Research on Small and Medium-sized Military Enterprise Valuation Based on Real Options

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Abstract: This paper uses real option theory —Schwartz Moon to discuss current market evaluation, and tries to find out key factors that can affect enterprise value. We also try to give management and investment suggestions to managers and investors of small and medium-sized military enterprises.

1. Introduction

Military enterprises have large investment in R&D, long profit cycle and obvious policy impact. With the advancement of civil-military integration process, more and more military enterprises, especially private military enterprises, use effective methods for enterprise operation and management, and try to participate in market environment , be evaluated by the market together with ordinary enterprises. It is not practical to invest in R&D regardless of cost any more.It is necessary to adjust the operation according to market demand. Therefore, it is of great guiding significance for investors and operators to explore method to calculate intrinsic value.

2. Literature review

Since the emergence of the theory of enterprise value research in 20th century, a relatively mature theoretical system has been formed. In addition to three traditional value assessment methods_ (asset-based method, market method and income method), new value assessment methods, such as EVA and real option, have successively emerged. Among them, income method which based on discounted cash flow model plays a major role in enterprise value assessment in China. Market is complex and changeable, however. Income method is based on a static prediction of future cash flow ([1]), which cannot deal with business uncertainty and growth opportunities very well.

In order to solve this problem, [1] divided enterprise value into asset value and investment opportunity value. He regarded the latter as call option, which thus opening the door of real option. Based on B-S model proposed in[2], real option theory developed two main models: BSM model from[3] and binary tree model from[4]. In the view of inevitable uncertainty in company's operation process, [5] creatively proposed the role of uncertainty in enhancing the company's value. [6] made discrete approximation of continuous time pricing model, combined it with Monte Carlo simulation, considered the change of company's cash flow from the perspective of probability, and evaluated the theoretical value of company.

Tech enterprise projects last longer, have more uncertainty factors([7]). Their managers also have decision-making flexibility in operations process ([8]). Therefore, simple hypothesis in traditional estination method is not excectly appropriate. However, Schwartz Moon model which considers uncertain value can better adapt to these characteristics of high-tech enterprises. [9] verified this model with data from 30,000 technology companies, found that it has a key advantage in valuation of small and unlisted companies. What’s more, its accuracy is significantly better than that of the

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sales-multiple valuation method.[10] used Schwartz Moon model to evaluate the rationality of Facebook's IPO pricing. After considering a series of uncertain factors,[10] considered that Facebook's IPO pricing was too high, which was confirmed by subsequent market reaction.

At present, researches on enterprise value assessment mainly focus on traditional income method. In the application of real option method, they mainly focus on B-S model and binary tree model. In fact, B-S model has strict assumptions and complicated derivation process, which is quite different from the actual production. Although the principle of binary tree model is relatively simple, it is tedious and difficult to deal with complex situations. Besides, its application efficiency is low. Therefore, it is significant to explore application of new real option method. Schwartz Moon model provides a good quantitative method for studying revenue uncertainty through Monte Carlo simulation, which is more suitable for enterprises with fluctuations in management process.

As technology-intensive enterprises, military enterprises themselves invest a lot in R&D and have a long effective cycle. In addition, affected by changes in military supply plans, they have characteristics of large income fluctuations. At the same time, for small and medium-sized military enterprises, their main business is usually concentrated in a certain segment of the field, which means weak impact resistance and tendency to show more instability in income. Therefore, this paper will use Schwartz Moon's real option theory to evaluate the value of small and medium-sized military enterprises.

3. Theoretical model

3.1 Model Assumption

Schwartz Moon model has some key assumptions for theoretical derivation, mainly as follows:

- Random variables are independent of each other.
- Instantaneous motion of the income satisfies the geometric Brownian motion.
- Standard deviation of expected revenue gradually returns to the normal level of industry.
- A gradual return to steady growth in income growth.
- Consider only fluctuating risk premiums of income.
- The company makes no dividend distribution.
- The risk-free rate is constant. After-tax net profit can be converted into cash.

3.2 Modeling

According to the hypothesis, the instantaneous change of enterprise income at time T is subject to geometric Brownian motion. Higher initial growth rate will converge randomly to the stable growth rate of same industry. Change of income will also converge to a more reasonable level. Enterprise's total cost is divided into fixed cost and variable cost, and there is a certain proportion between variable cost and income. As the business matures, variable cost ratio will converge to a reasonable level. After considering corporate taxes, depreciation and capital expenditure, we can get enterprise available cash. Next, assuming that only the uncertainty of revenue brings a risk premium, and then we will adjust risk of revenue. As in

$$V(0) = E_Q\{X(t) + M[R(t) - Cost(t)]\}e^{-rT} \quad (1)$$

Enterprise value is equal to the accumulated available cash and final value in last year of forecast period, which is calculated by the multiple of EBITDA. In this equation, $V(0)$ represents current enterprise value. E_Q is expected value under the risk-neutral assumption. $X(t)$ is the forecast of available cash in the last year. M is EBITDA multiples. $R(t)$ represents revenue. $Cost(t)$ represents total cost. e^{-rT} is the present value coefficient of continuous compound interest.

Since the financial data of an enterprise are provided at a certain time interval, it is necessary to discretize the above continuous time model to obtain an approximate formula. Then conduct operational simulation with Monte Carlo simulation. The expected value of all results will

approximate the true value of enterprise.

4. Empirical research

DL, a military enterprise engaged in the production of infrared products, is selected as a case here .DL is one of the few listed enterprises develop infrared military products in domestic market at present. Meanwhile, DL also engages in infrared civil products, which has a significant feature of military and civilian integration. In addition, DL's sales revenue and market value among listed enterprises are smaller than those of large enterprises in the industry. Its income has grown rapidly and fluctuated significantly in the past few years.To sum up, DL is characterized by large investment, rapid growth, unstable revenue and weak anti-risk capability caused by concentrated production business, These means DL is suitable for simulation valuation by using Schwartz Moon model.

4.1 Parameter Choice

1) According to the 2019 annual report: Initial income is 530.4508 million yuan.Fixed assets are worth 91.9239 million yuan.Available cash -- cash and cash equivalents, is 13,0729 million yuan.Income tax rate is 9.38%.Depreciation rate is 7%.Considering that companies will enter optoelectronic pod industry, the company's asset expenditure rate is set at 9%.Constrained by military products bulk delivery and the boom of industry, DL's revenue fluctuated significantly. Its growth rate of initial revenue was 25.25% year-on-year in 2019.

2) Data from 2015 to 2019 are taken for calculation: Standard deviation of revenue growth rate is 20.32%.Standard deviation of revenue growth is 34.09%.Average dividend yield is 30%.Take standard deviation of variable cost rate 5.81% as initial variable cost volatility.The unitary regression analysis of the 5-year variable cost and operating income yielded a fixed cost of 206,884,400 yuan, with a variable cost rate of 40.41%.

3) Long-term growth rate is estimated to be 7% according to the research of infrared product industry.Based on the estimates of Schwartz and Moon, the industry's long-term revenue volatility is set at 5%.GD and RN, which are mature companys in this field, are selected as reference.Thus, long-term variable cost rate is 56%.Mean standard deviation of the companys variable cost rate is taken as standard deviation of long-term change, 5%.

4) The model assumes that income growth rate and its volatility will return to the normal at same speed in the way of $e^{-\kappa t}$. According to the current pattern of infrared industry development, assuming that its update time is about 5 years.Therefore,average recovery speed of random process mean κ is 0.5545.Set time increment as 1 year and estimated period as 10 years. Take the exit multiple, M, to be 10, from Schwartz and Moon.

5) Take average interest rate of 10-year Treasury bonds issued in the past five years as risk-free rate of 3%.Take the average return rate of SSE Composite Index from January 1, 2009 to January 1, 2020 for calculation, and expected market return rate is 8.30%.Assuming that only the uncertainty of income brings risk premium, $\beta_0 = 1.2005$ excluding financial leverage is calculated through the correlation between the return rate of DL's shares in 2019 and the Shanghai Composite Index.As of December 31, 2019, DL's interest-bearing liabilities and shareholders' equity are 243.930 million and 115.27696 million respectively, so the risk premium of income factor λ can be calculated by the following formula:

$$\begin{aligned} &\beta=[1+(1-15\%)*24390.30/115276.96]*1.2005=1.3910 \\ &\lambda=\beta*（\mathrm{r}_m - r_f) = 1.3910*(8.30\% - 3\%) = 7.37\% \end{aligned} \tag{2}$$

4.2 Analysis of Simulation Results

Since Schwartz Moon model assumes that the company does not make dividend distribution, this paper assumes that DL's valuation without dividend distribution acts as a control group first. However, this is not consistent with the situation of the case company and industry, so dividend distribution rate of the company is set at 30% than. That is, 70% of annual net income can be turned

into disposable cash. In each simulation, 100,000 Monte Carlo simulations were conducted, and mean value of all results was taken as estimated value. After that, sensitivity analysis will be conducted to change the value of key variables to explore factors that have great impact on the company value.

Without considering dividend distribution, the simulated value of DL is 6.725 billion. While it is valued at $5.888 billion, down 12.44%, when it assumes 70% of net income is available cash, which means a 30% dividend yield. Theoretical stock prices (14.66 when there is no dividend and 12.84 when there is dividend) and current stock price fluctuations are compared as follows.

Fig.1 A comparison of theoretical and actual stock prices

Before 2020, DL's stock price has been fluctuating around 10 yuan, which means market undervalues DL. On the first trading day of 2020, stock price was 10.94 yuan, 1.7 yuan lower than the theoretical price with dividends. After 2020, due to the impact of COVID-19, market demand for infrared temperature measurement products surged, which greatly affected the entire industry pattern and revenue. The market was therefore apparently optimistic about DL. Then its price boomed. As a result, DL's market price after 2020 has risen substantially above simulation price baced on 2019. Meanwhile, its price fluctuates with the epidemic situation and gradually stabilizes at a higher level.

4.3 Sensitivity Analysis

In order to provide managers with reference directions for managing companies and provide investors with judgment basis for investment, this paper conducts sensitivity analysis on selected factors to try to find out the key factors that can significantly affect the value of companies and provide suggestions for users.The simulation results are as follows.

Table 1 Key factor test results

Parameter	Value Change		
	Parameter goes up 10%	***Parameter goes down 10%***	***Range of volatility***
Initial revenue growth rate	7.72%	-7.96%	15.67%
Long-term income growth rate	5.04%	-6.04%	11.08%
Initial revenue volatility	-0.01%	-1.03%	1.01%
Long-term income volatility	0.06%	-0.62%	0.68%
Initial revenue growth volatility	6.94%	-7.08%	14.02%
Variable cost rate	-1.70%	0.51%	-2.20%
Long-term variable cost rate	-19.30%	17.49%	-36.79%
Mean recovery average velocity of random process	-10.88%	14.56%	-25.44%
Calculate interval	12.13%	-12.67%	24.80%
M	6.65%	-7.85%	14.50%
Dividend distribution rate	-1.56%	0.24%	-1.80%

According to the sensitivity analysis, it can be seen that long-term variable cost rate, mean

recovery speed and calculation interval have the greatest impact on DL's value. When these parameters change by ±10%, its value changes by -36.79%, -25.44% and 24.80% respectively. Secondly, revenue growth rate and initial revenue volatility also have a significant impact on compny value.

This means that the key factors affecting a company's value are its profitability, ability to control costs and growth rate. This conclusion is reflected in DL's stock price in 2020.The market believes that COVID-19 has changed DL's long-term revenue level and industry pattern, so its market value has been greatly enhanced. In contrast, the volatility of corporate revenue does not have a very significant impact on enterprise value. This may be because that fluctuation of revenue is only an external reflection. While the real value of a company comes from its internal factors, namely operating ability and ability to grow after constant strategic adjustment. In the long run, a mature enterprise with strong R&D strength, excellent product quality and strong industry competitiveness will not be greatly affected by industry fluctuation. This gives enterprise managers a certain confidence to adhere to long-term layout strategy, even though the enterprise is of average size and is greatly affected by military supply policy.

5. Conclusion and suggestion

According to Schwartz Moon simulation, the market has been underestimating DL in 2019.So for investors, DL is a good place to start. When studying the key factors affecting enterprise value, this paper finds that the most critical factor affecting enterprise value is long-term ability to control costs and speed at which it grows into a mature enterprise. Of course, a company's profitability also affects its value. For managers of military enterprises, income is often affected by non-market factors, causing fluctuations. However, according to simulation results, the impact of such fluctuations on long-term enterprise value is relatively weak. Therefore, it is more important for a company to stick to its long-term strategy, even though the company's revenue has a clear tendency to fluctuate.

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