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What Affects the Growth of Military Enterprises in China: Research and Development?

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ABSTRACT Sustainable growth of military enterprises is key to developing the national defense industry. Therefore, we selected the financial data of 90 military enterprises listed in China. Using the factor analysis method, we obtained the growth evaluation index from the four dimensions of profitability, debt repayment, operation, and R&D (research and development). The results show that R&D is the critical factor for the growth of military enterprises, and profitability is a short board. In the industrial field, the growth of military shipbuilding enterprises is better than that of other fields, mainly because of the high attention paid to R&D. Regarding the conversion of military-oriented enterprises to civilian production, this study emphasizes the importance of improving profitability and ensuring scientific research incentives. The results of this study are also consistent with the stock market performance of military-listed enterprises, which means that the higher the growth score, the better is the market performance. At the same time, the growth evaluation results of military enterprises have guiding significance for enterprises and market investors.

INDEX TERMS Military enterprises, research and development, R&D, defence economics, China.

I. INTRODUCTION

In 2021, the State Council of China issued the 14th Five-Year Plan for the national, economic, and social development of the People's Republic of China and the outline of the long-term objectives for 2035. The plan requires that during the '14th Five-Year Plan' period, China's R&D (research and development) investment has an average annual growth rate of more than 7%, a basic research investment that accounts for more than 8%, and the added value of strategic emerging industries that accounts for more than 17% of the GDP. National defense construction is an integral part of China's development plan during the '14th Five-Year Plan' period. Implementing scientific and technological competition systems, such as 'taking the lead' and 'horse racing,' is essential in China to establish numerous national laboratories and constantly improve the classification and evaluation system of task-oriented scientific and technological [1], [2]. By building a major national science and technology infrastructure in appropriate areas in advance, China will continue to promote the implementation of a national long-term science and technology planning strategy.

As an indispensable part of China's national defense construction, military enterprises provide the military with required weapons and equipment. Technological innovation is often the key to the long-term development of military enterprises. Regarding military enterprises, establishing whether the factors affecting their growth differ from those of traditional manufacturing enterprises is the research focus of several scholars worldwide. Most research on China's military industry is related to military policies, national defense finance, the reform of military enterprises, military-civilian integration policies or R&D investment of military enterprises, and there is less quantitative research on the growth of military enterprises. This study explores the key factors affecting the growth of military enterprises in China to promote the development of the national military industry and compensate for the lack of relevant research. The conclusions of this study may be helpful for investors in the stock market and enterprise managers to make investment and management decisions, which have practical significance. Specifically, the growth score of military enterprises will guide

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investors to invest in enterprises with high growth score. Meanwhile, investors can decide the investment cycle of a military enterprise according to the score of the R&D factor. For military enterprises' managers, by comparing the growth scores with other military enterprises, they could make appropriate adjustments to their strategies to make up for their shortcomings in the certain factor, so as to promote the rise of the company's share price.

II. THEORETICAL FRAMEWORK: THE GROWTH EVALUATION MODEL

Many scholars at home and abroad have studied the factors that affect the growth of enterprises in different industries. Several scholars have chosen different evaluation indicators to establish factors that affect enterprise growth. Earlier research on the development of an enterprise confirmed that both the internal and external aspects of an enterprise affect its growth. The conclusion provided a theoretical basis for later scholars to include external factors in the growth model [3]. Laitinen used the model to evaluate the growth of Finnish high-tech enterprises by considering internal factors such as overall competitiveness, production capacity, financial management capacity, cost, product quality, and operating revenue [4]. To improve this model, certain external factors, such as ownership, the introduction of a new product strategy, industry competition intensity, and enterprise scale, were incorporated into the growth model, which was used to evaluate the growth of manufacturing enterprises in Vietnam and Finnish high-tech enterprises [5].

Considering the characteristics of China's economic policies, Chinese scholars have conducted growth evaluation studies of China's domestic enterprises. Early studies mainly focused on factors that should be considered in the enterprise growth model. The indicators that affected enterprise growth, such as financial potential, human capital, market public relations, and technological innovation, were considered in four aspects [6]–[9]. Using the AHP method, a growth evaluation model of the GEM of the Hong Kong Stock Exchange was developed [10], [11]. The enterprise growth model was improved in the application process. Scholars continued to apply the enterprise growth model to various fields, trying to determine the growth characteristics of enterprises in different areas. Selecting financial indicators from profitability, asset operation, and cash capability created an enterprise growth evaluation index. It was used to evaluate the growth of China's tourism and sports industry via the catastrophe progression method [12]–[14]. The factor analysis method was used to study the growth of enterprises listed on ChiNext and the medium-sized board in China's stock market from capital, enterprise expansion, cost, and profit perspectives [15]-[17]. R&D capability is gradually incorporated into the model to evaluate the growth of high-tech enterprises better. When assessing the development of new energy enterprises in China's stock market, some scholars have used principal component analysis and the catastrophe progression method to build a growth model from the aspects of debt repayment, profitability, operation, and R&D capability [18]–[20]. Most scholars select evaluation indicators from enterprise profitability, cash flow, debt, and enterprise expansion. However, there are only a few studies on the growth of Chinese military enterprises in China and abroad. The selected time span and sample number are limited because of the lack of data in previous studies. This study selected the data of 90 listed military enterprises in China's stock market from 2012 to 2020. Based on public financial data disclosed by military enterprises, we selected 14 indicators from the four aspects of profitability, solvency, operation, and R&D through factor analysis to formulate the growth evaluation index of military enterprises to determine the key elements that can be used to measure the growth of military enterprises. We hope this paper serves as a reference source and basis for national defense strategies towards developing military enterprises while filling the gap in relevant research fields.

III. RESEARCH DESIGN

A. SELECTION OF INDICATORS

The selection of indicators in this study was based mainly on the basic enterprise growth model. The early growth model usually includes three main indicators: profit, asset, and R&D indicators. In the subsequent improved model, human capital, protection of intellectual property rights, product competitiveness, cost of capital, market opportunities, and access to the capital market are continuously added to the growth model of enterprises. Since we are establishing a growth evaluation model for Chinese military enterprises, we must meet two requirements when selecting indicators: 1) availability of indicator data: to keep confidential, Chinese military enterprises will not disclose data such as human capital, product intellectual property rights, and competitiveness. Such data involve national security, so they are excluded from the model. 2) Validity of indicator data: Due to the nationalization nature of Chinese military enterprises, the growth of military enterprises has specific communist characteristics. On the premise of excluding the influence of national policies, we improved the basic enterprise growth model. On the premise of excluding the above unavailable indicators, the growth model of Chinese military enterprises was established by comprehensively selecting four indicators: profitability, debt repayment, operation, and R&D. For the selection of secondary indicators, to avoid multicollinearity between indicators as much as possible, we followed the principle of "less and optimal."

As a manufacturing industry, the national defense industry includes high-tech fields such as aerospace, weaponry, and ship manufacturing. There are similarities and differences between the military and traditional manufacturing enterprises. Operating profits mainly measure the profitability of military enterprises. However, the orders of military enterprises are primarily provided by the Ministry of National Defense or relevant military research institutes, and their market-oriented orders account for only a small part.

Although military enterprises have the same measurement indicators as traditional manufacturing enterprises in terms of profitability, there are still differences in their revenue sources. The proportion of operating profit is also a critical factor in measuring the profitability of military enterprises.

For the solvency of military enterprises, most of their actual controllers or controlling shareholders are the state-owned assets supervision and administration commission, SDIC Group, or local government investment institutions. Compared with traditional manufacturing enterprises, military enterprises have a stronger ability to bear liabilities, mainly because local governments or national investment institutions bear liabilities for them. The solvency of military enterprises is significantly weaker than that of traditional manufacturing enterprises mainly because of state-owned enterprises' complex internal audit mechanisms. This has also resulted in weak capital controls and asset liquidity.

The operating capacity of an enterprise is primarily used to measure asset turnover and revenue growth. The turnover rate of total assets reflects the flow of an enterprise's total assets. The indicators of current assets and accounts receivable are the financial data on enterprise liquidity, whereas the growth rate mainly measures the growth of enterprise operation data. Unlike traditional manufacturing enterprises, military enterprises have many fixed assets, and their research equipment and projects primarily exist in the form of fixed assets. However, ordinary manufacturing enterprises pay more attention to the proportion of current assets to total assets to improve the flexibility of enterprise operations. We measured the operational capacity of military enterprises from the perspective of asset turnover and revenue growth.

Military enterprises belong to the high-tech manufacturing industry, and their R&D investment is the same as that of traditional manufacturing enterprises. They have paid attention to their own scientific R&D. Military enterprises' R&D investments are transformed into intangible assets to form actual output. Military enterprises are primarily involved in aerospace and other high-tech fields. The R&D cost of military enterprises is higher than that of traditional manufacturing enterprises, which is one of their main characteristics. Therefore, we include indicators in the growth evaluation index, such as R&D investment and intangible assets.

To determine the four primary profitability indicators, debt repayment, operation, and R&D, we selected 14 secondary indicators and used the factor analysis method to determine the factor weight.

B. SELECTION OF THE SAMPLE DATA

According to the Industry Classification Guidelines for Listed Companies issued by the China Securities Regulatory Commission, we collected financial data of 90 listed companies in the military industry in China's stock market from 2012 to 2020. We chose this period because the China Securities Regulatory Commission (CSRC) first issued the industry division standard for Chinese listed enterprises in 2012, thus determining the scope of enterprises belonging to the military industry. Before that, there was no national standard for the division of military enterprises, and there was no explanation for the division of various fields within the military industry, such as ships and ground equipment. During the writing of this article, since the financial data of military enterprises in 2021 has not been disclosed, we did not include it in the model. We selected the military enterprises listed in aerospace, weaponry, and ship manufacturing that have formed a particular industrial scale.

As shown in Table 1, the indicators selected in this study included profitability, solvency, operating capacity, and R&D ability. We select operating profit margin, net profit margin, return on net assets, and net profit rate on total assets as second-level indicators in terms of profitability. We selected the current ratio, quick ratio, and asset liability ratio for solvency as secondary indicators. We select the total asset turnover ratio, current asset turnover ratio, accounts receivable turnover ratio, total assets growth ratio, revenue growth ratio, and cash ratio of revenue as second-level indicators of operating capacity. For R&D capability, we selected the proportion of intangible assets in total assets and the proportion of R&D investment in revenue.

TABLE 1. Indicator selection and calculation formula.

First-level Indicators	Second-level Indicators	Calculation Formula
Profitability	Operating profit margin	Operating profit / Revenue
	Net profit margin	Net profit / Operating income
	Return on net assets	Net profit / Owner's equity
	Net profit rate on total assets	Net profit / Total assets
Solvency	Current ratio	Current assets / Current liabilities
	Quick ratio	Quick assets / Current liabilities
	Asset liability ratio	Total liabilities / Total assets
Operating capacity	Total asset turnover	Revenue / Total assets
	Current asset turnover	Revenue / Current assets
	Accounts receivable turnover ratio	Revenue / Accounts receivable
	Total assets growth rate	Increase in total asset of the year / Total assets at the beginning of the year
	Revenue growth ratio	Increase in revenue of the year / Revenue of the previous year
R&D capability	Proportion of intangible assets in total assets	Intangible assets / Total assets
	Proportion of R&D investment in revenue	R&D investment / Revenue

We identified the 14 secondary indicators detailed above and assigned them as symbols $X_1 - X_{14}$, respectively. We conducted a multicollinearity test on the selected indicators, and the results showed that the variance inflation factor (VIF) values (Table 2) were not more than 2.00; therefore, there was no multicollinearity between the selected indicators [21]. After standardizing the selected sample data, we obtained a descriptive statistical table of secondary indicators (Table 2). For the indicators–profitability $X_1 - X_4$, the standard deviation range of the profit indicators is 0.13–2.47, and the overall dispersion is low. The solvency indicators, $X_5 - X_7$, were highly discrete, and the standard deviation of the

TABLE 2. Descriptive statistics of indicators.

Indicator Code	Indicator Name	Mean	Standard Deviation	VIF
X_1	Operating profit margin	0.03	1.46	1.34
X_2	Net profit margin	-0.10	2.47	1.72
X_3	Return on net assets	0.08	0.13	1.19
X_4	Net profit rate on total assets	0.04	0.14	1.61
X_5	Current ratio	67.70	140.08	1.89
X_6	Quick ratio	3.05	3.02	1.52
X_7	Asset liability ratio	36.34	28.58	1.30
X_8	Total asset turnover	0.43	0.17	1.64
X_9	Current asset turnover	0.64	0.26	1.42
X_{10}	Accounts receivable turnover ratio	3.07	2.92	1.78
X_{11}	Total assets growth rate	21.06	37.42	1.29
X_{12}	Revenue growth ratio	11.37	29.86	1.48
X_{13}	Proportion of intangible assets in total assets	0.04	0.03	1.65
X_{14}	Proportion of R&D investment in revenue	9.35	6.72	1.47

current ratio reached 140.08. The standard deviations of the operating capacity indicators, $X_8 - X_{12}$, range from 0.26 37.42. The standard deviation of the total asset growth rate reached 37.42, reflecting the indicator's high dispersion. The standard deviation range of the R&D capability indicators, $X_{13} - X_{14}$, is 0.03–6.72, which reflects the low dispersion of the indicators.

C. EMPIRICAL ANALYSIS

This study focuses on the growth of listed military enterprises based on profitability, solvency, operations, and R&D capability from 2012 to 2020. Thus, we use SPSS 26.0 to perform factor analysis based on the 9-year public data of the sample military enterprises.

First, we conducted the KMO test and Bartlett's sphericity test on the sample data of the selected military enterprises. We can determine whether the sample is suitable for factor analysis through the test mentioned above. The test results are listed in Table 3.

The test results show that the KMO statistic is $0.66 > 0.5$, indicating a significant KMO result. Therefore, the indicators selected in this study were suitable for factor analysis. The Bartlett sphericity test statistic was 1586.82, and the p-value of the test was close to 0. The results show a strong correlation between the 14 secondary indicators selected in this study; thus, we can conduct a comparative study of military enterprises through factor analysis.

Second, using the principal component method to extract the common factors of the index, we obtained the characteristic value and variance contribution rate of each element. The results are presented in Table 4. After rotating the sample data, the cumulative variance contribution rate of the first four principal components reached 73.10%; therefore, we can use the first four comprehensive indicators to reflect fully the $X_1 - X_{14}$ indicators' information.

We obtained a scree plot of these factors (Figure 1). Combined with the scree plot and total variance interpretation table, we extracted four common factors from the 14 factors

TABLE 3. KMO and Bartlett's sphericity test results of the sample data.

KMO test with sufficient degree		0.66
Bartlett's sphericity test	Approximate chi-square	1586.82
	df	91.00
	Sig.	0.00

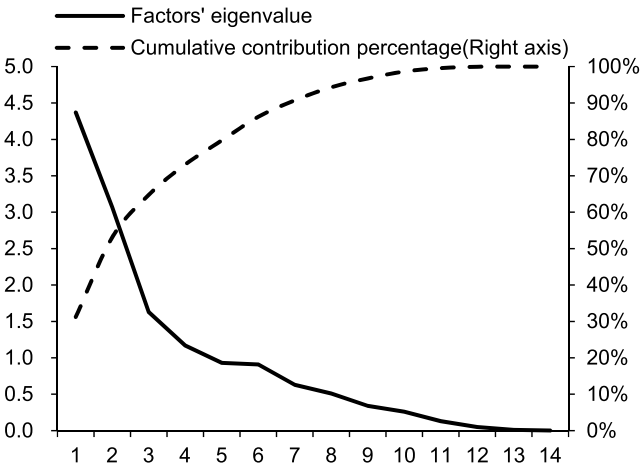

FIGURE 1. Scree plot of factors.

and rotated them to obtain the initial eigenvalues of the first four principal components: 4.37, 3.07, 1.63, and 1.17. Therefore, the four main factors selected can fully reflect the information of the 14 second-level indicators.

Third, we used the variance maximization method to rotate the existing correlation matrix based on the eigenvalues and variance contribution rate of each factor to obtain the load matrix of the factors. We calculated the weights of the four common factors, F_1–F_4, as listed in Table 5.

From the results in Table 4, we obtain the variance contribution rates of the four common factors. The variance contribution rate of $F_1$is 30.48%, and the factor load matrix has a high factor load for the four indicators of operating profit margin, net profit margin, return on net assets, and net profit rate on total assets. Because the four indicators comprehensively reflect the profitability of military enterprises, we can recognize F_1 as a common factor in profitability. The variance contribution rate of F_2 is 21.13%, and the factor load matrix has a high factor load for the five indicators of total asset turnover, current asset turnover, accounts receivable turnover ratio, total asset growth rate, and revenue growth ratio. Because the five indicators comprehensively reflect the operating capacity of listed military enterprises, we recognize F_2 as a common factor in operating capacity. The variance contribution rate of F_3 is 11.37%, and the factor load matrix has a high factor load in the three indicators of the current ratio, quick ratio, and asset-liability ratio. Notably, F_3 can comprehensively reflect the solvency of military enterprises and can be recognized as a common factor of solvency. The variance contribution rate of F_4 is 10.12%. The factor load

TABLE 4. Interpretation of sample total variance.

	Initial eigenvalues			Extracting sum of squares of loads			Rotating sum of squares of loads		
Indicator code	Total	Variance percentage %	Cumulative percentage %	Total	Variance percentage %	Cumulative percentage %	Total	Variance percentage %	Cumulative percentage %
X_1	4.37	31.21	31.21	4.37	31.21	31.21	4.27	30.48	30.48
X_2	3.07	21.90	53.11	3.07	21.90	53.11	2.96	21.13	51.61
X_3	1.63	11.66	64.77	1.63	11.66	64.77	1.59	11.37	62.98
X_4	1.17	8.33	73.10	1.17	8.33	73.10	1.42	10.12	73.10
X_5	0.93	6.61	79.71						
X_6	0.91	6.49	86.20						
X_7	0.63	4.52	90.72						
X_8	0.51	3.61	94.32						
X_9	0.34	2.42	96.74						
X_{10}	0.26	1.89	98.63						
X_{11}	0.13	0.94	99.57						
X_{12}	0.05	0.38	99.95						
X_{13}	0.01	0.05	99.99						
X_{14}	0.00	0.01	100.00						

Extraction method: Principal component analysis; Rotation method: Caesar normalization maximum variance method. (The data converged after 7 iterations of rotation)

matrix has a high factor load in the two indicators of the proportion of intangible assets in total assets and R&D investment in revenue. Therefore, F4 is recognized as a common factor of R&D capability.

Finally, we estimate the factor score matrix of the selected indicators via the regression method, which reflects the coefficient relationship between the four extracted common factors and the selected 14 secondary-level indicators. We can establish the score coefficient equation for the common factors, and the score coefficient matrix is presented in Table 6.

According to Table 6, by linearly combining the four common factors with the 14 secondary indicators, we can obtain the score formula for each common factor as follows:

$$\begin{aligned} F_1 = {} & 0.23X_1+0.23X_2-0.13X_3+0.21X_4+0.01X_5+0.09X_6 \\ & -0.22X_7-0.01X_8+0.01X_9+0.01X_{10}+0.08X_{11} \\ & +0.06X_{12}-0.01X_{13}-0.02X_{14} \end{aligned} \tag{1}$$

$$\begin{aligned} F_2 = {} & -0.01X_1+0.01X_2+0.05X_3+0.04X_4-0.08X_5 \\ & -0.08X_{11}-0.24X_6+0.09X_7+0.32X_8+0.32X_9 \\ & +0.09X_{10}+0.18X_{12}+0.06X_{13}-0.17X_{14} \end{aligned} \tag{2}$$

$$\begin{aligned} F_3 = {} & -0.07X_1-0.09X_2+0.45X_3+0.09X_4+0.13X_5 \\ & +0.11X_6+0.04X_7+0.16X_8-0.11X_9+0.01X_{10} \\ & +0.23X_{11}+0.30X_{12}-0.47X_{13}-0.03X_{14} \end{aligned} \tag{3}$$

$$\begin{aligned} F_4 = {} & 0.07X_1+0.08X_2-0.11X_3+0.01X_4+0.66X_5-0.02X_6 \\ & +0.08X_7-0.08X_8-0.17X_9+0.29X_{10}-0.05X_{11} \\ & -0.21X_{12}-0.31X_{13}-0.22X_{14} \end{aligned} \tag{4}$$

We used the variance contribution rate of each factor as the weight coefficient to linearly sum the scores of each factor and obtain the growth score F.

$$F = 0.3048F_1+0.2113F_2+0.1137F_3+0.1012F_4 \tag{5}$$

According to formulas (1)–(4) for the common factor scores and the comprehensive score, and formula (5) for military enterprise growth, we calculate the common factor and the growth scores of the selected 90 military enterprises. The common factors and growth scores of the selected military enterprises are shown in Table 7.

After evaluating the growth of the selected 90 military enterprises, the results show that the growth scores of 83 military enterprises are greater than 0, while only seven of them are less than 0. Based on the data presented above, we can establish that most Chinese military enterprises grow well in profitability, solvency, operations, and R&D capability. The top five military enterprises with growth scores were 601989, 000768, 600893, 600760, and 600967, while the bottom five military enterprises with growth scores were 688081, 000697, 688011, 300810, and 000687.

R&D capability has become a key indicator of military enterprise growth. When we rank the R&D capability factor, F_4, from high to low, the ranking of the top five military-industrial enterprises with growth scores does not change. The ranking of the bottom five enterprises improves because of the R&D factor score. Specifically, 688081's growth score ranking rose to 71, whereas those of 000697, 688011, 300810, and 000687 increased to 41, 54, 57, and 24, respectively.

According to the subdivided fields of the military industry, we roughly categorized the above-mentioned enterprises into four fields: aerospace equipment, aviation equipment, ground equipment, and shipbuilding. We calculated the mean values of the growth and common factor scores in each field, and the results are presented in Table 8. Shipbuilding had the highest growth score among the four fields mentioned above, whereas aerospace equipment had the lowest. In terms of profitability and solvency, the profit scores of the four military fields were negative, whereas shipbuilding had the lowest score in the two aspects stated above. The operating capacity scores of the four areas were positive, with shipbuilding having the highest score and aerospace equipment having the lowest score. The R&D capability score of shipbuilding is much higher than

TABLE 5. Load matrix of factors.

	F_1	F_2	F_3	F_4
X_1	0.93	-0.01	-0.07	0.07
X_2	0.93	0.01	-0.09	0.08
X_3	0.93	0.05	0.45	-0.11
X_4	0.91	0.04	0.09	0.01
X_5	0.01	-0.08	0.93	0.66
X_6	0.09	-0.24	0.91	-0.02
X_7	-0.22	0.09	0.84	0.08
X_8	-0.01	0.92	0.16	-0.08
X_9	0.01	0.92	-0.11	-0.17
X_{10}	0.01	0.89	0.01	0.29
X_{11}	0.08	0.88	0.23	-0.05
X_{12}	0.06	0.88	0.30	-0.21
X_{13}	-0.01	0.06	-0.47	0.91
X_{14}	-0.02	-0.17	-0.03	0.92

TABLE 6. Score coefficient matrix of the common factors.

	F_1	F_2	F_3	F_4
X_1	0.23	-0.01	-0.07	0.07
X_2	0.23	0.01	-0.09	0.08
X_3	-0.13	0.05	0.45	-0.11
X_4	0.21	0.04	0.09	0.01
X_5	0.01	-0.08	0.13	0.66
X_6	0.09	-0.24	0.11	-0.02
X_7	-0.22	0.09	0.04	0.08
X_8	-0.01	0.32	0.16	-0.08
X_9	0.01	0.32	-0.11	-0.17
X_{10}	0.01	0.09	0.01	0.29
X_{11}	0.08	-0.08	0.23	-0.05
X_{12}	0.06	0.18	0.30	-0.21
X_{13}	-0.01	0.06	-0.47	-0.31
X_{14}	-0.02	-0.17	-0.03	-0.22

those of the other three fields, which also contributes to its leading growth score.

IV. DISCUSSION

Since no scholars have conducted quantitative evaluations of the growth of Chinese military enterprises in the past, the results obtained in this study have no existing results for comparison. To verify the effectiveness of the research results, we selected the compound annual growth rate (CAGR) of the stock market value of 90 listed military enterprises from 2012 to 2020 as the test standard of the enterprise growth score. The growth of listed enterprises is ultimately reflected in the growth of the company's stock price and market value; therefore, it can be regarded as an external manifestation of the long-term development of enterprises.

According to the test results, the stock price of the enterprise with the highest growth score (Stock Code 601989) ranked first, with a growth rate of 36.42% from 2012 to 2020. However, the enterprise with the lowest growth score (Stock Code 000687) had a CAGR of −6.79%. By comparing the research results with the actual situation of Chinese military enterprises, we find that the evaluation results of the growth model of Chinese listed military enterprises have guiding significance for enterprise management and stock market investment decision-making.

TABLE 7. Growth scores of listed military enterprises.

Ranking	Stock Code	F	F_1	F_2	F_3	F_4
1	601989	808.8	-1.8	-94.0	148.8	755.8
2	000768	307.3	-12.8	-27.9	59.2	288.8
3	600893	278.8	-4.8	-26.3	56.8	253.1
4	600760	197.4	-10.5	-14.1	45.0	177.0
5	600967	193.5	-10.6	-14.9	42.2	176.9
6	600879	181.5	-9.7	-17.0	37.9	170.3
7	600038	175.0	-10.8	-8.8	40.4	154.3
8	002013	136.2	-8.2	-14.5	29.1	129.8
9	600685	134.9	-15.0	-20.3	11.1	159.1
10	600372	130.8	-9.6	-11.8	29.8	122.5
11	002179	119.0	-5.7	-10.8	32.7	102.8
12	600765	86.0	-9.5	-4.1	22.9	76.7
13	000519	71.3	-3.5	-0.8	21.0	54.6
14	002414	71.2	3.6	12.4	48.4	6.7
15	600764	63.2	-2.6	-5.5	21.5	49.7
16	600316	62.6	-7.5	-0.8	19.8	51.1
17	600118	62.5	-6.0	-3.9	15.1	57.3
18	002465	62.0	-3.6	-6.2	17.4	54.3
19	002625	56.9	2.1	-5.0	21.9	38.0
20	600562	53.3	-6.3	-3.6	19.5	43.7
21	002985	53.3	9.7	0.8	48.0	-5.2
22	000547	50.9	-3.1	-5.2	16.3	43.0
23	603678	50.0	-1.1	4.0	27.5	19.7
24	300875	46.9	18.6	-21.7	57.8	-7.8
25	603712	46.8	-8.6	-1.1	23.2	33.2
26	300726	45.7	3.0	6.9	35.4	0.4
27	000738	45.4	-3.6	-1.6	15.2	35.4
28	002025	45.4	-5.0	-1.0	18.1	33.3
29	688122	45.3	-6.1	7.0	24.4	20.0
30	603267	45.3	3.3	6.7	30.7	4.7
31	002214	44.0	3.4	16.4	38.1	-13.9
32	601698	42.6	-2.6	-5.2	8.7	41.8
33	000733	42.4	-6.1	-2.6	12.0	39.1
34	600990	40.9	-13.1	1.2	14.4	38.4
35	688788	38.0	12.2	-23.0	42.4	6.3
36	600435	37.6	-6.8	5.0	17.6	21.8
37	600862	36.7	-5.6	2.0	12.3	28.0
38	002111	35.1	-6.5	1.3	15.8	24.5
39	002151	34.0	-4.8	1.2	16.1	21.5
40	600184	33.9	-8.3	-0.6	16.6	26.1
41	300900	33.2	9.3	-9.0	35.0	-2.1
42	600501	32.1	-9.7	5.1	15.6	21.1
43	688586	31.5	-0.7	-2.2	26.6	7.8
44	002829	29.5	-1.6	11.5	27.7	-8.1
45	300696	29.1	3.5	8.7	25.8	-8.9
46	002389	29.0	-4.2	-4.2	7.4	29.9
47	300699	28.0	-1.2	0.1	15.0	14.1
48	300922	28.0	10.0	-11.7	32.0	-2.3
49	000901	27.7	-8.4	-3.2	5.4	33.9
50	300777	26.0	2.9	9.5	24.1	-10.5
51	688510	24.2	3.9	-5.2	28.4	-2.9
52	600391	21.3	-15.0	-1.4	3.4	34.4
53	300114	20.9	-4.7	1.6	12.2	11.8
54	300034	19.8	-5.6	0.6	10.7	14.1
55	002413	19.2	-3.8	-2.3	12.5	12.8
56	300397	18.7	-1.6	6.9	15.2	-1.8
57	300123	17.7	-8.1	-5.1	2.5	28.4
58	601606	16.1	-7.1	1.0	6.9	15.3
59	300065	16.0	-7.2	-0.4	11.6	12.0
60	300474	15.9	-0.6	-3.5	14.4	5.7
61	688682	15.7	-5.7	7.7	16.8	-3.1
62	300395	15.5	-1.3	-1.0	9.8	7.9
63	003009	15.2	-3.3	-0.5	12.2	6.7
64	000561	15.1	-10.6	-0.5	8.3	17.8
65	002977	15.1	3.3	-12.9	18.6	6.2
66	300447	14.9	-4.0	0.8	11.9	6.3
67	300775	13.8	-4.1	-1.5	6.9	12.6
68	300101	12.8	-5.7	1.7	13.7	3.2
69	300527	12.5	-7.7	-6.1	-0.5	26.8
70	002935	12.3	-4.3	-0.6	7.5	9.7

TABLE 7. *(Continued.)* **Growth scores of listed military enterprises.**

71	688070	11.5	-3.9	4.9	13.6	-3.2
72	688636	10.4	-4.4	1.7	16.5	-3.4
73	300719	8.7	-4.3	-0.5	8.5	5.0
74	300252	8.1	-13.7	-4.2	-1.0	27.0
75	300762	7.4	-3.9	-2.6	11.0	2.9
76	300581	7.3	-2.5	0.7	8.1	1.0
77	688685	6.4	-6.3	4.3	7.4	1.0
78	002338	5.2	-0.8	-1.2	5.5	1.6
79	300965	5.1	-3.1	0.4	8.2	-0.5
80	300722	2.6	-2.4	-0.1	5.5	-0.5
81	002933	1.9	-1.3	-7.9	0.2	10.8
82	300045	0.8	-5.8	-3.6	3.5	6.7
83	300424	0.2	-17.0	1.5	-3.4	19.0
84	600343	-2.8	-12.5	-8.2	-14.0	31.8
85	002190	-5.4	-7.2	-7.5	-8.2	17.6
86	688081	-6.2	-2.1	-5.5	-0.6	2.0
87	000697	-10.8	-18.8	-1.1	-11.2	20.2
88	688011	-11.8	-2.6	-12.9	-7.4	11.1
89	300810	-25.2	-4.9	-17.3	-12.1	9.0
90	000687	-54.3	-73.6	5.5	-22.2	36.1

TABLE 8. **Average score of the subdivided military industry.**

Fields	F	F_1	F_2	F_3	F_4
Aerospace equipment	35.25	-3.93	-1.90	14.87	26.21
Aviation equipment	53.91	-7.26	-4.10	17.37	47.90
Ground equipment	44.99	-2.57	-5.44	20.72	32.27
Shipbuilding	233.62	-7.22	-33.00	39.85	233.99

According to the research result, by comparing the growth scores of listed military enterprises in the same field, the company's managers could make appropriate adjustments to their strategies to make up for their shortcomings in the certain factor, so as to promote the rise of the company's share price. However, when the investors choose the investment target of military enterprises in the stock market, they should pay more attention to the enterprises with high growth score, and the growth of enterprises will be reflected in the stock price. The profitability and R&D factors in the model can be used as the key factors for investors to divide short-term or long-term investment. The short-term investors pay more attention to the profitability factor score of enterprises. The long-term investors will pay more attention to the R&D factor score, because of the long R&D cycle of military enterprises, and the impact of their R&D investment on the stock price will lag for several years. As for the applicability of the model, we find that it may not be suitable for the growth evaluation of all industries. For enterprises in specific industries, the indicators and models should be modified to improve the accuracy of the evaluation results.

V. CONCLUSION

By employing factor analysis, we examine the growth of 90 listed military enterprises in China, evaluate their growth, profitability, solvency, operation, and R&D capability, and draw the following conclusions:

Military enterprises have strong growth; more than 90% of the sample enterprises have positive growth scores, and only seven have negative growth scores. Among military enterprises in various fields, shipbuilding enterprises have the strongest growth, which is significantly better than that of military enterprises in aviation, aerospace, and ground equipment.

The factor scores of profitability and solvency of military enterprises are negative, mainly because most military enterprises are state-owned. To ensure the development of the military industry, the process of 'converting military-oriented enterprises to civilian production,' which remains hindered by national policies and markets, must be enhanced. In the past, most military enterprises did not aim to make profits, and government subsidies and long-term fixed orders were the primary sources of income [22]. Therefore, the debts of military enterprises are covered by state funds. Recently, national policy support and industrial R&D fund investments have ensured that military enterprises obtain high R&D capability scores. The shipbuilding industry has the highest score in R&D capability, which is inseparable from China's continuous attention to the South China Sea issue in recent years. China's shipbuilding industry has also developed rapidly [22].

In the process of enterprise growth evaluation, we find that although the variance contribution rate of R&D capability is only 10.12%, it has become a key factor affecting the growth of military enterprises. This factor comprises the proportion of R&D investment in revenue and the proportion of intangible assets in total assets, which reflect the importance of enterprises to R&D and the ability of enterprises to convert R&D investment into intangible assets. The variance contribution rate of profitability is 30.48%, which is much higher than that of R&D capability in the growth evaluation system, although the impact on military enterprises is minimal.

The research results of this study have a guiding role in the management of listed military enterprises and stock market investment. In addition, on the premise of determining the factors influencing the growth of Chinese listed military enterprises, this study lays a theoretical foundation for the subsequent establishment of the value growth model of Chinese military enterprises. However, owing to the limited sample size of this model, there are only 90 selected enterprises, which affects the accuracy of the model. The small sample size is mainly due to the fact that the classification of Chinese listed military enterprises is mainly based on the industry classification standard of the China Securities Regulatory Commission (CSRC). According to this standard, only 90 qualified listed enterprises were selected, while the data and information of other unlisted military enterprises were confidential.

VI. POLICY ENLIGHTENMENT

As the mainstay of national industrial development, military enterprises face several challenges vis-à-vis improving their growth. Based on the results of this study, the following

insights are drawn to promote the sustainable growth of military enterprises:

A. PROMOTE THE PROCESS OF 'CONVERTING MILITARY-ORIENTED ENTERPRISES TO CIVILIAN PRODUCTION' AND IMPROVE THE PROFITABILITY OF MILITARY ENTERPRISES

Profitability is an essential factor affecting the growth of military enterprises. Promoting the 'converting military-oriented enterprises to civilian production' policy will help commercialize scientific and technological achievements in the military industry [23]. The transformation of some unclassified technologies is conducive to promoting the entry of military enterprises into the civil market, expanding profit channels, improving the industry's competitiveness, and facilitating the continuous renewal and iteration of cutting-edge technologies in the industry [24], [25]. The separation of ownership and the use, disposal, and profit rights of scientific and technological achievements in the military sector is a practical approach towards realizing the 'converting military-oriented enterprises to civilian production' strategy. This means that scientific and technological achievements belong to the state, but use, disposal, and income rights belong to the legal entity, conducive to promoting the enterprise's realization of independent profits and being responsible for its profits and losses to actualize its effective growth.

B. EFFECTIVELY PROMOTE THE JOINT-STOCK REFORM AND REALIZE THE 'REBIRTH' OF TRADITIONAL MILITARY ENTERPRISES

Military enterprises cannot deepen the market economy reform without the help of the capital market. Owing to the lag in the marketization process, poor profitability, slow market response, and lack of vitality are the main characteristics of traditional military enterprises, which have become the main factors restricting their sustainable growth. The effective use of the capital market to promote the joint stock reform of military enterprises is the first step in strengthening military enterprises. According to the requirements of the modern enterprise system, a standardized board of directors, board of supervisors, general meeting of shareholders, and introduction of independent directors should be established in military enterprises to continuously strengthen internal operations management, which helps engender effective supervision. Military enterprises should reorganize their internal structure and business according to the principles of specialization and centralization and establish a new organizational structure of 'military holding group–subsidiary group–specialized subsidiary.' Encouraging market capital to enter subsidiaries will promote the moderate privatization process of military enterprises.

C. IMPROVE R&D CAPABILITY AND ESTABLISH AN EFFECTIVE PROPERTY RIGHTS INCENTIVE SYSTEM

R&D capability is the key index for determining the growth of military enterprises, and scientific research achievements are inseparable from national reward and support policies for scientific researchers and projects [26]. A perfect R&D property rights incentive mechanism should be established to form an effective ownership relationship between R&D personnel and achievements to ensure that scientific and technological innovation personnel benefit. The exclusivity of innovators' property rights should be protected by law to prevent the negative impact of technology spillovers and promote the sustainable development of military enterprises' R&D capabilities.

REFERENCES

[1] X. Li, "Research on influencing factors and methods of military enterprise financing under the background of military civilian integration," M.S. thesis, Harbin Inst. Technol., Harbin, China, 2016.
[2] Y. Xu and Z. Zhang, "Between gain and loss: A study on the problem of 'military to civilian' in the small third line of Jiangxi Province," *J. Anhui Norm. Univ.*, vol. 48, no. 4, pp. 111–119, Jul. 2020, doi: 10.14182/j.cnki.j.anu.2020.04.014.
[3] D. J. Storey and B. S. Tether, "New technology-based firms in European union: An introduction," *Resour. Policy*, vol. 26, no. 9, pp. 933–946, Apr. 1998, doi: 10.1016/S0048-7333(97)00052-8.
[4] E. K. Laitinen, "A dynamic performance measurement system: Evidence from small Finnish technology companies," *Scand. J. Manag.*, vol. 18, no. 1, pp. 65–99, Jan. 2002, doi: 10.1016/S0956-5221(00)00021-X.
[5] N. P. Tuan, "Gender, innovation and the growth of small medium enterprises: An empirical analysis of Vietnam's manufacturing firms," *VNU J. Sci., Econ. Bus.*, vol. 28, no. 2, Jun. 2012.
[6] E. Hui, "Analysis on the growth of listed companies," *Rev. Financial Econ. Iss.*, vol. 4, pp. 49–52, Apr. 1998.
[7] H. Xiao and X. Peng, "Tetrahedral structure of enterprise sustainable competitive advantage and growth management," *China Ind. Econ.*, vol. 7, pp. 69–74, Jul. 2003, doi: 10.19581/j.cnki.ciejournal.2003.07.010.
[8] H. Zhu and T. Wang, "An empirical analysis on the growth of Chinese ChiNext listed companies," *J. Huazhong Univ. Sci. Technol. Nat. Sci. Ed.*, vol. 32, no. 10, pp. 82–85, Jul. 2004, doi: 10.13245/j.hust.2004.10.028.
[9] Q. Wang and Y. He, "Analysis on the main factors affecting the growth of Chinese listed companies," *Stat. Decis.*, vol. 2, pp. 61–63, Jan. 2006.
[10] X. Zhang *et al.*, "An empirical study on the profitability and growth of core competence of listed companies: Taking 'CSI top 50 Asian business listed companies' as an example," *Acc. Res.*, vol. 7, pp. 72–77, Jul. 2004.
[11] X. Yao and Y. Huang, "Research on growth evaluation of hotel listed companies based on familiarity model," *Math. Pract. Theor.*, vol. 43, no. 22, pp. 71–77, Nov. 2013.
[12] C. Zhang and H. Zhang, "Research on the growth of China's listed tourism companies based on catastrophe progression method," *Tourism Tribune*, vol. 25, no. 7, pp. 19–27, Jul. 2010.
[13] L. Fu *et al.*, "An empirical study on the growth judgment method of listed companies," *Rev. Financial Econ. Iss.*, vol. 6, pp. 71–77, Jun. 2008.
[14] Q. Lv and S. Gong, "Growth evaluation of listed sporting goods companies in China: Analysis based on data from 2009 to 2013," *China Sport Sci.*, vol. 36, no. 1, pp. 49–58, Jan. 2016, doi: 10.16469/j.css.201601006.
[15] X. Che *et al.*, "Comparative study on growth evaluation methods of small and medium-sized listed companies," *Sci. Res. Manag.*, vol. 27, no. 1, pp. 145–151, Jan. 2006, doi: 10.19571/j.cnki.1000-2995.2006.01.023.
[16] J. Liu, "Design and empirical research on growth evaluation index of enterprises listed on ChiNext," *Macroecon*, vol. 52, no. 8, pp. 56–64, Aug. 2011, doi: 10.16304/j.cnki.11-3952/f.2011.08.005.
[17] Y. Liu and S. Shi, "Verification and analysis of influencing factors of growth of small and medium-sized board listed companies," *Stat. Decis.*, vol. 1, pp. 147–149, Jan. 2011, doi: 10.13546/j.cnki.tjyjc.2011.01.033.
[18] L. Feng and Y. Guo, "Growth evaluation of new energy listed companies based on catastrophe progression method," *Finance. Account. Mon.*, vol. 21, no. 10, pp. 64–68, May 2014, doi: 10.19641/j.cnki.42-1290/f.2014.10.014.

[19] T. Lv and L. Pan, "Research on growth evaluation of China's new energy listed companies," *Ind. Technol. Econ.*, vol. 36, no. 2, pp. 118–125, Feb. 2017.
[20] Z. Fang *et al.*, "Research on the evaluation of technological innovation efficiency of China's listed military enterprises from the perspective of innovation value chain," *Res. Econ. Manag.*, vol. 35, no. 6, pp. 37–48, Dec. 2019, doi: 10.13962/j.cnki.37-1486/f.2019.06.004.
[21] O. Dospinescu and N. Dospinescu, "Workaholism in IT: An analysis of the influence factors," *Administ. Sci.*, vol. 10, no. 4, pp. 96–108, Nov. 2020, doi: 10.3390/admsci10040096.
[22] Y. Fang *et al.*, "Exploration and practice of supervision and management of the whole process of fixed assets investment and construction in Aerospace Military Enterprises," *Finance. Account.*, vol. 15, pp. 26–30, Aug. 2020.
[23] Y. Lim and J. Kim, "Determining the determinants: Factors of change in China's south China sea strategy, 1995–2015," *Pacific Focus*, vol. 35, no. 2, pp. 200–228, Aug. 2020, doi: 10.1111/pafo.12167.
[24] Q. Zhang, "Research on internal market-oriented management mode of military enterprises in China," M.S. thesis, Southwest Univ. Financ. Econ. Chengdu, China, 2011.
[25] P. He and X. Wang, "Research on the organization, policy and system of military-civilian integration technology transfer," *Sci. Technol. Manag. Res.*, vol. 39, no. 15, pp. 29–36, Aug. 2019.
[26] Z. Ji and W. Wang, "Promote the innovative development of military to civilian conversion in the new era," *Defen Ind. Convers. China*, vol. 6, pp. 63–66, Jun. 2019.

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