pharmaceutical enterprises to build a closed loop of industrial chain. At the same time, with the deepening of medical system reform, new industrial changes such as access to Internet medical services, gene sequencing, cell therapy, and public hospital reform are also priorities for the future development of enterprises.

3. Brief Introduction to enterprise value assessment methods
In The Asset Appraisal Criterion -- Enterprise Value written by China asset appraisal association in February 2012, defines the enterprise value assessment as the process and behavior of certified asset appraisers to analyze, estimate and give professional opinions on the overall value of the enterprises under the specific purpose of the base date of appraisal in accordance with relevant laws, regulations and asset appraisal criteria.

In the complex m&a transactions, each valuation method has different preconditions and applicability. Therefore, enterprises should consider various factors comprehensively to determine the most suitable method and model.

1) Cost method. Also known as the asset value-based method, it reveals the enterprise value from the perspective of the reconstruction of each individual asset that constitutes the overall value of the enterprise. The use of cost method has two basic assumptions: first, the enterprise's single asset correlation is not strong, so that the overall profitability of the enterprise is poor; Second, the cost of each asset of the replacement enterprise can be accurately calculated. Under different application conditions, cost method can be divided into book value of net assets, replacement value and liquidation value [2]. Cost method is one of the most frequently used methods in the disposal of assets of state-owned enterprises in China, but it is difficult to fully reflect the overall value of enterprises in the valuation of intangible assets and therefore it often needs to be applied in combination with other methods according to the actual situations of specific targets.

2) Market method. It refers to that enterprises similar to the target company in product model, business model, market share and other aspects are found through the capital market as a reference, and various indicators such as its PE ratio and Net assets yield rate are used for analysis and comparison, and appropriate parameters are selected for appropriate correction, and accordingly the corresponding valuation is given. There are two basic assumptions in the market method: Firstly, the capital market is broad enough that there are listed companies in various industries with sufficient active trading volume. Secondly, in the capital market, all kinds of indicators and relevant data of benchmarking enterprise are true and effective, and the stock price given by the market can fully reflect their value. Market method can evaluate the company more accurately, but it needs a similar reference or merger cases in the capital market. In practice, the market method is mostly used for the real estate evaluation of the same location or M&A in the same industry.

3) Income method. It is to estimate the future income of the assessed asset according to a certain service life, and then is to discount the present value by a certain discount rate, which is the valuation of the asset. The conditional assumptions of the income method are the enterprise must have sustainable profitability and cash flow. When income method is used, how to determine the expected income, discount rate and duration of each stage of the target enterprise is the key. According to the different references of cash flow, it can be divided into equity cash flow discounted model, free cash
flow discounted model and economic profit discounted model. Income method is the most effective method of all kinds of valuation methods to reflect the future profitability of capital. Through the enterprise's profitability and risk considerations, as well as the time value of currency, it can better reflect the intrinsic value of the enterprise, and can also be applied to the evaluation of intangible assets such as patent technology, brand, and license plate approval [3]. The income method mainly emphasizes the discount of expected income, but there are too many variables and uncertainties in the actual operation. In addition, it is difficult to determine the discount rate accurately, which is also the difficulty in the application of the income method.

4) Real option method. Option refers to the rights of the contract holder to buy or sell an agreed asset after paying certain fee at the agreed price on a certain date. Real option is a kind of option with the investment opportunity as the agreed target. The adjustment of whether the future option is exercised or not can more accurately reflect the intrinsic value of the enterprise. Especially in the valuation of high-tech enterprises intangible assets, the results will be more scientific and reasonable [4]. According to the uncertainty of the investment cost and the discounted value of post-investment income of the project, Stettwitz (2003) first applied the real option method to the evaluation of the patent value. The real option method is mainly divided into Black-Scholes formula and binary tree model. In practice, a "counterparty agreement" should also be considered as a kind of real option method. Option valuation method releases the time value of investment opportunity, and the operating conditions of high-tech enterprises and pharmaceutical enterprises are very consistent with the conditions for option pricing [5].

In a word, the valuation of an enterprise is characterized by integrity, multi-angle, comprehensiveness, uncertainty, etc. In the actual operation process, we should use a combination of methods for valuation according to the actual situation and transaction position of the evaluated enterprise, so as to make the results more accurate and effective.

Table 2. Basic Method Comparison on Value Assessment of Target Enterprises in m&a.

| basic methods of value assessment | cost method | market method | income method | real option method |
|----------------------------------|-------------|---------------|---------------|-------------------|
| basic assumptions                | Enterprise value is the sum of the tangible asset values minus the liability value | The capital market runs standardly, and effectively; Market information is reliable. | Enterprise value can be expressed as the present value of future cash flow. | Information asymmetry |
| main methods                     | book value method; liquidation value method; cost method of replacement | comparable companies method; comparable transaction method | discounted cash flow method; economic value added evaluation method | BSM model; binary tree method; bet agreement |
| assessment result                | fair market value; liquidating value | market value | intrinsic value of enterprise; continuous operating value | performance commitments |

4. Analysis and comparison on valuation methods of pharmaceutical enterprises
In consideration of their economic interests, foreign large enterprises generally employ professional institutions such as Goldman Sachs, Merrill Lynch as independent financial advisers to provide
integrated merger and acquisition plans. China's M&A service intermediaries are relatively late in development and belong to the emerging industry. Therefore, the assets of M&A investment companies or consulting companies are relatively small. At present, investment banking departments of securities firms are the main body, and some professional investment banking service institutions and industrial capital systems such as Oriental Gaosheng, Wutong system and Zhongzhi system have also appeared in the M&A cases of a-shares.

When pharmaceutical enterprise in merger and acquisition is valuating the target enterprise, the lack of a comprehensive and reasonable evaluation often leads to a large price deviation, and further leads to valuation differences and merger failures between the two negotiating parties. This paper analyzes and compares the valuation methods of pharmaceutical enterprises based on the characteristics of China's pharmaceutical industry, the influencing factors of enterprise value and the situation of mergers and acquisitions.

1) Cost method. Basically, it cannot be used for the evaluation of the overall value in pharmaceutical enterprises, mainly because of the unrepeatable professional barriers such as patent technology, license plate approval and drug approval number of pharmaceutical enterprises, and the value of these intangible assets cannot be expressed by cost method. At the same time, the actual benefits and operation efficiency of pharmaceutical enterprises are relatively high, and the cost method can not accurately calculate their value and the future potentials of enterprises, so the cost method is not applicable to the value evaluation of pharmaceutical enterprises in China.

2) Market Method. The accuracy of market method valuation is greatly affected by the degree of market development and efficiency. At present, there are license barriers for entry and exit in China's pharmaceutical industries. The capital market in the efficiency of resource allocation is underdeveloped, which makes the influence of the stock market weakly effective.

3) Income Method. Our country medicine industry with the coming of aging society in China and the national health industry policy is in the rising development. Combined with the above situation, the growth rate and discount rate of large and medium-sized pharmaceutical enterprises can be basically predicted and determined. However, for the valuation of start-up and innovative small and medium-sized pharmaceutical enterprises (due to their short operating time, insufficient cash flow and other reasons), income method is difficult to fully reflect their future value.

4) Real Option Method. The pharmaceutical industry is deeply affected by uncertain factors such as the expiry date of prescription patents, the expiry date of equipment patents and technologies, the emergence of product life cycle and alternative drugs, and the change of enterprise market environment. Therefore, its capital characteristics are characterized by multi-stage continuous investment and high risk. In the process of M&A, these uncertainties lead to asymmetric information and M&A risks for both parties. These uncertainties and asymmetric information risks can be reflected in the merger and acquisition agreement of the two parties through real options [6], therefore the evaluation results are closer to the real value of the enterprise.

5. Valuation method of pharmaceutical enterprises by real options

High-tech industries represented by TMT, new materials and biomedicine have great uncertainty and potential value in M&A transactions, so the valuation method of real options is widely used in M&A in these fields. When the option is applied to real assets, it is called real option, which is a realistic choice right defined by the concept of option, which is mainly manifested in the adjustable option right of certain assets or equity in face of the uncertain factors of future performance in the M&A agreement due to the uncertainties about future performance in the M&A agreement.

The value of patent rights in pharmaceutical industries is mainly reflected in the fact that it has a certain timeliness of legal protection of monopoly, and it contains an opportunity to obtain a certain amount of cash flow within the future validity period, which is equivalent to the real option to pay investment income in the future and can be regarded as the call option.

The acquirer often faces many uncontrollable risks such as technical risk, market risk and moral risk when implementing the acquired patent rights [7]; The real option method takes these uncertain
factors into consideration when pricing, and it can better adjust the demands of both sides of merger and acquisition than the traditional evaluation method. Therefore, in practice, many large merger and acquisition cases use the evaluation method of real option theory to replace the traditional evaluation method. Many examples prove that the theoretical method of real option is a method that can accurately evaluate the patent value of related enterprises. The main models of real option theory should be B-S-M option model and binary tree model, as well as valuation adjustment agreement, as follows:

1) B-S-M Option Model and Binary Tree Model

Real option models mainly include discrete model and continuous model, among which the most representative are B-S-M option model and binary tree model. The B-S-M option model is only suitable for European options. And it is difficult to find the expression of the solution. Moreover, the process of mathematical deduction and solution is too complicated for the average person to understand and master. The binary tree model is suitable for both European and American options and is more easily accepted for simplified calculation and increased intuition [8].

(1) B-S-M option model

\[ C = S \cdot N(d_1) - X \cdot \exp(-r \cdot T) \cdot N(d_2) \]

Where:
- Initial reasonable price of the option, \( X \)
- Option execution price, \( T \)
- Option validity period, \( r \) - Continuous compound interest rate risk-free rate
- Annual volatility of stock continuous compound rate of return (logarithm) rate of return (standard deviation)
- The annual average of return rate of stock continuous compounding (logarithm)
- \( N(d_1) \) - Cumulative probability distribution function of normally distributed variables.

According to the revised price earning ratio model, the pharmaceutical industry is a high growth industry, price earning ratio should be relatively high. The B-S-M option model can calculate a relatively reasonable enterprise valuation by considering a certain risk function and risk-free interest rate in the future. Take the contract price of a pharmaceutical company’s acquisition of a pharmaceutical company in the same industry as an example to calculate, the closing price of a pharmaceutical company is 5 yuan per share. If the agreed performance is not achieved within 24 months, one million shares can be executed at the price of 4 yuan per share, and the option is valid within 24 months; During the same period, the risk-free interest rate of the national debt in the capital market is 2% annual interest; The annual volatility of stock’s continuous compound rate of return is 0.5; The annual average of the stock’s continuous compound rate of return is 1. The current price is calculated as follows:

\[ d_1 = \frac{\ln(S/X) + (r + 0.5 \cdot \sigma^2)T}{\sigma \sqrt{T}} \]
\[ d_2 = d_1 - \sigma \sqrt{T} \]
\[ C = S \cdot N(d_1) - X \cdot \exp(-r \cdot T) \cdot N(d_2) \]
\[ C = 5 \cdot N(0.7256) - 4 \cdot \exp(-2\% \cdot 2) \cdot N(0.0186) = 1.87951 \]

(2) Binary Tree Model

Option pricing model (also called binomial model or binomial tree method) is a kind of option pricing model proposed by Cox, Ross, Rubinstein and Sharp, and is mainly used to calculate the value of American options. The binomial option pricing model assumes that there are only two directions of price fluctuation: upward and downward, and that the probability and amplitude of each price fluctuation remain unchanged throughout the validity period. The model divides the duration of the study into several stages. The historical volatility of stock price is used to simulate all possible development paths of the price in the whole duration. In addition, the exercise income of warrants and
the discount price of warrants are calculated for each node on each path [9]. Because American authority card can exercise authority ahead of schedule, therefore, the theoretical price of the warrant on each node, should be the bigger one between the warrant price calculated by warrants exercise income and the warrant price calculated by discount.

While calculating mergers and acquisitions valuation in the pharmaceutical industry according to the binomial tree model, exercise of B-S-M option model at the appointed time is more suitable for the following reasons: it can exercise the right at any time on the basis of American warrants; The agreed time period in M&A transactions is usually measured by years to calculate the discount rate, more similar to the European option [10].

2) Valuation Adjustment Agreement

Valuation adjustment agreement (also known as the bet agreement) is a tool used for risk management by enterprises in mergers and acquisitions. Its theoretical basis is option theory and information asymmetry theory. The bet agreement is a kind of option, which can be exercised by both parties according to the agreement. As an option, its value comes from the uncertainty in the future, which is directly related to the success or failure of M&A [11]. The bet agreement can well solve the moral problems and adverse selection caused by information asymmetry and coordinates the interests and risks of both sides in a consistent position.

Due to the information asymmetry between the two parties in the merger and acquisition, the valuation of the target enterprise will be greatly different from the two parties in terms of internal management, customer relationship, market value of the patent and stability of the core technical team. After the merger and acquisition, it is crucial for the acquirer needs to integrate the original enterprise, retain the core technical team and management, continue the integration of efficient management and corporate culture, and it is necessary to design good incentive measures to motivate the core technical team and management of the target enterprise [12]. Cory Smith (2003) suggests that these problems can be solved by designing effective bet (essentially options on both sides) in a trading agreement: By the later payment, based on future performance cashing of the target company as a reference standard, it can bridge valuation gaps and differences and thus retain and motivate the target enterprise's management and core technology team [13].

The payment method of the bet agreement in the merger transaction is divided into two parts: The advance payment to the original shareholders of the target enterprise at the end of the transaction; the remaining payment based on the future performance of the target enterprise after the transaction (adjustable option), and multiple factors need to be considered to achieve an appropriate balance between the two parts [14]. The composition of the bet agreement is relatively complex. When the acquirer and the transferor reach the merger agreement, they agree on the uncertain situation in the future: The transferor may exercise certain rights if the agreed terms are realized (usually for profit performance or market share, etc.); If the agreed terms are not fulfilled, the purchaser exercises certain rights. The bet terms mainly include valuation adjustment terms, performance compensation terms and equity repurchase terms. The three terms above are aimed at the uncertainty of the future of the enterprise and the asymmetry of information between the two parties, so they also include option structure design [15]. Transaction amount, term, performance target, co-sale equity, payment schedule, competitive restriction, anti-dilution, stock price and other factors will play a great role in the effective implementation of the bet agreement, and various factors shall be taken into consideration in its design.

When evaluating mergers and acquisitions of pharmaceutical enterprises, patent technology and patent right are often faced with many uncontrollable risks such as technical risk, market risk and moral risk in the implementation process and there are cognitive differences between the two parties in its value and risk [16]. Therefore, by using the bet agreement, adjusting option selection on whether future performance or indicators can be achieved is a relatively fair and effective method to facilitate m&a transactions. In the mature capital market, valuation adjustment is a very important technical link in M&A: Both parties of the transaction cannot make 100% correct judgment on the future prospect changes of the target enterprise. Therefore, both parties tend to adjust the transaction price according
to the actual situation in the future. The specific technical operation is usually completed by means of equity ceding or cash payment.

The real option method regards the uncertainty in M&A transactions as a positive state. Through the structural design of options, it can integrate the post-merger integration and team incentive design, and can provide important strategic methods for evaluating complex assets and making project decisions. In the property appraisal of patent right with great uncertainty, the real option method not only retains the essence of the traditional appraisal method, but also corrects some of its defects, which is of great significance and practical value.

6. Conclusion
The value assessment of patented technology is an important factor affecting the valuation of pharmaceutical mergers and acquisitions, which is a non-material commodity. The means, forms, methods and time required in the whole process from project approval, research and development to patent achievement, and finally to marketing and application of products are uncertain. After the merger, its profitability is not only affected by the patent itself, but also restricted by many external factors, including the market capacity of terminal products, the market capacity of patented technology trade and the substitution of competing products. Therefore, various factors should be taken into consideration in the evaluation process, and adjustments should be made according to different positions of both parties. Among them, the transaction design method of real options is very valuable for reference in practice.

It can be seen from the articles above that all the enterprise valuation methods have basic assumptions. From a certain perspective, the enterprise value is evaluated according to specific approaches. The assessment methods in the calculating process reflect their different focus of the valuation methods. In the practical operation, it should be used selectively according to the different positions of both parties, market environment, evaluation purpose, relevant laws and regulations.

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References
[1] Reference mechanism: Shanghai national accounting institute. Merger and reorganization of enterprises [M]. Beijing: Economic Science Press, 2011.
[2] Z.D. Liu, W.G. Zhang. Several Misunderstandings on the Application and Existence of Real Option Theory in China [J]. Science of science and management of science and technology. 2009(01):98-101.
[3] H.S. Wang. Intangible Assets Assessment [M]. China Renmin University Press, 2002.
[4] Z.G. Liu, L. Yin. Further Discussion on Patent Value Assessment [J]. Value engineering, 2004(5):29-31.
[5] X. Zhang. Research on Patent Assets Evaluation Methods in Intellectual Property Transaction [J]. Theoretical Wide Angle, 2014(1):363.
[6] M.Y. Li, G.M. Liu. Analysis on Influencing Factors of Patent Value Assessment [J]. Chinese Invention and Patent, 2013(07):31-33.
[7] X.J. Li. Risk Factor Analysis in Patent Value Assessment [J]. Electronic Intellectual Property, 2009(12):66-69.
[8] W.T. Cheng. Value assessment of patent assets [J]. Electronic Intellectual Property, 2011(08):74-80.
[9] J. Wang, Y.C. Wu and D.H. Sun. Research on Evaluation Methods of Non-commercial Patent Value Based on Decision Tree Model [J]. Economic BBS, 2012(10):131-136.
[10] M.Y. Li, G.M. Liu. Analysis of Influencing Factors of Patent Value Assessment [J]. Chinese
[11] G.W. Han, Z. Liu. Review on Real Options Research at Home and Abroad [J]. Technical Economy, 2006(04):95-96.

[12] W.J. Xu. Analysis on the Current Situation of Patent Value Assessment in High-tech Enterprises in China [J]. Journal of Jilin Normal University of Engineering Technology. 2014(5):78-81.

[13] C. Zhao. Methods and Practices of Patent Value Assessment [J]. Electronic Intellectual Property, 2006(11):24-27.

[14] Y. Yang, W.X. Hu and N.D. Yang. Review on Real Option Pricing Theory and Prospect of Future Research Field [J]. Research on Quantitative Economy and Technical Economy, 2004(12):147-151.

[15] Y. Pan. Fuzzy Evaluation of Patent Value Based on Analytic Hierarchy Process [J]. Information Exploration, 2014(10):16-19.

[16] Q.L. Yu, H.J. Zhao. Research Review on Value Assessment of Enterprise Patent Asset [J]. Modern Intelligence, 2014(9):171-176.