

Artificial Intelligence Enterprise Value Evaluation Based on the Combination of DDM and B-S Model :Taking TSR as an Example

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ABSTRACT

With the development and progress of the society, the AI industry has gradually emerged in the market and has become a hot focus of many investors. However, it is difficult for investors to control the investment, the amount and the expected trend of the market. Hence, it is vital to evaluate the value of AI enterprises. In this work, we can use the method of combining DDM and B-S model to evaluate the value of TSR. It is concluded that the combined model is more suitable for AI enterprises than the traditional model. Firstly, it is to make up for the defects of a single model. Then the B-S model is more fit for the characteristics of AI enterprises to avoid the undervalue of enterprises.

KEYWORDS

Enterprise value evaluation; DDM model; B-S model

1 Introduction

1.1 Research background and significance

With the rapid progress of the Internet, the development momentum of traditional industry gradually weakened, and artificial intelligence as an emerging industry, occupy a more important position in the market economy, its development also attracted the attention of many investors, but because the artificial intelligence industry is different from the traditional industry, and the development time is short, academia for its research less than traditional industry, so how to invest, whether the investment income is considerable and controllable has become the main concern of many investors. Then the enterprise value evaluation is necessary, nowadays, people's study on enterprise value assessment in the AI field is still in its infancy[1], and the development of the industry is uncertain, the proportion of intangible assets is high, R & D investment brings more growth and risk[2], The traditional valuation method cannot explore the potential value of enterprises[3], At this time, according to the traditional value evaluation method, no reasonable value evaluation of AI enterprises, In order to provide investors with a scientific basis for making their decisions, reduce the investment risk, look for the enterprise value evaluation methods suitable for the AI industry and in line with its development characteristics. In this work, DDM and B-S models are selected to evaluate the enterprise value, and to evaluate the intrinsic value and potential value of the enterprise respectively. The totaling of values is the overall worth of the company. The combination of the two models has the following benefits: one is to build a new value evaluation tool suitable for the AI industry; the other is to make up for the defects of a single model, more comprehensive evaluation, and avoid the underestimate of the value of AI enterprises[2]. The combination of DDM and B-S model to evaluate the enterprise value is more accurate and comprehensive, which also makes up for the deficiency of the traditional enterprise valuation

method.

1.2 Literature review

Nowadays, there are a large number of cases in the research of AI enterprise value evaluation, which provides theoretical support for the AI enterprise value evaluation in this paper. Michel F Spivey and Jeffrey J McMillan (2001) suggests that companies should consider equity value whether to attract new investors or make investment decisions[4]. Song XH and Qi C (2013) put forward that the valuation of enterprises is of great significance, which can investigate the asset and environmental adaptability of enterprises from a strategic perspective[5]. However, the traditional dividend valuation model is not suitable for high-tech enterprises, which will lead to undervaluation. Gao YT, Guo SH and H M (2010) pointed out that the traditional enterprise value evaluation methods do not consider the flexibility of management[6]. Zhu NJ (2004) compared the three discounted cash flow models and pointed out that some people think that the dividend discount model is too conservative, which is the result of only focusing on the rapid growth period of the company, while ignoring the maturity stage and the decline stage[7]. Many scholars have also proposed the combination of two models for value evaluation, so as to make up for the defects of a single valuation model. Yang XQ (2021) proposed to use the combination of models, consider the non-financial indicators of the business, calculate the existing value of the free cash flow for the firm, and evaluate the potential value of the business by using the B-S model[1]. This work uses the case study method as an example, and combines DDM and B-S model to evaluate the enterprise value of the AI industry.

2 Summary of relevant theories

2.1 Enterprise value evaluation theory

Enterprise value is the market's evaluation of business assets. Based on the past financial situation as the benchmark, consider the enterprise risk, capital structure, market position and other factors, forecast the cash flow of the company, and discount according to the WACC of the enterprise [8]. As an organic entity, the company relies on the total assets owned or occupied and overall profitability, considering varieties of factors which influence the profitability of the company, and combined with the background of industry where the company is located, the integrated assessment of the overall fair value of the company. This is the enterprise value evaluation theory. Its core and purpose is to analyze and estimate the overall worth or part of the equity worth of the firm, as well as to evaluate the continuous profitability of the business[3].

2.2 The DDM theory

The DDM model is the dividend discount model that was proposed by Williams and Gordon in 1938 to evaluate the intrinsic value of stocks. It is the theoretical basis for the quantitative analysis of virtual capital, assets and business value. The form of equity is the stock. The investor gets two kinds of cash flow from the stock: the cash dividend obtained from the sale of the stock. Since the cash flow that the investors obtain by selling shares is also determined by the amount of future dividends to be paid to shareholder. The present value of the future dividends is equivalent to the value of the shares[7].

2.3 The B-S theory

The B-S model belongs to one kind of physical options method. The B-S model, proposed by Fisher Black and Scholes, is a formula for the pricing of European options. In many documents such as Yang XQ (2021) and so on, it is pointed out that an artificial intelligence companies can use the B-S model to estimate their potential value, and the valuation method combined with another enterprise valuation model can comprehensively evaluate the overall value of the business and avoid undervaluing the business[1].

3 TSR Corporation

TSR Information Technology Co., founded in 1993, is the founder of Chinese full-text retrieval technology. Since its establishment, the company has been focusing on the natural language processing core (NLP), with semantic intelligence as the main technology line, research and development of related artificial intelligence, big data and content management technology, the development of a series of general platform and industrial application software products.

Advantages analysis: (1) develop independent core technologies such as semantic intelligence and big data. The main technical advantage of TSR is semantic intelligence, which mainly covers sub-fields such as NLP and knowledge graph. Developing semantic intelligence can raise technical barriers and enhance the potential profitability of companies. (2) Large R&D investment. Since its establishment, it has continuously promoted technology research and development, increased investment in research and development efforts, and built a research and development team. This series of measures further enhance the company's independent research and development ability. (3) Stable customer resources. It covers a wide range of fields, and has a certain leadership position and brand advantages in many fields. By virtue of this position, the company has formed a stable cooperative relationship with its customers to ensure the long-term development of the company.

4 Enterprise value assessment

4.1 The Enterprise Value Evaluation based on DDM model

4.1.1 Dividend discount model

The sum of the company's future dividends to evaluate the intrinsic value of the company is the dividend discount model. The frequently-used formula is:

$$P_0 = \frac{D_1}{(1 + E_{(ri)})^1} + \frac{D_2}{(1 + E_{(ri)})^2} + \dots = \sum_{t=1}^{\infty} \frac{D_t}{(1 + E_{(ri)})^t} \quad \#(1)$$

P_0 denotes intrinsic value of the stock. DPS_t denotes expected value of the dividend per stock in the t year. And $E_{(ri)}$ denotes necessary return rate of the stock[6]. For most companies, the stock price is not a zero or fixed growth rate, but a two-stage growth. the two-stage dividend growth model is assumed that the enterprise growth presents two stages, the first stage is the company dividend growth at a high growth rate; the second stage is the steady-growth stage of dividends. At this time, the intrinsic value of stocks is expressed by the formula:

$$P_0 = \sum_{t=1}^n \frac{D_0(1 + g_1)^t}{(1 + E_{(ri)})^t} + \frac{EPS_n(1 + g_1)^n * PER}{(1 + E_{(ri)})^n} \quad \#(2)$$

Among them, PER is the P / E ratio[9].

4.1.2 Existing value analysis

It is a high-tech enterprise with high market share and good prospects. The company has been paying dividends steadily for many years, which is suitable for using the two-stage dividend growth model to evaluate the intrinsic value of the enterprise. Assuming that the enterprise dividend will grow at a high growth rate in the next five years (2022-2026), and then stabilize (after 2026).

(1) Sustainable growth rate

The highest sales growth rate that a business can attain without issuing new shares or altering operating effectiveness and financial policies is referred to as its sustainable growth rate[10]. For reducing the influence of random variables, the financial data of 2017-2021 was selected for analysis.

$$\text{sustainable growth rate} = \text{ROE} * (1 - \text{Dividend Payout Ratio}) \# (3)$$

Table 1 Financial data of TSR from 2017 to 2021 (Data source: <http://www.cninfo.com>)

Year	Earnings per share	Basic earnings per share	Dividend payout ratio (%)	ROE
2017	0.05	0.34	14.71	9.16
2018	0.0502	0.13	38.62	3.35
2019	0.05	0.22	22.73	8.09
2020	0.05	0.45	11.11	15.83
2021	0.049	0.34	14.41	10.17

The arithmetic average of dividend payment rate that can be obtained from Table 1 is 20.31%, and the ROE in 2021 is 10.17%, so the sustainable growth rate of the company is $g = 10.17\% * (1 - 20.31\%) = 8.1\%$. 8.1% is selected as the expected growth rate of the first phase of the company.

(2) Cost of equity capital

The cost of equity capital refers to the price paid by an enterprise by issuing common stock[11], which is the necessary rate of return for shareholders. The cost of equity capital is calculated in this study using the capital asset pricing model using the following formula:

$$E_{(r)} = R_f + \beta (E_{(rm)} - R_f) \# (4)$$

Among them, R_f denotes the risk-free rate of return, $E_{(rm)}$ denotes the expected market rate of return, β denotes the system risk coefficient, $(E_{(rm)} - R_f)$ denotes the market risk premium[10]. When the risk-free yield is given, the capital is invested in the yield of an investment object without any risk. The yield of short-term Treasury bond yield generally replaces the risk-free yield, and the one-year short-term Treasury bond yield of the central bank on April 12, 2023 is 2.2091% as R_f , and the data comes from the China Bond Information Network. Expected market return is under the condition of uncertainty, forecast the future yields, the 2012-2021, nine years of the Shanghai composite index compound growth rate of 7.8% as a system risk coefficient is used to measure individual stock or stock fund relative to the whole stock market price fluctuations, according to the Oriental wealth choice financial terminal data, β value of the TSR is 1.0585. The cost of equity capital is 8.13%.

(3) P / E ratio

The stock price divided by earnings per share is the P / E ratio. Generally speaking, the lower the P / E ratio of company and the end of the profitability of the stock, the shorter the investment payback period, the less the investment risk; If the higher the P / E ratio of company, vice versa. But if the p / E ratio is too high, the company is overvalued. In the Oriental wealth choice financial terminal can check P / E ratio is 88.59 on the April 12, 2023 of the TSR.

(4) Intrinsic value calculation of the enterprise

Put the above data into the two-stage dividend growth model of stock intrinsic value calculation formula:

$$P_0 = \sum_{t=1}^5 \frac{0.049(1+8.1\%)^t}{(1+8.13\%)^t} + \frac{0.34(1+8.1\%)^5 * 88.59}{(1+8.13\%)^5} = 30.32 \#(5)$$

Through using a two-stage dividend growth model to calculate the intrinsic value of TSR, it can be concluded that each price should be 30.32 yuan, a total 79529.30 million shares on March 24, 2023 can be used in the calculate the intrinsic value of the company. The computational formula is $79529.20 * 30.32 = 2411325.344$ million. The stock market price is 27.87 yuan per share on April 12, 2023, lower than using the DDM model to find the intrinsic value, so TSR has investment prospects. (Data source: Oriental Fortune Choice Data)

4.2 TSR Enterprise value Assessment based on B-S model

4.2.1 B-S model

Real option pricing method is a concept derived from financial options, which is mainly divided into the following two categories: one is to calculate the option value through numerical methods, such as the binomial model; the other is the pricing method based on the B-S model. The calculation formula for the B-S model is as follows:

$$C = S \times N(d_1) - X e^{-rT} N(d_2) \#(6)$$

$$d_1 = \frac{\ln \frac{S}{X} + (r + 0.5 \times \sigma^2)T}{\sigma \times \sqrt{T}} \#(7)$$

$$d_2 = \frac{\ln \frac{S}{X} + (r - 0.5 \times \sigma^2)T}{\sigma \times \sqrt{T}} = d_1 - \sigma \sqrt{T} \#(8)$$

Where C denotes option price, X denotes option execution price, S denotes present value of the underlying asset, T denotes execution time of the option, r denotes the risk-free interest rate of continuous compounding, σ^2 which denotes the annual variance, and N denotes cumulative probability distribution function of normally distributed variables $\{ \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{d_n} e^{-\frac{x^2}{2}} dx \} [12]$.

4.2.2 TSR potential value analysis

According to the summary of its 2022 annual report, it will comprehensively accelerate the development of cloud and data intelligence services in the future, and accelerate the implementation of artificial intelligence technology in diversified scenarios. The company has a future development prospect, and is expected to be in the rapid development stage in the next five years, and then in the stable development stage. December 31, 2021 is selected as the base date of evaluation, and the option execution time is 5 years, that is, $T=5$ years.

(1) Stock price volatility

Stock price volatility is an important indicator to measure the degree of stock price movement, which can predict the future performance of a stock. This paper selects the daily stock closing price of 243 trading days from January 1, 2021 to December 31, 2021 to calculate the stock price volatility. Using the STDEVA function in Excel table, the standard deviation of daily stock yield is calculated as 4.37%, and then the standard deviation of daily stock yield is converted into annual standard deviation of 68.07%, that is, the stock price volatility $\sigma = 68.07\%$. (Data source: Oriental Fortune Choice Data)

(2) Continuous compound interest of the risk-free interest rate

A risk-free interest rate is the interest rate that can be obtained by investing money in an

investment without any risk[13]. The Treasury bond interest rate is generally used instead of the risk-free interest rate. The single interest rate of the 5-year Treasury bond on December 31, 2021 is 2.6092%, and then the compound interest rate is calculated as the risk-free interest rate of continuous compound interest. The calculation process is as follows, $2.6092\% \times 5 = (1 + r)^5 - 1$, then $r = 2.48\%$. (Data source: China Bond Information Network)

(3) Option execution price

The option execution price is the price at which the two parties agree to execute the purchase right and sale right contract within a specific period in the future[14]. This paper intends to take the total liabilities of The Company on the base date of December 31, 2021 as the option execution price. According to the balance sheet data of the Company, the total liabilities of the Company on December 31, 2021 are 1148,383,400 yuan, namely $X = 1148,383,400$ yuan. (Data source: <http://www.cninfo.com>)

(4) Present value of the underlying assets

In this paper, the total assets as of December 31, 2021 are selected as the present value of the underlying assets, namely $S = 3725979,600$ yuan.

(5) Potential value calculation of enterprises

Put the above data into the calculation formula of the B-S model:

$$d_1 = \frac{\ln \frac{372597.96}{114838.34} + (2.48\% + 0.5 \times 68.07\%^2) \times 5}{68.07\% \times \sqrt{5}} = 1.62\#(9)$$

$$d_2 = \frac{\ln \frac{372597.96}{114838.34} + (2.48\% - 0.5 \times 68.07\%^2) \times 5}{68.07\% \times \sqrt{5}} = 0.09\#(10)$$

Check the standard normal distribution cumulative probability function table is available:

$$N(d_1) = 0.9474, N(d_2) = 0.5359$$

The option price is:

$$C = 372597.96 \times 0.9474 - 114838.34^{-2.48\% \times 5} \times 0.5359 = 352999.1809\#(11)$$

4.3 Overall value of the enterprise

In conclusion, the overall value of the business is $2411325.344 + 352999.1809 = 2764324.52.49$ million yuan.

5 Study conclusions and prospects

Combined with the characteristics of the high proportion of intangible assets in the artificial intelligence industry, this paper chooses the combination of DDM and B-S model to evaluate the enterprise value of TSR, so as to evaluate the intrinsic value and potential value of enterprises respectively. The combination of models can evaluate enterprise value more comprehensively to avoid the single value evaluation model. Through calculation, it can be seen that the overall value of TSR is high compared with the actual market value, which indicates that the enterprise value of really is undervalued, but the deviation is not large, which proves the feasibility of the two models in the enterprise value evaluation of artificial intelligence.

In the process of enterprise value evaluation with TSR as an example, there are still deficiencies such as non-financial indicators. In the future research process, we should fully consider the impact of the market environment and non-financial factors such as enterprise strategy on the business value evaluation results, so as to improve the precision of the enterprise value evaluation

consequences. The DDM and B-S models should also be continuously improved to expand their application scope to evaluate more enterprises of different types and fields.

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