

Review of Chinese Patent Value Evaluation Methods

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Abstract With the development of era, Chinese government pays increasingly more attention to the improvement of innovation ability. Under the guidance of the government, the number of patents in China has exploded in recent years. However, the increase of the patents number does not necessarily imply the improvement of the value. Many scholars focus on the evaluation of patent value. This paper provides a review of Chinese patent value evaluation methods including the traditional and emerging approaches as well as other modern mainstream methods. Some suggestions are further proposed.

Keywords: patent value, traditional approach, emerging approaches, patent value model

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1. Introduction

Since the founding of New China, its economic development has embarked on a fast track. However, the lack of core technologies has put China at a disadvantage when confronted with a trade war or other crises, which has forced China to pay more attention to innovative development. Since China established its patent system in 1985, the number of patents in China driven by the Patent Promotion Policies (PPP) has grown rapidly. In 2011, China ranked the first in the world in patent applications. Not only do the surge of patent applications bring great pressure on patent examiners, but also causes domestic scholars to question the quality and value of patents. How to estimate the patent value is an important but challenging research topic. More and more scholars have made great efforts to explore the evaluation methods of patent value. This paper will summarize the evaluation methods of patent value in China.

2. Traditional Methods

Traditional patent value evaluation methods mainly include cost method, market method and revenue method. These methods regard patent as an ordinary intangible asset and evaluate patent value based on traditional asset evaluation method.

2.1. Cost Method

The idea of cost method is to use the R&D cost or replacement cost of patent to measure the patent value [1]. In this method, patents are regarded as an ordinary commodity for exchange, and the necessary labor productivity to

produce a patent is the value contained in the patent. The biggest disadvantage of using cost method to estimate patent value lies in that it does not conform to the way patent value reflects. Most companies applying for patents do not sell them directly, but make products and then earn profits by selling them. Thus the value of patents generally far exceeds their research and development costs. Directly using the R&D input cost to measure the value of the patent may greatly underestimate the patent value.

2.2. Market Method

The idea of the market method is to use the value of similar patents in the market to evaluate the patent value [2]. This method takes the market's attitude towards a certain patent into account, believing that fair value can reasonably reflect the value of a patent. Similar to the cost method, it does not consider the way in which the patent value reflects. Obviously, simply using market value to measure the patent value may generate large bias. In addition, this method also has practical difficulties. Generally speaking, patents are not used for exchange directly. Hence, there is a lack of market value for similar patents reference. Therefore, this method is not suitable for evaluating the patent value either in thinking or in practice.

2.3. Revenue Method

The idea behind the revenue method is that the present value of future cash flows from using patents minus the present value of future cash outflows from R&D and maintenance of patents [3]. This method can accurately calculate the net cash flow to enterprises brought by patents, which can reflect the patent value to some extent. The disadvantages of this method, however, are also obvious, mainly because it is difficult to determine the parameters required for the calculation as well as large

amount of computation. First of all, it is impossible to accurately estimate how much revenue a patent will generate in the future. Especially, it is difficult to predict when the rapidly updated patent will be replaced by other patents and lose its economic value. Second, patents are not the same as the mature technology. A technology may contain many patents, and a product often contains many technologies. Even if we can accurately predict the future revenue of the product, it is still difficult to calculate the specific revenue generated by a patent separately. Moreover, the discount rate may be subjective when calculating the net present value. Finally, this method has a large amount of computation, and the determination of parameters contains a lot of subjective judgments. It indicates that the calculation results are often not in line with the actual situation even though the idea is correct.

3. Emerging Methods

As time goes on, more and more scholars find that the traditional asset evaluation methods are not applicable to the evaluation of patent value. Many domestic and foreign scholars have made long-term efforts to build a new set of modern patent value evaluation system. In this system, the patent value is mainly divided into technical value, economic value and legal value. Each type of value inside is further divided into several related indicators, to measure patent value from a relatively objective and reasonable perspective.

3.1. Technical Value

Frankly speaking, technical value is simply the value that a patent contains in its own technology. It doesn't matter how much economic interest the patent will bring in the future. Instead, we should see how much value the patent contains from the perspective of technology. The evaluation index of technical value includes the number of references, the number of citations, and the degree of substitutability.

3.1.1. Number of References

The number of references refers to the number of citing other relevant documents for a patent. If a patent refers to a lot of existing research results, it shows, on the one hand, that the patent is closely related to the previous research results and has technical continuity. It develops the previous research results, which are valuable and in line with the reality. On the other hand, the more other research results are available to prove a patent, the more difficult the technology contained in a patent is to overturn. And it is also not made up at will. Of course, there are drawbacks merely using the number of references to measure a patent technical value. If almost every patent is the stack of previous research results, it may also indicate that the patent itself is not innovative enough. Therefore, we should use the number of citations together with other indicators to reflect the value of the patented technology reasonably.

3.1.2. Number of Citations

Contrary to the number of references, the citation number refers to the number a patent is cited by other

patents [4]. This index can reflect the technical influence of patents to some extent. If a patent is never cited by other patents and exists alone, it may indicate that the technical value of the patent is limited and its influence is small. On the contrary, if a patent is cited many times, it indicates that the patent is highly recognized and influential. Its technology can not only be used by one patent, but also affect many later patents, which are likely to be the core patents. The number of citations has been generally recognized, but there are still some problems in the practical use process. For example, it is quite reasonable that the citation number of newly granted patents is much less than that of old patents, which does not generally indicate that the value of newly granted patents is low. Besides, we cannot directly compare the citation numbers of patents in different fields because their distributions are inconsistent. In view of these problems, some scholars have revised this indicator.

3.1.3. Degree of Substitutability

The degree of substitutability refers to the degree to which a patent can be replaced by another patent. One of the important reasons for establishing a patent system is to avoid duplication of research and the waste of resources. Due to geographical barriers, technologies that have been popular in one area may be vigorously developed in another. Obviously, the technical value of this technology is greatly reduced after the second development, because it can be completely replaced. Therefore, patents of high technological value should be in low degree of substitutability. Only in this way can the core competitiveness of the patent be highlighted. The biggest problem with this indicator is that, it is difficult to quantify the degree of substitutability and need a large number of other indicators to calculate the degree of substitutability.

3.2. Economic Value

Economic value is an important component of patent value. The best way for a patent to generate revenue is to convert it into technology, produce and sell products, and then generate revenue. Due to the existence of scale effect, the patent value generated by this method is far higher than the cost of the R&D investment of the patent itself and the patent technical value. Therefore, calculating the economic value of patent becomes an important part in evaluating the patent value. In the following, we will make a detailed introduction from the perspectives of patent conversion degree, patent demand relationship, market competitiveness and market monopoly degree, policy support and other indicators [5].

3.2.1. Patent Conversion Degree

The degree of patent conversion refers to whether the patent can be transformed into a technology that be used to produce products. Patents with high economic value should be put on the market to generate large cash inflows. However, not all patentees apply for patents to turn them into productive forces. With the national innovation strategy, local governments and organizations take possession of patents as a bonus when evaluating professional titles or being promoted. It is in response to the national call to

increase the number of patents in their regions. Therefore, some patentees usually apply for a patent with the intention of earning a high salary and getting a professional title. However, they discard the patent after that and do not carry out further development and utilization. This is also an important reason why the number of patents in China has exploded but the quality is decreasing. As a result, the degree of patent conversion is an important indicator to measure the economic value of patent.

3.2.2. Patent Demand

Patent demand relationship refers to the degree of patent demanding in the corresponding product market. When a patent is converted into a production technology, it will be affected by the relationship of market demand. If we want a patent to produce high economic value, it must have enough market demand. If we just produce some products inconsistent with market demand, they will be eliminated by the market naturally and cannot generate the inflow of economic benefits.

3.2.3. Market Competitiveness and Market Monopoly

Market competitiveness and degree of market monopoly refers to the competitive power of patent in the corresponding product market, and whether the market monopoly has been formed. It is a complicated process of converting patent into product to earn a large number of economic benefits. Transforming patent into technology and then into production and sales is only a basic part. What is more important is that the product has market competitiveness. In a market, as long as there is market demand, many similar products will emerge. Product competition is inseparable from patent competition. When the patent technology contained in the product has strong market competitiveness or even reaches the level of market monopoly, its technical barriers can often make the product sell smoothly and obtain huge scale benefits.

3.2.4. Policy Support

Policy support refers to the policy for the corresponding product of a patent or the related fields of a patent. Policy environment is an important environment that affects enterprise development and product sales. China has issued many policies to support the development of some emerging environmental protection industries, such as artificial intelligence industry, and also issued some policies to restrict or even eliminate some industries, such as electrolytic aluminum industry. The more strongly a patent is supported by the policy, the more likely it is to be widely promoted, so as to expand product sales and increase sales revenue. On the contrary, if a patent can only be applied to an industry that has been eliminated, it will be difficult to generate economic benefits.

3.3. Legal Value

The legal value of patents is the value that is granted to a patent after he or she has applied for the patent. Actually, legal value does not directly bring economic benefits to the patentee. However, only with legal value can the patentee develop the patent product and generate economic value. As for how to measure the legal value of

patent, there are patent remaining period, patent stability, patent family size and so on.

3.3.1. The Patent Remaining Period

The patent remaining period refers to the remaining protected period that a patent is under the provisions of law. No law can protect patent forever. According to our country's "patent law" regulation, the time limit of invention patent is 20 years from the date of application. Utility model patent and exterior design patent are 10 years separately. In addition, the protected period for patent will terminate accordingly if the patentee fails to pay the annual fee as stipulated. After the protection period ends, the patentee no longer owns the patent and also loses the right of control over the patent, leaving the legal value of the patent disappear. Thus, the longer the remaining patent period is, the more likely it will have other value. In a word, the patent residual period is a basic indicator of the patent value.

3.3.2. Patent Stability

Patent stability refers to whether the patent encountered legal proceedings and the outcome of the litigation. Only when the patentee controls the patent does it have legal value. If there is a dispute over the ownership of the patent and impossible for us to confirm or even deny the patentee's ownership of the patent, then the legal value of the patent will reduce or even be lost. Therefore, the stability of patent resembles the patent remaining period, which are both the basic conditions for the legal value of patent. Losing these conditions, we cannot generate the legal value of patent and the generation of economic value will be affected consequently.

3.3.3. The Scale of Patent Family

In a narrow sense, the scale of patent family refers to the collection that the patentee applies for a patent in different countries. In a broad sense, it also includes the derivative patent of one. The scale of patent family is an embodiment of patent influence. The larger it is, the greater a patent's influence in regional and relevant fields is. Therefore, we can use the size of patent family to measure the value of a patent [6]. However, there are some exceptions. For example, some patentees may not be willing to apply for their patents abroad due to the different patent systems vary in countries, but the value of the patent may be high.

4. Other Evaluation Methods

Apart from the traditional and the emerging patent value evaluation methods, many scholars have proposed some other patent value evaluation methods. These methods are based on the existing methods with their own innovations.

4.1. Patent Life Cycle Theory

Patents are different from ordinary products, yet their economic value depends on the existence of products. Hence patents also have some characteristics similar to

ordinary goods. Some scholars have conducted research on the patent life cycle with the help of this feature, and found that a patent value varies in life cycles [7].

There are many classifications of patent life cycle. The mainstream classifications refer to product life cycle and it is generally divided into leading stage, growth stage, maturity stage and decline stage [8]. Combining life cycle theory with specific indicators, we can obviously observe advantages. Firstly, life cycle theory evaluates the value of patents from different time dimensions. Life cycle theory is more detailed and comparable compared with the theory putting all patents at the same time. Secondly, the life cycle theory avoids the defects of some indicators. For example, the citation numbers of new and old patents are significantly different. Considering the life cycle of patents, the defects of the indicators can be eliminated. Finally, the economic value of patents mainly reflects in the sales of corresponding products. It is favorable for enterprises to make correct strategic decisions considering the combination of patent life cycle and product life.

4.2. Patent Value Theory Based on Duration

This theory is different from the current mainstream technology value, economic value and legal value, which measure the patent value in three different dimensions. Patent value theory assumes that the patentee is rational. When the economic benefits of patent inflows cannot compensate the annual fee caused by the outflow of economic benefit, the patent holder can stop paying an annual fee, namely patent no longer survival. In this way, the duration of patent becomes an important indicator to reflect the patent value [9]. Foreign scholars have studied this theory for a long time, and domestic scholars have also modified the models of foreign scholars based on China's national situations [10].

In terms of this theory, [11] have done an empirical analysis of patent value evaluation model based on the duration. As the implementation period of China's patent law is relatively shorter than that of foreign countries, many patents have not been invalidated. So domestic scholars consider the unexpired patents in the model and use the modified model for data analysis. The results show that the patent value of Chinese enterprises is higher than that of research institutions, and there are few high-value patents, most of which are of low value [12].

4.3. Patent Value Model Theory

The patent value theoretical model refers to the Boston matrix. Taking the current rate of return as the horizontal axis and the coefficient of revenue growth as the vertical axis, the patent value is divided into growth type, problem type, high-quality type and short-term type [13]. Short-term type's current rate of return is high while the growth ability is low. High-quality type's yield and growth capacity are both also high. Growth type's current rate of return is low while the ability to grow high. Problem type's current rates of return and growth ability are both low.

This theory is mainly used as a reference for enterprises to make patent strategic decisions. The advantage of this theory is that it is intuitive and can easily see where the

patent lies, but its disadvantages are also obvious. On the one hand, there is subjective speculation in the definition of the coefficient of return and growth ability. When the patent value is near the dividing line, it is difficult to determine to which interval the patent should belong. On the other hand, it is too simple to divide the patent into four intervals and difficult to accurately measure the patent value.

5. Existing Problems

Chinese scholars' research on patent value is deepening from the traditional cost method, market method and revenue method to the three-dimensional patent value evaluation method, and then to other patent value evaluation methods. In this process, however, there are also some problems. First, China has not established a sound patent value evaluation system. Although the patent value evaluation system based on technical value, economic value and legal value has increasingly improving, there is a lack of a unified standard to define the weight coefficient of various indicators. Related studies have been controversial but inconclusive, which is not conducive to the comprehensive evaluation of patent value in China. Secondly, there are problems in setting some patent value indexes. Obviously, it is not comprehensive to evaluate the patent value by a single index, but it is overcorrecting to try to comprehensively evaluate the patent value by a wave of indicators. The indicators mentioned in this paper are only representative of a large number of patent value research literature. Many more detailed indicators are constantly being proposed. It is difficult to define whether some indicators are really suitable for evaluating patent value. In addition, piling a large number of indicators into the patent value assessment system not only increases the difficulty of assessment, but also reduces the accuracy of the final assessment results with some unnecessary indicators. Finally, the results of patent value are fuzzy and uncertain. No matter how scientific the evaluation method is, it is difficult to calculate the actual value of patent accurately. In addition, it is difficult to directly verify the effectiveness of the evaluation method in the process of studying its value evaluation method. Most scholars can only prove the effectiveness of the method through indirect methods. Moreover, even if some indicators have been generally accepted, there will be some cases where the patent value is high but does not meet the indicators. Therefore, when looking at the problem of patent value, we should not entirely rely on the patent value evaluation model, but make judgments based on the actual situation.

6. Conclusion

This paper reviews the literature of patent value evaluation methods, including the traditional cost method, market method, revenue method, emerging three-dimension patent value evaluation method and other patent value evaluation methods. In addition, this paper also discusses the problems in the research of patent value evaluation methods.

At present, the number of patents in China is soaring while the quality is worrying. Establishing a relatively

complete patent evaluation method system can not only measure the value of each patent, quickly select high-value patents in the patent examination, reduce the examination pressure of examiners, but also be conducive to the evaluation of China's overall patent value. In this way we can test China's innovation ability. With the improvement of scholars' attention to patent value, the patent value evaluation method system is becoming more and more perfect. However, there is still a long time to go before the system is put into use.

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Statement of Competing Interests

The authors have no competing interests.

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