Research on Enterprise Value Management of Emerging Industries in the Age of Artificial Intelligence

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Abstract. The arrival of the era of artificial intelligence is both an opportunity and a challenge, and the main research of artificial intelligence enterprises, belongs to the emerging industry, it is very different from the traditional industry. How to measure its enterprise value, has become a controversial issue. This article from the artificial intelligence industry analysis, combined with its particularity, through comparative analysis of all kinds of enterprise valuation method, choose the real options method to measure the value of the company, applying Schwartz - Moon model combined with Monte Carlo simulation to evaluate the enterprise value of Robots(300024), find out the reasonable artificial intelligence class enterprise value evaluation model, and gives the corresponding Suggestions, helps to guide the orderly development of the industry, promote the development of artificial intelligence and innovation.

1. Introduction
Into the 21st century, artificial intelligence into our field of vision, its development is becoming more and more quickly, research in this field including robots, speech recognition, image recognition, natural language processing and expert system, etc. Relevant researches on artificial intelligence are mainly focused on technology application and intelligence research, which are academic and theoretical. However, there are few researches on artificial intelligence enterprises, especially on the value of artificial intelligence enterprises. With the advent of artificial intelligence, more and more high-tech enterprises to choose the research of artificial intelligence, but this kind of business model, the future direction of and differences between traditional enterprise, so by the traditional methods of artificial intelligence estimate companies will cause a great error, prompted us to find more suitable for the specific approaches to the study of the artificial intelligence enterprise valuation.

2. The selection of research methods and the establishment of models
Compared with traditional enterprises, artificial intelligence enterprises are very different, mainly reflected in its potential value. Artificial intelligence enterprise focus on technology research and development and technological innovation, into a larger but may cause considerable profits, in a short period of time can't put into marginal cost and marginal returns do not match, lead to the existing value is low, but there is potential value, at the same time on innovation ability, research and development of facing the failure risk, such as its value is volatile, so a simple historical financial data cannot be measured artificial intelligence, the future development of the enterprise potential, we need not only consider the current actual value, need to pay attention to the potential value of the future, the more you need to consider the non-financial factors to predict the future.
2.1. Real option method

Traditional methods of evaluating enterprise value are biased to measure financial data, such as: cost method, market method, income method, etc. The future uncertainty is not taken into account, and the measurement content mostly focuses on tangible assets, so the potential value of the enterprise cannot be accurately estimated. Therefore, for the particularity of artificial intelligence enterprises, the real option method is chosen to evaluate the value of the enterprise through various considerations. Compared with traditional methods, it defines enterprise value as the sum of the value of real assets and the value of investment opportunities, and believes that the value of investment opportunities is uncertain and will affect the decision-making of enterprises. It is an option asset, similar to a call option, which fully considers the potential value of enterprises. Through comparative study, the real option method takes into account the uncertainty in production and operation, intangible assets and other aspects, and pricing the flexible investment choice decision right of the management, which can better reflect the value of the artificial intelligence listed companies.

2.2. Monte Carlo Simulation

Through the in-depth study of real option method, Monte Carlo simulation method is chosen to evaluate the value of artificial intelligence enterprises. Monte Carlo simulation method is a kind of expected value solution method, relying on computer technology, through repeated simulation of business decisions, finally get the mean value as the evaluation result, can effectively deal with the uncertainty

\[ U = E(X) = \frac{1}{n} \sum_{i=1}^{n} x_i, \]

\[ X \] is simulated for \( n \) times, then \( n \times \) values are obtained. The mean value is \( \bar{x} \). By the central limit theorem, if \( n \) is large enough, \( \bar{x} \) is an estimator of \( U \).

2.3. Schwartz-Moon valuation model construction

After determining the method, a valuation model suitable for AI enterprises is introduced: Schwartz-Moon model, which takes into account the fluctuation of variables, predicts cash flow through probability distribution, and fully considers uncertainty and dynamics.

2.3.1. Application hypothesis

(1) The random variables in the model are independent of each other
(2) The market's risk-free rate is a fixed value
(3) Changes in income follow the Brownian movement. The standard deviation will converge to the normal level
(4) The company does not distribute dividends. And after tax net profit can be converted into cash
(5) Consider only the risk premium caused by the uncertainty of income

2.3.2. Model construction

(1) Revenue

Revenue \( R(t) \):

\[ \frac{dR(t)}{R(t)} = \mu(t)dt + \sigma(t)dz_1 \]

\( \mu(t) \): expected revenue growth rate; \( \sigma(t) \): income volatility; \( z_1 \): wiener processes are normally distributed.

With the development of the enterprise, the expected revenue growth rate \( \mu(t) \) will return to the stable level of the industry \( \mu \), and \( \sigma(t) \) will converge to \( \sigma \), \( \eta(t) \) will also converge to zero. The process is as follows:

\[ d\mu(t) = k(\mu - \mu(t))dt + \eta(t)dz_2 \]
\[ d\sigma(t) = k_1(\sigma - \sigma(t))dt \]
\[ d\eta(t) = -k_2\eta(t)dt \]

\( K \): mean regression coefficient, reflecting the average convergence rate of income growth rate; \( \eta(t) \):

Revenue growth volatility

(2) Cost

\[ \text{Cost}(t) = \gamma(t)R(t) + F \]
γ(t): variable cost; F: Fixed cost (since artificial intelligence enterprises mainly focus on intangible asset cost, so simplified F=0)

With the development of the enterprise, the cost rate will return to the stable level of the industry $\bar{\gamma}$ and $\varphi(t)$ converge to $\bar{\varphi}$. The process is as follows:

$$d\gamma(t) = k_3(\bar{\gamma} - \gamma(t))dt + \varphi(t)dz_3$$
$$d\varphi(t) = k_4(\bar{\varphi} - \varphi(t))dt$$

$\varphi(t)$: Volatility of cost change rate, $z_1, z_2, z_3$ are independent of each other.

(3) After-tax net income(depreciation is tax deductible)

After-tax net income $Y(t): Y(t) = (R(t) - Cost(t) - Dep(t))(1 - r_c)$

Dep(t): Depreciation value; $r_c$: Corporate tax rate

(4) Fixed assets

Fixed assets $P(t): dp(t) = (Capx(t) - Dep(t))dt$

Capx(t): Capital expenditure, CR and DR are fixed proportions.

Among them $Capx(t) = CR \times R(t); \ Dep(t) = DR \times P(t)$

(5) Cash available

Available cash $X(t): dX(t) = (rX(t) + Y(t) + Dep(t) + Capx(t))dt$

R: Risk-free rate

(6) Adjustment of income risk

The uncertainty of enterprise income will lead to risk premium. Combined with the capital pricing model, the following can be obtained:

$$\frac{dr(t)}{R(t)} = (\mu(t) - \lambda(t))dt + \sigma(t)dz_1$$

$$\lambda(t) = \beta(r_m - r_f)$$

β: Company risk coefficient; $r_m$: market risk return rate; $r_f$: risk-free rate of return

(7) Company value (the sum of accumulative available cash in the last year and the value of continuing operations)

Company value $V(0): V(0) = E_\pi(X(t) + M(R(t) - Cost(t))e^{-rT}}$

$E_\pi$: the expected value under the risk-neutral assumption; $e^{-rT}$: Continuous compounding discount coefficient; M: Exit multiple

3. The application of Schwartz-Moon valuation model

3.1. Parameter value

SIASUN Robot & Automation Co., Ltd is a listed high-tech enterprise with robot technology as the core and dedicated to full intelligent products and services. It is the core leading enterprise of the top 10 robot industry in China. It is a typical artificial intelligence enterprise that focuses on the research of artificial intelligence technology, devotes itself to the research and development of robot brain, and achieves the intelligent level. The values of parameters in the model were calculated according to the company's annual report and the characteristics of the artificial intelligence industry.

Table 1. Values of model related parameters

| Parameter                      | The values         | Access method                                      |
|--------------------------------|--------------------|----------------------------------------------------|
| Initial revenue: $R_0$         | 3.09473 billion    | Income statement 2018 operating income             |
| Initial revenue growth rate: $\mu_0$ | 26.05%             | Profit statement 2018 growth rate of operating revenue |
| Initial income volatility: $\sigma_0$ | 5.86%             | Standard deviation of growth rate of operating revenue 2013 to 2018 |
| Initial revenue growth volatility: $\eta_0$ | 53.49%             | Standard deviation of percentage change in revenue growth rate from 2013 to 2018 |
### Summary of Key Parameters

| Parameter                          | Value                          | Notes                                           |
|------------------------------------|-------------------------------|------------------------------------------------|
| Long-term revenue growth rate: $\mu$ | 14%                           | Weighted average revenue growth across the industry |
| Long-term income volatility: $\sigma$ | 5%                           | The estimate                                   |
| Initial cost rate: $\gamma_0$     | 86.91%                        | Ratio of operating costs to revenue in 2018     |
| Initial cost volatility: $\varphi_0$ | 1.60%                       | Standard deviation of cost variation rate in 2013-18 |
| Long term cost rate: $\bar{\gamma}$ | 70%                         | Average cost volatility in the industry        |
| Long-term cost volatility: $\bar{\varphi}$ | 2%                          | Standard deviation of industry-wide cost volatility |
| Cash available at the beginning: $X_0$ | 1.99698 billion             | Cash Flow Statement 2018                        |
| Depreciation rate: DR             | 18%                           | Average depreciation rate for 2013-18 years     |
| Capital expenditure rate: CR      | 12%                           | Average Capital expenditure rates for 2013-18   |
| Corporate tax rate: $r_c$         | 10%                           | The annual report in 2018                       |
| Risk-free rate: $r_f$             | 3.50%                         | Treasury rates                                 |
| Return on risk: $\lambda$        | 4%                            | The formula                                    |
| Fixed assets at the beginning: $P_0$ | 1.25208 billion             | Balance Sheet 2018                             |
| Time increment: $\Delta t$       | 1                             | Data interval                                  |
| Estimated interval: $T$          | 5                             | It is expected to fluctuate between large ranges |
| The mean recovery rate: $k$       | 1.4                           | estimate                                       |
| Exit multiple: $M$               | 10                            | Historical research                            |

### Analog Result

Matlab software is used to program the model, based on the Schwartz-Moon pricing model combined with Monte Carlo simulation to evaluate the value of SIASUN Robot & Automation Co., Ltd, and the parameters are set into the program.
After 20,000 simulations, the expected value of the company on December 31, 2018 is 2196600 million yuan, the total share capital in 2018 is 156002396 million shares, the theoretical price per share is 14.32 yuan, and the closing price of SIASUN Robot & Automation Co., Ltd at the end of 2018 is 13.22 yuan. The theoretical value is 6.5% higher than the actual value, there is a certain difference, but generally more similar. As an artificial intelligence enterprise, SIASUN Robot & Automation Co., Ltd is currently developing rapidly in the artificial intelligence industry. Therefore, the uncertainty it is facing leads to that the theoretical estimated value is higher than the actual stock value, and the higher part may come from the potential value of the enterprise itself.

4. Conclusions
(1) Assess the value of SIASUN Robot & Automation Co., Ltd. Based on the Schwartz-Moon model and Monte Carlo simulation method, the value of the company at the end of 2018 is evaluated. The results show that the theoretical value of the company is higher than the actual value, indicating that the company has growth option value. The results are similar, and the error rate is less than 10%, which indicates that the real option method is feasible to evaluate the value of artificial intelligence enterprises. Meanwhile, it also verifies the characteristics of artificial intelligence enterprises: the potential price of the enterprise should be considered as well as the existing value of the enterprise.

(2) at the same time, this article research also has certain limitation, such as considering the listed are typical artificial intelligence industry leading enterprises, and does not take into account the unlisted small and medium enterprises in the study, secondly, the model, there are a number of assumptions may therefore information and actual gap, so a lot of research in the aspect of theory, practice remains to be further studied.

(3) With the rapid development of artificial intelligence, the number of artificial intelligence enterprises is gradually increasing. When more artificial intelligence-related technologies are developed, the standard management of artificial intelligence enterprises should also be strengthened simultaneously, so as to contribute to the development of the industry and the continuous progress of artificial intelligence technology.
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