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Research Article

Venture Risk of Small- and Medium-Sized Sci-Tech Enterprises Based on Markov Model

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Small- and medium-sized enterprises are an important part of my country's national economy. Among the small- and medium-sized enterprises, scientific and technological small- and medium-sized enterprises account for a considerable proportion and play an extremely important role. Compared with large enterprises, technology-based small- and medium-sized enterprises have small scale and weak financial strength. In R&D activities, they will encounter external environmental risks such as market change risks and government policy restrictions. At the same time, the internal technical strength and management ability of enterprises will also affect the development effect of enterprise R&D work. Therefore, this paper will study the risk of small- and medium-sized high-tech enterprises in the start-up period through Markov model and design and experiment the feasibility and accuracy of the risk prediction model. Markov model is a probabilistic model about time series, which is used in many fields such as speech and behavior recognition and fault diagnosis. The risk prediction in this paper can play a key role. In the experiment, the accuracy of environmental risk assessment and analysis reached 74.4%, which will greatly help enterprises make reasonable development strategies to deal with the pressure from different periods and places.

1. Introduction

Today, with the rapid development of science and technology, the overall scale and scientific research strength of small- and medium-sized scientific and technological enterprises are constantly increasing, and they occupy an important position in the national economic structure [1]. The market economy is destined that competition is the main theme of the survival and development of enterprises, and the continuous development of economic globalization makes the competition in the international market more intense [2]. In order to survive, develop, and remain invincible in the international competition, an enterprise must rely on its own research and development capabilities to produce competitive products [3]. Under the macro background of building an innovative country, scientific and technological small- and medium-sized enterprises are an important driving force for China's economic development. Specifically, it refers to the management process of setting up the corresponding institutions and personnel of enterprise risk management, identifying, measuring, evaluating, and dealing with enterprise risks with the help of enterprise risk management plans and control measures, so as to prevent the occurrence of enterprise risk events or minimize the loss and impact of risk events after the occurrence of enterprise risk events, so as to protect the survival and sustainable development ability of enterprises and maximize the economic benefits of enterprises [4]. However, as most of the technology-based SMEs are in the growth stage, the characteristics of "small amount of capital, large proportion of technology, and high financing risk" determine that it is difficult for banks and other financial institutions to establish their trust in them and obtain loan support from banks, which has a certain impact on the rapid development of technology-based SMEs.

Venture capital is closely integrated with the industrialization of scientific and technological achievements, and there is a huge financial and economic value behind it:

venture capital provides high-tech small- and medium-sized enterprises with financing arrangements, production, and management support, which accelerates the speed of scientific and technological industrialization and is conducive to cultivating entrepreneurship and the development of an entrepreneurial economy [5]. The occurrence of any kind of risk in R&D activities may cause risk consequences such as failure of R&D decision, extension of R&D cycle, R&D expenses exceeding the planned expenditure, and R&D income failing to reach the expected goal, which will bring huge losses to enterprises [6]. Small- and medium-sized scientific and technological enterprises are representatives of knowledge-intensive enterprises. The ownership of independent intellectual property rights is not only related to the development fate of enterprises but also related to the innovation ability of industries, regions, and countries and the ability of core competition [7]. In various industries and various enterprises, technology-based SMEs have relatively high innovation efficiency and relatively low trial and error costs, which are the foundation of national innovation [8]. In recent years, these risk problems have aroused the general concern and attention of governments, business circles, and academic circles in various countries. Many scholars have conducted risk management research on them, and the state has continuously introduced new policies, giving strong support to technological innovation, especially R&D, of small- and medium-sized scientific and technological enterprises, thus reducing the risk of technological innovation [9]. Since the Markov model was proposed, its application has been widely used in speech recognition, automatic part of speech tagging, voice word conversion, probabilistic grammar, natural language processing, and other application fields. Its main function is to meet the prediction function under different needs by constructing the transition probability matrix, and the core is the construction of the transition probability matrix.

The real-time risk assessment method based on Markov model classifies the running state of the system and expresses it as a hidden state. The real-time alarm data obtained from the intrusion detection system is processed to get the corresponding observation value as input, and the probability of being in a certain state at present is obtained according to the probability of state transition [10]. In the process of analyzing the Markov model, this paper found that the establishment of most of the initial parameters of the model is based on experience, the subjective consciousness is too strong, and there are some drawbacks in the traditional Markov model and algorithm [11]. Therefore, a more scientific method for establishing the initial parameters of the Markov model is proposed, which solves the problem that the initial parameters of the model are too subjective and improves the accuracy of the Markov model [12]. However, for small- and medium-sized scientific and technological enterprises, how to use Markov model analysis to improve the risk assessment and warning in the start-up period is not in place in the model design. In the start-up period, especially when the initial investment of small- and medium-sized scientific and technological enterprises is small, the final risk assessment is inaccurate due to the complexity of capital chain and enterprise management [13]. Therefore, this paper puts forward the following innovations when designing the processing model:

(1) In the research of the risk assessment model based on Markov method, comprehensively consider the influencing factors of the enterprise risk state transition process, and construct the transition probability matrix with errors. When improving the risk assessment model, the occurrence of threat events in the risk is considered, and the repair of the risk state is taken into account according to the actual situation, so that the state transition process can reduce the deviation

(2) In addition, it is difficult to obtain the optimal parameters of BP neural network situation assessment model, which leads to the problem of low assessment accuracy. By combining the theory to fuse and filter the risk elements and combining the algorithm to optimize the structure and parameters of BP neural network, a BP neural network situation assessment model based on algorithm optimization is constructed

The chapters of this paper are arranged as follows: the first chapter of this paper is the introduction, which discusses the background and significance of the topic selection and expounds the innovation of the article. The second chapter is the main body of this paper. It mainly combines the research results of domestic and foreign Markov models in the field of risk assessment of technology-based SMEs in the entrepreneurial period and proposes innovative results and research ideas of this paper. The third chapter of this paper is the method part, which deeply discusses the application and principle of related algorithms and proposes a new risk assessment model based on the previous research results and the innovation of this paper. The fourth chapter of this paper mainly discusses the experimental part of the application of the algorithm. Through the experimental results, on the basis of sorting out the data, a risk assessment model is established. The fifth chapter is the summary part, which summarizes the research results and shortcomings of this paper, as well as the prospect of follow-up research.

2. Related Work

Thalmann and Hertig put forward a qualitative analysis method based on quantitative analysis, that is, the risk reduction method of technological innovation: first, determine the evaluation index, and use analytic hierarchy process to select a number of innovative projects; second, analyze the risk factors of the selected project; third, determine the sensitivity of the project objectives to various sensitive factors; fourth, extract the most sensitive factors; fifth, implement control measures for sensitive factors [14]. Lofgren believes that it is very important to establish a reasonable and effective risk sharing mechanism to effectively prevent and manage its risks. It is a necessary condition for enterprises to achieve their own healthy development, and it is also a way for banks, guarantee institutions, and evaluation institutions to explore new businesses. At the same time, it is a practical exploration of the use of intellectual property rights by the state [15]. The research of Osibajo et al. shows that based on the massive alarm information and network performance index of intrusion detection system, using hierarchical structure, combined with the importance of service, host itself, and the organizational structure of network system, a hierarchical security situation assessment model from bottom to top, part to whole, is proposed [16]. Arshad et al. think that static risk assessment is to assess the risk of a system in a relatively short period of time or at a certain point in time. The assessed system is regarded as a relatively static object, and the assessment process is not continuous in time [17]. Jo and Park believe that under certain conditions, the risk-free rate of return can be used to discount the asset value in the future. However, the real market is full of uncertainty, thus forming the risk of assets. At this time, investors' risk preference is different, and the trade-off between risks and returns is also different [18]. By improving the algorithm of hidden Markov model, Zhang X et al. can help network security managers more accurately identify the current network security situation in complex cyberspace, so as to provide more accurate decision-making basis for network security managers when deploying security in the network environment [19]. Civelek et al.' research shows that at present, a large number of small- and medium-sized scientific and technological enterprises in China have some problems in financial risk management, such as poor awareness of risk prevention and control, insufficient management ability, lack of identification ability, and prevention and control management ability to deal with the financial risks existing or faced by enterprises. The existence of these problems is the key factor that affects the survival, development, stability, and security of small- and medium-sized scientific and technological enterprises in China and leads to severe financial risk challenges for enterprises [20]. Sandu et al. think that of course independent innovation is not an idle innovation, it is not a single-handedly refusing to introduce and apply other people's technology or a cooperative model, it can be innovation based on self-development, or it can be based on others. Technological improvement or secondary research and development can also be jointly developed and innovative with other subjects [21]. Soliman and Adam pointed out that there is insufficient research on the technological innovation risk of scientific and technological small- and medium-sized enterprises, especially the R&D activities of scientific and technological small- and medium-sized enterprises, but the risk is an important feature of the R&D activities of scientific and technological small- and medium-sized enterprises, and a consensus has been formed. However, the research on the risk factors and risk avoidance of R&D activities is still in an imperfect stage [22]. Chuk et al. divided the new product development into six stages: innovative ideas, investigation and evaluation, research and development, pilot test, mass production, and marketing. Each stage has technical risks, financial risks, production risks, and policy risks and puts forward the idea of controlling various risks based on different stages [23]. Zabashta believes that dynamic risk assessment methods are divided into two categories: one is a model-based assessment method, which uses environmental information encountered in the operation of the system to assess network risks; the other is to follow the static risk assessment idea to assess assets and threats. Vulnerability is assessed online to obtain the dynamic value-at-risk of the network [24]. The Morris and James knowledge innovation is the most significant technical feature at this stage. The start-up period is the stage for enterprises to develop products and realize industrial production. At this stage, enterprises need to invest a lot of human and material resources in the process of realizing enterprise organization construction and industrialization of early scientific and technological achievements, and the capital demand is also significantly higher than that in the seed stage [25]. In Theriou N et al., from the risk point of view, the risk of small- and medium-sized science and technology enterprises in the seed stage is high, but the capital flow is almost zero, so there is a big financing risk. However, the products of the start-up enterprises are still in the market development stage and have not yet been fully recognized by the market, with less cash inflow, making it difficult to achieve a balance between input and output, and even less likely to be profitable [26].

On the basis of the above-mentioned research work, this paper determines the positive role of Markov model in the field of risk model of small- and medium-sized high-tech enterprises, constructs a Markov model with a combination of various algorithms, and makes a deep analysis and research on the acquired and collected data by using Markov model, so as to make more effective use of the data, mine the valuable knowledge hidden behind the data, and find out the potential problems that affect the risks of small- and medium-sized high-tech enterprises.

3. Methodology

3.1. Related Theoretical Analysis and Research

3.1.1. Markov Model Analysis and Application. A Markov model is a mathematical model. It is a probabilistic model of time series, which is used in many fields such as speech and behavior recognition and risk judgment. The analysis and processing of Meng and Xiu in the field of enterprise risk based on Markov model is very relevant [27]. Markov model is used to describe the process of randomly generating an unobservable state random sequence from a hidden Markov chain and then generating an observable random sequence from each state. Its main work is to determine the corresponding probability and state-containing sequence from an observable state sequence and, finally, identify and predict the state at this stage, so as to get the final result. It is composed of a general stochastic process and a Markov chain, which is a double stochastic process. The stochastic process part uses the observation value probability to describe the statistical correspondence between the observation value and the state, and the Markov chain part uses the

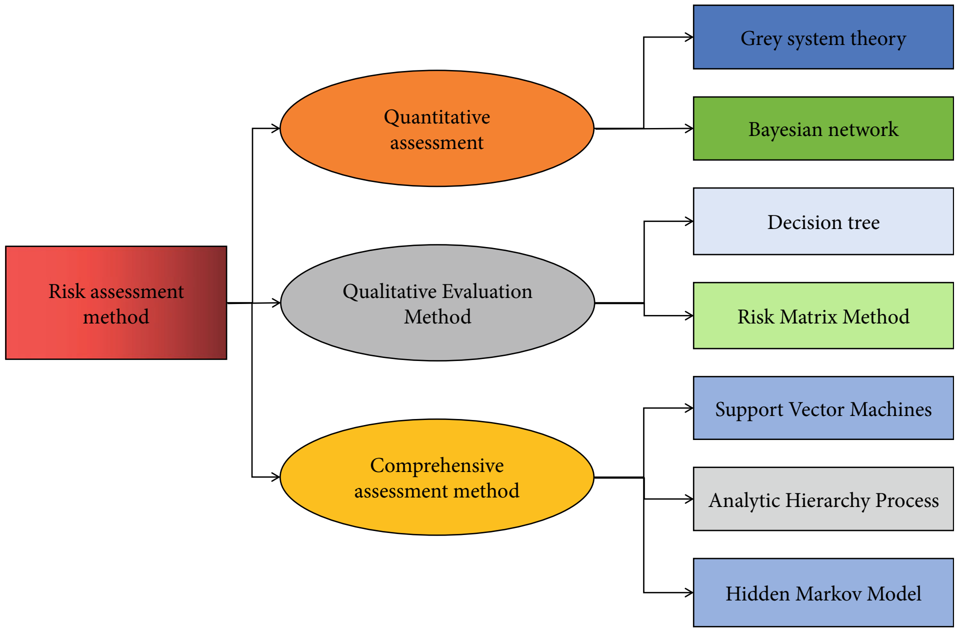

Figure 1: Framework structure diagram of basic risk assessment method.

transition probability to describe the transition between each state. Figure 1 shows the frame structure of the basic risk assessment method.

The Markov model is a model built on the Markov decision process and used to solve sequence decision problems. When the Markov model is applied to risk assessment, combined with the temporal characteristics of data, the assessment results have better real time and pertinence, and dynamic assessment of risks can be realized. Among the above methods, the main Bayesian network is a quantitative analysis method. Bayesian network is composed of point set and edge set to form a directed acyclic graph structure. When using analytic hierarchy process for risk assessment, decision-makers can directly participate in decision-making. However, this method largely depends on people's experience and is greatly affected by subjective factors. Hierarchical situation assessment method mainly divides risks into different levels according to expert's qualitative knowledge, assigns different weights, evaluates subnets of each level separately, and then comprehensively obtains the overall risk security situation value, which has low computational complexity. However, depending on expert's knowledge to stratify risks, it will lead to a certain delay and lack of timeliness; that is, the evaluation value of risk situation cannot reflect the real-time risk security situation.

3.1.2. Entrepreneurship Risk Research. At present, the research on entrepreneurship mainly focuses on the second and second board market of enterprises, the generation process of enterprise entrepreneurship, the generation mechanism, and mode of enterprise entrepreneurship. The research on enterprise risk mainly focuses on venture capital, risk control theory, risk control of banks and finance, and risk management of projects. Because of the connotation characteristics of small- and medium-sized scientific and technological enterprises, their entrepreneurial development process is different from that of ordinary small- and medium-sized enterprises. These characteristics determine the growth process of small- and medium-sized scientific and technological enterprises and their own unique development laws. In China, the life cycle of small- and medium-sized scientific and technological enterprises is generally divided into five stages: seed stage, start-up stage, growth stage, expansion stage, and mature stage. The identification of scientific and technological enterprises is mainly based on two standards: first, professional and technical personnel account for a high proportion. Generally speaking, a scientific and technological enterprise should have engineering researchers with professional degrees. Second, the proportion of reinvestment for research and development in sales revenue is high, and the reinvestment for risk should generally account for 5%-15% of sales revenue. These two standards both emphasize that scientific and technological enterprises must have knowledge-intensive characteristics, which is also the main characteristic that distinguishes scientific and technological enterprises from traditional enterprises. Generally, there are six risk factors in the venture period: environmental risk, market risk, technical risk, management risk, capital risk, and talent risk. These risk factors may have different degrees of impact on the subsequent risk decision-making of the enterprise. After identifying the corresponding risk, it is very important to take corresponding preventive measures, so that the risk decision can be implemented smoothly. Figure 2 shows the risk research model.

Although there are different definitions of entrepreneurship, they all emphasize that entrepreneurship is a process. The reason why entrepreneurship is called a "process" is that entrepreneurship is not just a matter of opening up. Entrepreneurship has been going on before it develops into a mature enterprise. Even after the enterprise matures, if the

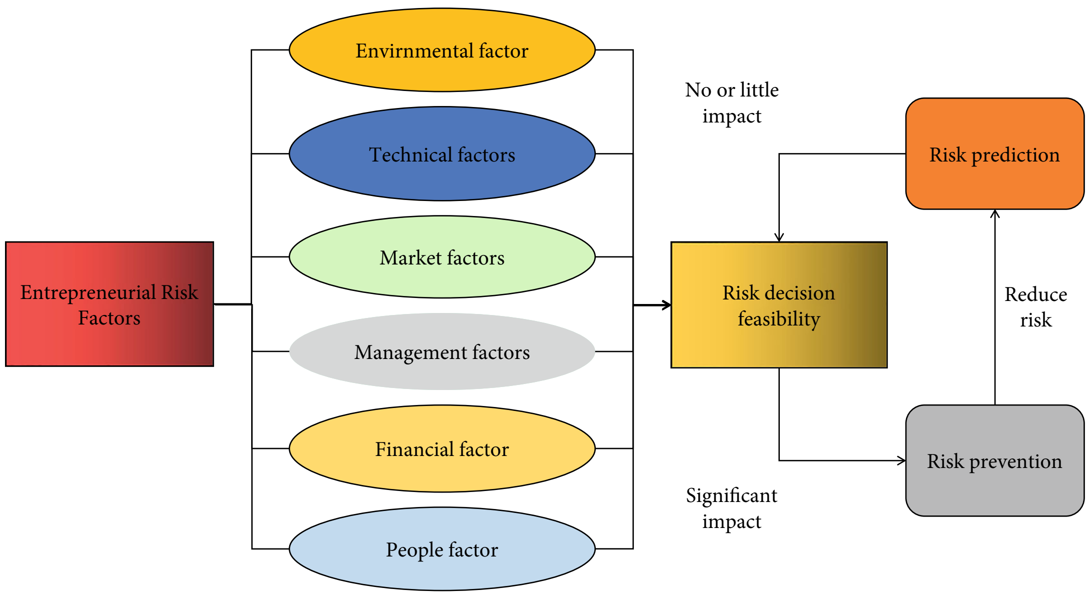

Figure 2: Risk research model.

product market or management problems get into trouble, it still needs to be revived through the second venture. From the perspective of risk, the inclusiveness of government financial funds means that it has a high level of risk tolerance, but its support for technology-based SMEs has a screening mechanism. Therefore, the risk tolerance of government financial funds is lower than that of own funds. Entrepreneurial activity is a market-driven behavior process based on opportunities. It is an opportunity pursuit and management process under the premise of lack of controllable resources. It is a highly comprehensive management activity. It is manifested in the behavior process that entrepreneurs seize opportunities and finally realize the survival and growth of new enterprises based on the concept of perceiving entrepreneurial opportunities and identifying innovative products or services that can bring new value to the market.

3.2. BP Neural Network Theory and Principle. It is divided into different kinds of neural networks according to different layers and different connection modes. It can be understood as a kind of operation related model, which is composed of many neurons connected with each other. Every node in other layers except the input layer simulates an output function, which is called activation function. As the research of neural network continues to deepen and explore, it is found that it has good processing ability in pattern recognition, mathematics, and economics, showing its excellent performance. BP neural network is a kind of feedforward neural network. Its important characteristics are the forward transmission of network signal and the backward propagation of error. When the network signal is transmitted forward, it goes through the input layer, hidden layer, and output layer in turn. The neural network state of each layer changes only with the change of the node state of the upper neuron. Figure 3 is the basic model diagram of three-layer BP neural network.

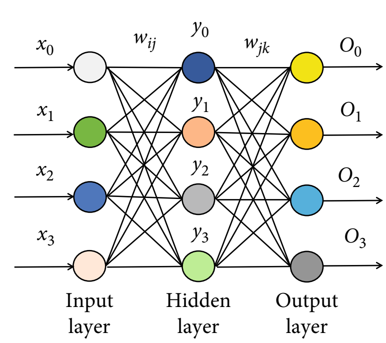

Figure 3: Basic model diagram of three-layer BP neural network.

Because the initialization neural network parameters can be randomly generated, this paper sets the full-time parameters of input layer-hidden layer and hidden layer-output layer as $w_{ij}$and w_{jk}. The thresholds of the hidden layer and the output layer are represented by θ_j, φ_k. Therefore, when the risk sample data is obtained, it is input into the neural network, and the information is propagated forward. In the node of the hidden layer, the output formula is

$$d_j = f\left(U_j\right), \quad j = 1, 2, \cdots, h, \tag{1}$$

where $U_j = \sum_i W_{ij} x_i + \theta_j$ and w_{ij} are the weights between the input layer and the hidden layer. Therefore, the output of the output layer node can be calculated as

$$Q_k = f(S_k), \quad k = 1, 2, \cdots, m, \tag{2}$$

where $S_k = \sum_j W_{jk} d_k + \varphi_k$ and w_{jk} are the weights between the hidden layer and the output layer. From this, it is possible to calculate the error formula between the actual output of each node in the output layer and the expected output R_k

and the error formula of the hidden layer:

$$\alpha_k = Q_k(Q_k - R_k)(1 - Q_k), \tag{3}$$

$$\beta_j = Q_k(1 - Q_k) \cdot \sum_k \alpha_k W_{jk} \beta j = Ok(1 - Ok) \cdot \sum \alpha_k W_{jk}. \tag{4}$$

The core of BP neural network updating weight and threshold algorithm is gradient descent method. Analogous to a two-dimensional surface, the error function surface has many uneven areas, and the lowest point of each depression represents a minimum value. Only when the error function is a strictly convex function, there will be only one depression in the whole surface. At this time, the lowest point of the depression is the global minimum.

3.3. Algorithmic Content and Optimization of Model Design. Markov risk assessment theory has been widely recognized. For risk management, the HMM method first defines that each host in the network has N states, expressed as

$$S = \{S_1, S_2, \cdots, S_N\}. \tag{5}$$

The sequence of states for the risk is

$$X = \{x_1, x_2, \cdots, x_T\}. \tag{6}$$

Therefore, this paper holds that there are four states of risk: G, P, A, C, which represent good, perceived, evaluated ,and dangerous, namely,

$$S = \{G, P, A, C\}. \tag{7}$$

It is represented in the form of triples by HMM, where I represents the initial state distribution, that is, the probability that the risk is in each state at the initial moment, and T represents the state transition matrix, that is, the probability of the host transitioning between states. For example, use T_{ij} to represent the probability that the risk state changes from t to $t+1$ from time S_i to time S_j, namely,

$$T_{ij} = P\{x_{t+1} = S_j | x_t = S_i\}, \tag{8}$$

where $1 \leq i, j \leq N$ and O represents the observation matrix, that is, the probability of being impacted when the risk is in a certain state, and O_{mn} represents the probability that the risk is in t state and attacked by S_n at a_m moment, which is expressed as

$$O_{mn} = P\{y_t = a_m | x_t = S_n\}, \tag{9}$$

including $1 \leq n \leq N, 1 \leq m \leq M$. Therefore, the distribution probability formula of the risk state will be obtained, and at the same time, the vector will be introduced. According to the significance of the vector in algebra, when complex and intractable complex numbers or complex expressions are generated in the establishment of mathematical models, the vector can be quoted to be a more flexible and convenient expression. Through the calculation of the above triples, the state values of risk pairs in four states can be expressed:

$$R_t = \sum r_i c_i. \tag{10}$$

To calculate the current risk, we should not only consider the external environment but also consider the corresponding impact of the daily operations of internal management on risk management. Normal and standardized operations will reduce or not increase the risks faced by risk management and control, while wrong decisions and operational operations will improve the risks faced by technology-based small- and medium-sized enterprises in their entrepreneurial period. Through the optimized BP neural network algorithm and risk prediction algorithm designed in this paper, it has a good role in risk prediction for scientific and technological small- and medium-sized enterprises in different situations and has a benign effect on the development of enterprises.

4. Result Analysis and Discussion

Establishing a scientific, accurate, and practical evaluation index system is the premise and foundation for correctly evaluating the venture risk of small- and medium-sized scientific and technological enterprises. Therefore, the principles of integrity, comparability, scientificity, and practicality should be followed when establishing the evaluation index system. This paper designs an evaluation model for the venture period risk of technology-based small- and medium-sized enterprises and will analyze the important aspects of technical risk, management risk, financial risk, market trade risk, and environmental risk. Let A, B, and C be the three influencing factors of technical risk and management risk, which can be obtained through the calculation and analysis of the model, as shown in Figures 4 and 5.

In the above figure, it can be found in the experiment that the prediction performance of the model between dimensions 2 and 3 is low in the sample number quantification process, which may be due to the risk fluctuations generated when the samples belong to the case where there are not many samples. Because of the technical uncertainty and the complexity of internal and external management, the prediction will be vague when the sample size is not very prominent. However, with the continuous increase of the sample size, it can be found that the corresponding prediction indicators will basically have a good effect, and the risk prediction rate caused by technology and management is as high as 84.6%, which will avoid great risk obstacles for enterprises in the initial stage of starting a business. Let Q and W be the two dimensional indicators of financial risk and market trade risk, as shown in the analysis charts in Figures 6 and 7.

It can also be seen from the figure that the financial risk in the early stage of the company's business venture continues to rise. This is also an obvious weak point of the initial company. However, most financial risks can be effectively avoided through a model that is not tenderly designed, and

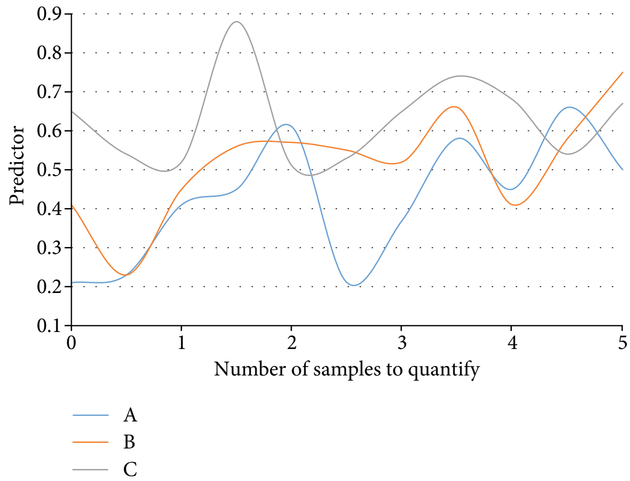

Figure 4: Multidimensional analysis diagram of technical risk.

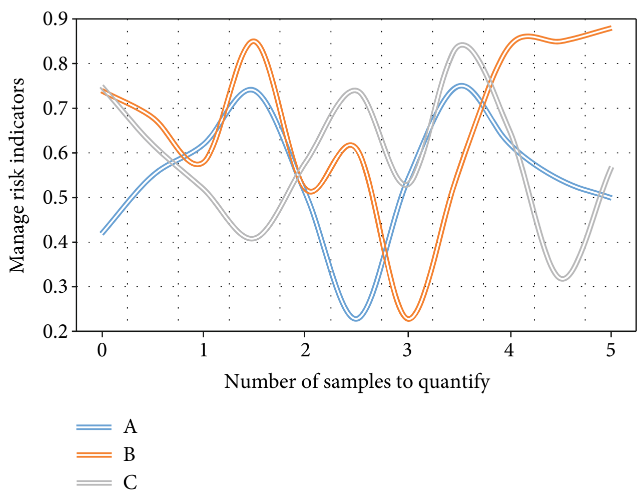

Figure 5: Multidimensional analysis diagram of managing risk.

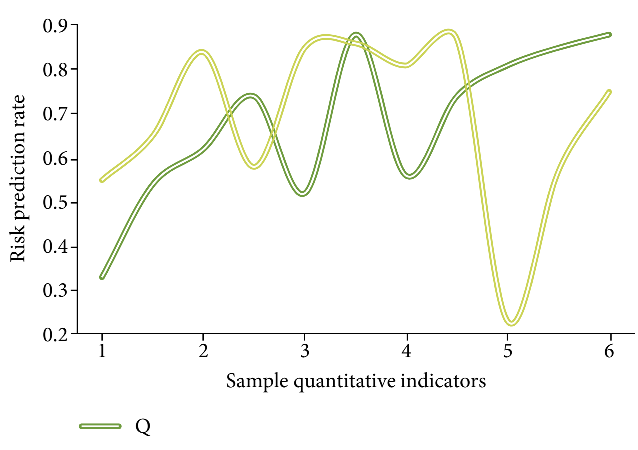

Figure 6: Forecast under financial risk.

the company's financial risk can be reduced, causing adverse development of the enterprise. In the establishment stage, the company was unable to raise enough R&D and entrepre-

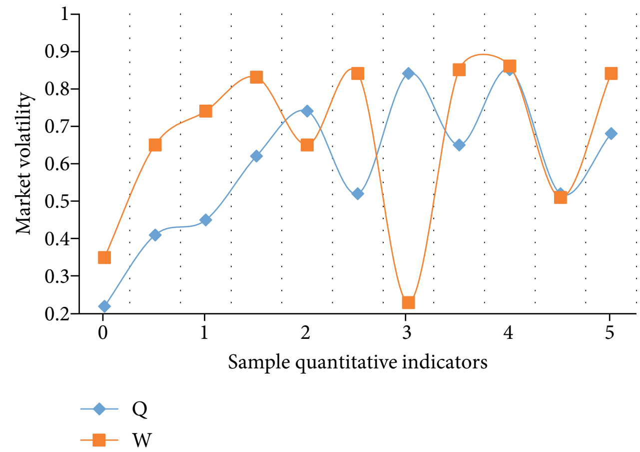

Figure 7: Enterprise risk assessment of market trade risk.

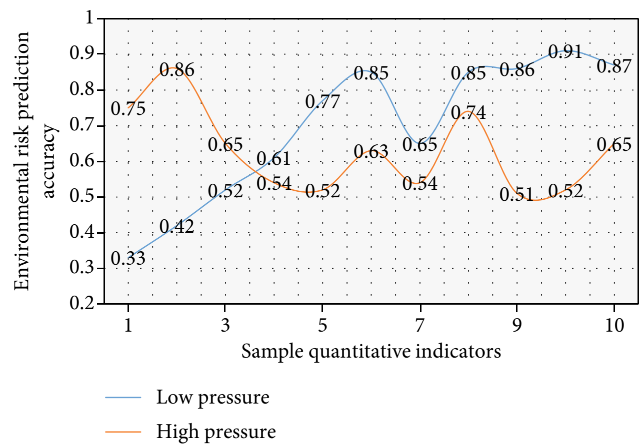

Figure 8: Risk prediction under high and low pressure environment.

neurship funds and finally adopted partnership. At the same time, it applied for financial support such as national innovation, entrepreneurship fund, and angel investment. It can also design financial supervision departments to supervise the financial situation of the enterprise. These measures can improve the financial environment of the enterprise. In addition, in order to avoid the risk of low-cost performance of products, in the process of research and development, the cost of future products should be fully considered, and appropriate feasibility study on cost reduction should be made. The company should combine the development strategy, according to the requirements of the target market and according to the external environmental factors, make the most effective use of its own human, material, and financial resources, formulate the best marketing mix strategy of the enterprise, and play a role in mitigating market risks to the greatest extent. Figure 8 shows the risk prediction of the model under two different environments of high pressure and low pressure.

Generally, the environment of an enterprise is mainly divided into high pressure and low pressure. It can be seen from the above figure that the model fluctuates greatly between indicators 5-9. The reason is that it is in the middle of the enterprise's start-up, and all aspects of its business volume and management level have been significantly improved. Therefore, different risk predictions will be made when it comes to the pressure from internal and external situations, which will lead to the volatility. Because of the high-pressure and low-pressure knowledge range, there are few accurate values of two extreme channels. Therefore, it should be vaguely dealt with in the evaluation and research of environmental risks, and the prediction should be more reasonable and accurate on the basis of grasping the trend, and the model designed in this paper is also based on this idea. The accuracy rate of environmental risk assessment and analysis reached 74.4%, which will greatly help enterprises formulate reasonable development strategies and cope with the pressure from different periods.

5. Conclusions

This paper takes the entrepreneurial risk of scientific and technological small- and medium-sized enterprises as the research object, establishes the evaluation index of entrepreneurial risk of scientific and technological small- and medium-sized enterprises through the method of pattern design experimental analysis, verifies the reliability and validity of the index system, evaluates the risk factors by using BP neural network method and Markov model, and confirms the key risk factors affecting enterprise R&D decision-making and the corresponding influence degree. According to the analysis of the risk factors, this paper believes that the current external environment for entrepreneurship of technology-based SMEs is more favorable and the risk is small; but the internal factors have a large impact and the risk is large. When evaluating the risks of small- and medium-sized scientific and technological enterprises, the risks should be divided into technical risks, production risks, market risks, financial risks, management risks, personnel risks, and environmental risks, so as to be more conducive to risk evaluation. The HMM model in the enterprise entrepreneurial risk model is established, and the factors in the risk prediction are mapped to the HMM parameters. Using this model, the unobservable risk state can be obtained, which solves the unobservability of the enterprise's risk state. Moreover, in the experiment, the accuracy of environmental risk assessment and analysis reached 74.4%, which will greatly help enterprises make reasonable development strategies to deal with the pressure from different periods and places.

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The author declares no conflicts of interest.

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