Theoretical Model for Optimizing Enterprise Capital Structure from the Perspective of Data Science

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Abstract: This paper studies how to optimize the capital structure of enterprises from the perspective of data science. First, it talks about how important it is to optimize capital structure. Then, it analyzes the influence of data science on the study of enterprise capital structure. Then, it uses data science to build a theoretical framework for optimizing enterprise capital structure, including theoretical basis, analysis of influencing factors, and optimization goal setting. Finally, it discusses how to apply this theoretical model in practice, hoping to help enterprises provide theoretical support and practical guidance when optimizing capital structure.

Keywords: Data Science; Enterprise Capital Structure; Optimization Theory Model; Factors Influencing Capital Structure

1. Introduction

The capital structure of an enterprise is the core content of financial decision-making and occupies a key position in the operation and development of an enterprise. It is directly related to many important aspects, such as financing costs, financial risk, market value, and long-term development strategy of enterprises. A reasonable capital structure is the cornerstone of the steady progress of enterprises, which can effectively reduce the comprehensive capital cost. When enterprises choose an appropriate debt-equity ratio, they can make full use of the tax shield effect of debt financing and reduce interest expenses, thus reducing the overall financing cost [1]. At the same time, a reasonable capital structure can also enhance the profitability and market competitiveness of enterprises. Lower financing costs mean that enterprises have more funds for key activities such as production and operation, R&D and innovation, thus improving the profit level of enterprises [2]. In the market competition, stronger profitability helps enterprises to better cope with the challenges of competitors, increase market share and maximize enterprise value.

In the past, enterprises mainly relied on financial theory and empirical analysis to optimize their capital structure. Financial theories, such as MM theory and trade-off theory, provide a theoretical basis, but these theories all have strict assumptions and limitations in the complex realistic environment [3]. Empirical analysis relies on historical data and cases, although it can reflect some characteristics and laws, but it is difficult to fully and accurately grasp the dynamic changes of capital structure and the complex relationship between various factors. The change of market environment, the intensification of industry competition and the development of technological innovation will all affect the capital structure of enterprises. It is difficult for traditional methods to fully consider these dynamic factors.

With the development of data science, a large number of enterprise data provide us with materials for in-depth study of capital structure. Data science includes data collection, storage, processing, analysis and display, and its methods and technologies can help enterprises to analyze various factors affecting capital structure more comprehensively and accurately. By collecting and analyzing different types of data from different channels, enterprises can find the laws in the data and understand how the factors interact with each other, so as to build a more scientific and reasonable theoretical model of capital structure optimization [4]. This model can better adapt to market changes and provide enterprises with more targeted and easy-to-operate decision-making suggestions. Therefore, it is very important to study the optimization of enterprise capital structure from the perspective of data science. Theoretically, it can enrich and perfect related theories and provide new ideas for future research. In fact, it can help enterprises optimize capital structure, reduce financial risks, improve economic

benefits and market competitiveness, and promote sustainable development.

2. The Impact of Data Science on the Study of Enterprise Capital Structure

2.1 Enhancement of Comprehensive and Accurate Data Acquisition

In the past, when studying the capital structure of enterprises, the data sources mainly relied on limited channels such as financial statements and industry reports, and the information available was small in dimension and narrow in scope [5]. But now, with data science, enterprises can get more comprehensive and accurate data in more ways. For example, with big data technology, enterprises can collect massive information, including market transaction data, consumer behavior data, supply chain data, and so on. These data can not only reflect the financial situation of enterprises, but also show the influence of non-financial factors such as the business environment and market competitiveness on capital structure. By integrating and analyzing these multi-source data, enterprises can evaluate their capital structure more accurately and provide a more reliable basis for optimizing decision-making [6].

2.2 Innovation and Deepening of Data Analysis Methods

Data science has brought many advanced data analysis methods and tools, such as machine learning, data mining and deep learning. These methods can deeply analyze and mine a large amount of company data, and find out the laws and patterns that can't be found by the old methods. For example, a machine learning algorithm can establish a complex relationship model between capital structure and various influencing factors by learning previous data, so that it can predict the performance of companies under different capital structures [7]. Data mining technology can find useful information from massive data, help companies find out which are the key factors that affect capital structure, and provide targeted suggestions for optimizing decisions [8]. Deep learning can deal with nonlinear and high-dimensional data, and can more accurately simulate the process of making capital structure decisions, making the optimization model more accurate and reliable.

2.3 Real-time Dynamic Monitoring and Decision Support

Data science enables enterprises to monitor the changes of capital structure in real time and adjust their optimization strategies in time. By establishing a data monitoring system, enterprises can collect and analyze financial data, market data and other information in real time, and track the dynamic changes of capital structure. When the market environment, business conditions and other factors change, the system can send out early warning signals in time to remind the management to adjust the capital structure. At the same time, data science can also provide real-time decision support, recommend the best capital structure adjustment scheme for enterprises based on real-time data and optimization model, and help them make scientific and reasonable decisions in the complex and changeable market environment.

3. The Theoretical Framework for Optimizing Enterprise Capital Structure Based on Data Science

3.1 Theoretical Basis

3.1.1 MM theory

MM theory is the beginning of modern capital structure theory, which provides an important basis for studying how to optimize capital structure. Under a perfect capital market hypothesis, MM theory, who doesn't pay taxes, thinks that the value of a company has nothing to do with its capital structure, that is, a company can't make itself more valuable by changing the ratio of debt to equity. This theory tells us that capital structure is not a simple proportional game, which makes researchers pay attention to other factors that affect the company's value. Later, the revised MM theory added corporate income tax, pointing out that the interest expense of debt can be deducted before tax, which will produce a tax shield effect, so that the value of the company will increase with the increase of debt ratio. Theoretically, companies should borrow as much money as possible in order to maximize the benefits of the tax shield. However, the revised MM theory also ignores some factors in reality, such as the cost of financial distress.

3.1.2 Trade-off theory

Trade-off theory, based on the revised MM theory, further considers the financial distress cost. Although debt brings tax shield benefits, it also increases the risk of the enterprise not being able to repay debts on time, that is, the financial

distress cost, including bankruptcy liquidation costs, management distraction, customer loss, etc. The optimal capital structure of the enterprise is to weigh the tax shield benefits and financial distress costs, finding the balance point where the marginal tax shield benefits equal the marginal financial distress costs. Data science can help enterprises more accurately estimate the tax shield benefits and financial distress costs by analyzing historical data and market information, and establish corresponding models to predict the tax shield benefits and financial distress costs under different debt levels, thereby providing a basis for enterprises to determine the optimal capital structure.

3.1.3 Agency cost theory

Agency cost theory focuses on the conflict of interests among shareholders, creditors, and management. Debt can alleviate the agency problem between shareholders and management, such as excessive investment by the management, because the repayment pressure of debt will constrain the behavior of the management. However, debt will also exacerbate the agency problem between shareholders and creditors, such as asset substitution, investment insufficiency, etc. Capital structure optimization needs to balance these agency costs. Data science can analyze information such as the equity structure of the enterprise, management behavior data, debt contract terms, etc., to assess the level of agency costs under different capital structures, helping enterprises find the best capital structure to reduce agency costs.

3.1.4 Pecking order theory

Pecking order theory holds that enterprises have a clear preference order when financing: internal financing first, debt financing second, and equity financing last. This is because information asymmetry leads to higher external financing costs, and equity financing conveys the worst signal to the market, which may be interpreted as overvaluation of the stock price. Data science can analyze the financing history data of the enterprise, market reactions, etc., to verify the applicability of the pecking order theory in different enterprises, and based on the specific circumstances of the enterprise, formulate reasonable financing sequence and capital structure adjustment strategies.

3.2 Analysis of Influencing Factors

3.2.1 Industry characteristics

The operating risks, asset structure, and cash flow stability of different industries vary greatly, which will affect the capital structure choice of the enterprise. High operating risk industries, such as high-tech and biopharmaceuticals, usually prefer a lower debt level to reduce financial risks and avoid the 叠加 of double risks. Low operating risk industries， such as utilities and mature manufacturing， have stable cash flows and high asset collateral value， and can tolerate a higher debt level. Data science can analyze industry data to establish an industry capital structure characteristic model，providing a reference for enterprises to determine a capital structure suitable for their own industry.

3.2.2 Enterprise lifecycle

At different stages of development, enterprises have completely different financing needs and risk tolerance. Start-up enterprises have high operating risks and unstable cash flows, mainly relying on equity financing, with an extremely low debt ratio. Growth-stage enterprises have rapid business expansion and need a large amount of funds. On the basis of equity financing, they start to introduce moderate debt financing. Mature-stage enterprises have a stable market position, abundant cash flows, and increased retained earnings. At the same time, to increase shareholder returns and utilize tax shields, the debt ratio may reach a relatively high level. In the recession stage, enterprises have shrinking business and reduced cash flows, and need to reduce debt and contract their operations. Data science can analyze the financial indicators and market performance of enterprises to determine the stage of the enterprise's lifecycle, and formulate corresponding capital structure adjustment strategies for enterprises.

3.2.3 Enterprise size

Enterprise size restricts the capital scale and capital structure of the company. Generally, large enterprises tend to adopt a diversified, vertical integration, or horizontal integration business strategy. The diversified business strategy enables enterprises to effectively diversify risks, have stable cash flows, be less affected by financial conditions, and thus face lower bankruptcy costs, and can tolerate a relatively high level of debt to a certain extent. The vertical integration business strategy can save transaction costs for the enterprise and improve the overall operating efficiency level, which not only enhances the debt capacity of the enterprise but also improves the internal

financing ability. For enterprises implementing the horizontal integration strategy, due to the expansion of enterprise size, it will increase the market share of products, thereby bringing higher and more stable returns, and can appropriately increase the debt level of the enterprise. Data science can analyze the relevant data of enterprise size to establish a relationship model between enterprise size and capital structure, providing guidance for enterprises to determine a reasonable capital structure based on their own size.

3.2.4 Asset structure

Enterprises with a large amount of tangible assets, such as factories and equipment, are more likely to obtain mortgage loans and have a stronger debt capacity; while enterprises with a high proportion of intangible assets have a relatively weaker debt capacity. Data science can analyze the balance sheet data of enterprises to assess the asset structure of the enterprise, determine the collateral capacity and debt level upper limit of the enterprise, and provide a basis for enterprises to optimize the capital structure.

3.2.5 Macroeconomic environment

The macroeconomic environment also has an important influence on the capital structure of enterprises. When the economy is good, enterprises feel that they can make money and are more willing to borrow money; when the economy is bad, enterprises will worry about risks and find ways to reduce debts. The interest rate level is also an important factor in the macroeconomic environment. When the interest rate is low, the cost of borrowing money is low, and enterprises like to borrow more money; when the interest rate is high, the situation is reversed. Data science can analyze macroeconomic data, establish a relationship model between macroeconomic indicators and capital structure of enterprises, predict how macroeconomic changes will affect the capital structure of enterprises, and help enterprises adjust in advance. From the perspective of data science, maximizing enterprise value is not only about making money, but also includes many aspects such as long-term development ability, market competitiveness and innovation ability. Therefore, when we set the goal of optimizing the capital structure, we need to consider many indicators. For example, in addition to financial indicators such as return on net assets and earnings per share, we can also think about non-financial indicators such as market share, customer satisfaction, and research and development investment. Data science can help us to establish a comprehensive evaluation system, and make these different indicators clear and together, so as to help enterprises set more scientific and reasonable capital structure optimization goals.

4. Application Path of the Enterprise Capital Structure Optimization Theory Model from the Perspective of Data Science

4.1 Data Collection and Integration

Companies need to collect and integrate data from different places, such as financial data, market data, industry data, and macroeconomic data. Financial data can be found in the company's financial statements, market data can be obtained through stock exchanges and financial data service companies, industry data can refer to the reports of industry associations, and macroeconomic data can be obtained from official institutions such as the National Bureau of Statistics. At the same time, companies can also use big data technology to collect irregular data, such as news reports and information on social media, so as to better understand the company's operating environment and market changes. The collected data need to be cleaned and preprocessed to remove useless and wrong information, so as to make the quality and usability of the data better.

4.2 Data Analysis and Modeling

Use data science methods and technologies to analyze and model the collected data. Machine learning algorithms can be used to establish a relationship model between capital structure and various influencing factors, predicting the performance of the enterprise under different capital structures. For example, decision tree algorithms can be used to analyze the impact of industry characteristics, enterprise size, etc. on capital structure, and neural network algorithms can be used to establish complex nonlinear relationship models. At the same time, data mining technology can be used to discover potential patterns and rules in the data, providing targeted suggestions for optimizing the capital structure of the enterprise. For example, through association rule mining, the correlation between different factors can be discovered, providing reference for adjusting the capital structure of the enterprise.

4.3 Decision Support and Adjustment

Based on the results of data analysis and modeling, provide decision support for the enterprise. The system can recommend the best capital structure adjustment plan for the enterprise, including the selection of financing methods, adjustment of debt ratio, etc. At the same time, the enterprise needs to establish a dynamic monitoring mechanism to track the changes in the capital structure and the changes in the market environment in real time. When factors such as the market environment and the enterprise's operating conditions change, the capital structure optimization strategy should be adjusted in a timely manner to ensure that the enterprise always maintains a reasonable capital structure. For example, when interest rates rise, the enterprise can consider reducing debt financing, increasing equity financing or internal financing; when industry competition intensifies, the enterprise can appropriately reduce the debt level to improve the enterprise's risk resistance capacity.

4.4 Performance Evaluation and Feedback

Establish a capital structure optimization performance evaluation system to evaluate and provide feedback on the optimization effect. By comparing the enterprise's financial indicators, market value and other indicators before and after optimization, the effectiveness of capital structure optimization can be evaluated. At the same time, problems and deficiencies in the optimization process can be analyzed, lessons learned, and used as references for subsequent optimization work. Based on the performance evaluation results, the optimization strategy and methods should be adjusted in a timely manner, and the capital structure optimization theory model should be continuously improved to enhance the enterprise's capital structure optimization level.

5. Conclusion

Studying the optimization of enterprise capital structure from the perspective of data science holds significant theoretical and practical importance. The development of data science has provided enterprises with more comprehensive and accurate data for capital structure research, innovative data analysis methods, and enabled real-time dynamic monitoring and decision support. The theoretical framework for optimizing enterprise capital structure based on data science takes into account multiple theoretical foundations and influencing factors, and sets scientific and reasonable optimization goals. Through application paths such as data collection and integration, data analysis and modeling, decision support and adjustment, as well as performance evaluation and feedback, enterprises can apply this theoretical model to actual capital structure optimization work, achieving the maximization of enterprise value. In the future, with the continuous development and application of data science, the theoretical model for optimizing enterprise capital structure will be continuously improved and enriched, providing more powerful support for the development of enterprises.

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