Research on Enterprise Competitiveness Evaluation Based on Natural Selection

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Abstract. In the social organization structure, enterprises have certain biological attributes. The biological attributes of enterprises determine that the competitiveness of enterprises must have basic characteristics of organisms, namely its basic viability, competitiveness, and ability to adapt to environmental changes. Based on Darwin's natural selection theory, this paper simulates a market demand as prey, enterprises as predators and competitors as predators of other species. Through the analytic hierarchy (AHP) process to determine the factors of enterprise competitiveness and weights of the factors, the fuzzy comprehensive evaluation method is used to convert the data of various factors, and the converted results are substituted into the natural selection model to simulate the enterprise life cycle and its development status and evaluate its competitiveness.

Introduction

With the deepening of reform and the continuous improvement of the market economy system, Chinese enterprises have ushered in a period of rapid development. But the company's survival time is too short, the ability of sustainable development is weak and other problems are gradually emerging. At present, there are few literature on the survival ability of small and medium-sized enterprises in the academic world, and their emphases are different. Including: through fuzzy evaluation method to determine the new enterprise survival factors of the weight; the enterprise survival probability model is established based on the square of the number of employees, asset profit rate, age and age [1]; Research on the growth mechanism of new enterprises based on social network.

Based on the theory of natural selection, this paper compares the enterprise with the natural population through the biological attributes of the enterprise, determines the weight factors of the enterprise competitiveness, and optimizes the natural selection model to evaluate the enterprise competitiveness. By evaluating the current situation of enterprises, we can judge the advantages and disadvantages of our own operation and extend the life cycle by making use of the advantages of enterprises. In the face of social environment changes, enterprise competitiveness evaluation enables decision makers to actively adjust and respond, improve internal management of organizational structure and financial risks, and improve enterprise level vitality [2]. In each life cycle, an enterprise can combine its industry environment with its own organizational characteristics to improve its competitiveness.

Theory of Natural Selection

Every organism has to go through all kinds of struggles, including the natural environment, the individual of the same species, and the individual of other species, among which the struggle between the species is the most intense. And in nature, all kinds of organisms influence, restrict and depend on each other. So even if organisms are very fertile, very few offspring of each species survive in fact. Any organism must fight for survival in the course of life. The survival of the fittest is the survival of
the fittest. Darwin called the process of survival in the struggle for survival and the elimination of the discomfort as natural selection.

In the biological world, the ability of an organism to continue its species is required. First, organisms must have the basic ability to survive. For example, animals have the basic survival ability of foraging, avoiding natural enemies and reproducing offspring [3]. Second, organisms need to be competitive. We can see that between the same species, some are strong, some are weak. Apparently, among the same species, strong individuals are more likely to win than their peers. This keeps them from starving to death when food is scarce, and allows them to survive longer than weaker individuals. Finally, organisms must be able to adapt to changes in their environment. Species that are unable to adapt to environmental changes, whether strong or weak, will be eliminated. Darwin found that the species that can be propagated are not the strongest among the same species, but the species that best adapts to the environment. It can be seen that the ability of living organisms to sustain life has three kinds: basic survival ability, competitiveness, and adaptability to environmental changes.

Factors Affecting Enterprises Competitiveness

In the social organization structure, enterprises have certain biological attributes. The biological attribute of an enterprise determines that the survival and development of an enterprise must have the basic characteristics of general organisms, that is, the enterprise has a certain life span, and at the same time conforms to the basic law of "survival of the fittest" in biological evolution. The "fittest" referred to here is those that can satisfy the needs of social development and consumers, adapt to changes in the environment, and are better than similar companies [4].

At the same time, the influence of external factors is very important, just as the development of organisms cannot be separated from external nutrients such as water, soil and sunlight. The special external environment even has a decisive impact on the survival of the company. The influence of environment can come from the overall environment, industry environment and competition environment. The overall environment includes population, economics, social culture, globalization factors, legal policies, etc. [5]. The factors influencing the industrial environment are the same as the physical model of competition, including the same type of new entrants, bargaining power of suppliers, bargaining power of buyers, threat of substitutes and competition. Competitive environment includes specific competitive level, competitor strategy and other factors.

The goal of enterprise competitiveness evaluation is to fully understand the advantages and disadvantages of organizational system and the way to carry out business operation. Aspects of unilateral evaluation of a company's performance and reliance on a single indicator often do not reflect sufficient information. It also does not help analyze and improve company management issues. Therefore, if we want to grasp the overall living conditions of the enterprise, we must adopt appropriate standards and use the relevant indicator system for comprehensive evaluation.

Enterprise-Species Mapping

The natural selection model simulates the life cycle of three species, and the disappearance of any species will lead to the end of the simulation. Among them, prey corresponds to the resource market, the initial number and reproductive capacity of prey correspond to the space size of the market, and the mobile ability of prey corresponds to the instability of the resource market. The new predator corresponds to the enterprise, the reproduction ability of the predator corresponds to the survival ability of the enterprise, and the hunting ability of the new predator corresponds to the competitiveness of the enterprise. The "old" predator corresponds to competing units, and the "old" predator has the same abilities as the new predator. However, the capability varies, which also directly affects the simulation results. The corresponding relationship between species and enterprise capability is shown in Table 1:
Table 1. Enterprises - Species Mapping.

<table>
<thead>
<tr>
<th>Species</th>
<th>Biology Attributes</th>
<th>Modern Society</th>
<th>Market/Enterprise Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prey</td>
<td>Reproduction</td>
<td>Movement</td>
<td>Market Resources</td>
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<td></td>
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<td>Death</td>
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<tr>
<td>Predator</td>
<td>Reproduction</td>
<td>Movement/Preation</td>
<td>New Enterprises</td>
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<td></td>
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<td>Death</td>
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<tr>
<td>Advanced Predator</td>
<td>Reproduction</td>
<td>Movement/Preation</td>
<td>Enterprise’s Competitors</td>
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<td></td>
<td></td>
<td>Death</td>
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</tbody>
</table>

Natural Selection Model

Based on Darwin's natural selection algorithm, the natural selection model is implemented in Python language, and the weight of each capability of the enterprise is determined by the analytic hierarchy process (AHP). The fuzzy comprehensive analysis method is used to initialize the enterprise capability into the natural selection model, simulates the life cycle of enterprise. The evaluation of the viability of enterprise is according to the life cycle, the detailed steps are shown in Figure 1:

Natural selection model simulates the life cycle of species based on the initial value, and the simulation process can accurately represent the life cycle of species under the framework of natural selection algorithm. The simulation results show dynamic interactions between three species (prey, predator, and advanced predator). Predators and advanced predators are affected by the number of prey, and there is a competitive relationship between them. The prey will be greatly reduced by the predation of two species, and the decrease of prey will affect the number of two predators. Three species showed different population trends in a certain period. After the simulation of enterprise life cycle, it will judge the stage of enterprise life cycle and the trend of enterprise in the simulation,
evaluate enterprise based on the existing problems of enterprise, and put forward suggestions for the development of the enterprise.

**Enterprise Life Cycle**

For enterprise life cycle function and life cycle stage, the quantitative research method based on the exponential model proposed by the famous scholar Yijie Xiong[6] is adopted:

\[ Y = K + AB^t \]

Where, \( Y \) represents the time series studied, comprehensive survivability score in this simulation, \( K \) represents a positive constant, is an extreme value of time series changing with time, \( AB \) is an undetermined parameter, and \( t \) is a time variable.

In this paper, the comprehensive score of enterprise survivability is taken as a time series and a life-cycle function model with time as an independent variable is constructed. However, the above life cycle function has some deficiencies in empirical research. It needs some improvement. First, because the model requires that the y-coordinate be positive, and the parameter B requires the same. However, the comprehensive score of factor analysis and evaluation will involve negative values, so this method is inconsistent with the empirical study. Secondly, the regression process of the model is too complex, and the fitting process often shows extreme values, and the trend is predetermined. It's not obvious. To sum up, this paper combines the basic principles of life cycle model taught by Yijie Xiong. \( Y=\ln X+B \) model discrimination method was used to replace the original model.

Model: \( Y = \ln X + B \); Where X represents the time variable and B is a constant. The specific model is shown in figure 2:

![Figure 2. Life cycle improvement model.](image)

When \( A > 0 \), the function model is consistent with the third case of the \( Y = K + AB^t \) model, so the time series is at the maturity stage. When \( A < 0 \), the function model is consistent with the fourth case of the Xiong Yijie model. But in this paper, it was included in the recession phase.

**Example**

This paper studies the well-known enterprise A company in Shanghai as a case study, taking time as the abscissa and the enterprise's survivability as the vertical axis. This paper combines the simulation results with the actual development of the sample enterprises, and analyzes the focus of the strategic decision of the enterprise.

Company A is a game company that has always focused on independent research and development and is distributed to the world. It is committed to creating super-class page games and mobile games products, and is determined to bring joy to the game for global players. Substitute the survey results into the natural selection model by calculating the initialization data, the result is shown in figure 3.

The yellow line represents company A, the red line represents its competitors, and the blue line represents the enterprise market. It can be seen that the life cycle of the yellow line is in the mature
stage, and the enterprise is stable in one stage without obvious improvement or decline. The simulation results can predict that the enterprise viability will not be further improved in the next year, and there will be a downward trend.

According to the survey, A company has many popular games. In September 2010, the number of registered users of a certain game exceeded 40 million, and the average number of online users exceeded 200,000, and successfully won the top three positions in the page game market. The total profit and operating income can both grow rapidly, and the product line is constantly enriched. However, according to the life function curve in this simulation, the growth trend of the enterprise's viability is obviously slowing down, and gradually tends to be stable, indicating that the enterprise has entered the mature stage. This study suggests that enterprises adopt the following development strategies: first, continue to promote diversification strategy. The core business of company A is page game/mobile game, but games tend to be strategic games. In order to achieve better development of the company, it is necessary to continuously investigate the market environment and seek diversified opportunities. When existing products have certain problems (such as limited market size, fierce competition, etc.), it is more conducive to the development of enterprises. Second, it should develop an international strategy to expand overseas markets. The characteristic of the mature stage of an enterprise is that it has a relatively high market share. Company A enjoys a high reputation in the page game company, but it is still limited to the domestic market, so it has become an inevitable choice to expand the overseas market. Third, it implements cost leadership strategy. Enterprises in the mature stage should pay more attention to the profit margin of products. While maintaining the development strategy of the first two points, they should further pursue cost leadership.

Decision

In this paper, based on the natural selection algorithm, combined with the biological attributes of enterprises, social problems are solved through the laws of natural development, and the development path of enterprises is demonstrated by computer simulation. Through this model, the ability of an enterprise to survive in the market is analyzed to find its own shortcomings. Decision-makers can actively adjust and respond, improve internal management of organizational structure and financial risks, improve enterprise competitiveness, and achieve sustainable development of the enterprise. At present, there is little research on solutions to simulate enterprise development through natural selection, but with the development of big data and other technologies, such research has become a trend.

Acknowledgement

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References

[1] Li He. The influence of external environment on the internal control of China's small and medium-sized enterprises [D], Henan Normal University, 2015.


