The Efficient Portfolio in Chinese Automobile Industry

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Abstract: In recent years, the automobile industry is developing well, and the annual sales of cars are increasing year by year. Through the summary of all aspects of performance indicators of automobile companies, I have conducted a comprehensive multi-dimensional analysis of these companies to prove their value. In order to make the data and results as comprehensive as possible, I select nearly 20 stocks from seven segments for analysis. Under Markowitz's efficient frontier theory, I get the effective frontier map of the selected stock and the weight of each stock under the predetermined return. At the same time, I also make detailed suggestions on the buying and selling behavior of investors and the number of stocks they buy and sell. Investors can decide which portfolio to choose according to their own risk preference. It is hoped that this paper can help investors understand the automobile market, configure their own investment portfolios through effective frontier methods.

1. Introduction

With the continuous development of automation industrial, the production and sales of automobiles are increasing year by year. In recent years, the global auto market appears favorable development foreground. Over the last decade, stable supply and demand keep sales-output ratio above 96 percent. In the meantime, Chinese car business transits from growth period to mature period. China has been the world's top automobiles seller for many years. Chinese new energy vehicle and self-driving cars has developed rapidly because of the support from government policy and the injection of capital. Good performance of automotive field, excellent development prospects of automotive market, and solid growth of automotive companies attracts more and more investors recent years. Stocks, as one of the most important negotiable securities and investment tool, becomes the main target that investor invests. It is especially important to carry on the selection of numerous stocks of listed companies and allocate them efficiently.

The efficient frontier optimization model first formulated by Markowitz (1952) is an easy and popular method to construct efficient portfolios which satisfy the condition that no other portfolio exists with a higher expected return but with the same standard deviation of return. Merton (1972) showed that the efficient frontier isn't correct under some conditions. Partovi and Caputo (2004) further proposed a new method of analyzing the efficient portfolio problem when short sales are allowed. Besides, Liu et al. (2015) use the DEA to estimate the portfolio efficiency, and proved that DEA is an effective and practical method. Ratner and Klein (2008) use the to obtain the optimal

portfolios when adding gold holdings to a global portfolio, and their results show marginal, if any, long-term benefit to U.S. investors since 1975. And Galvani and Plourde (2010) focused on the energy market, and found that futures for crude oil, natural gas and unleaded gasoline fail to improve the performance of energy stocks in terms of return to risk, but can decrease the risk exposure. This paper will show how to build a portfolio with effective frontiers for maximizing investors' profit in Chinese stocks market.

2. Chinese Automobile Industry

In recent years, with the rapid development of Chinese economy and the continuous improvement of the quality of life of residents, cars, no matter used as a means of daily transportation or as a status symbol, are needed by more and more families. This has led to a continuous increase in annual car sales. Figure 1 shows that between 2000 and 2018, with the exception of a slight decline in 2018, car sales increased year by year. Among these years, sales in 2002, 2003 and 2010 grew by more than 30%, and even as high as 45.5% in 2009. During 2000 and 2018, car sales have increased nearly 14 times in less than twenty years.

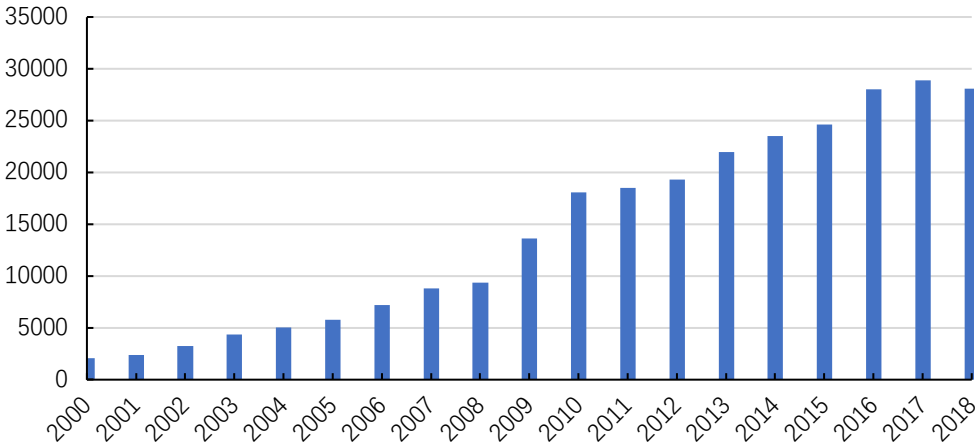

Figure 1: Annual car sales in China.

I analyze the profitability and growth ability of automotive companies in terms of their year-on-year growth rate of net profit and total assets. First of all, net profit, which also called after-tax profit, is an important index to measure the operating efficiency of an enterprise. For the investors of the enterprise, the net profit is the basic factor to obtain the return on investment; for the enterprise managers, the net profit is the basis for making management decisions. At the same time, net profit is also a basic tool to evaluate corporate profitability, to measure management performance and solvency, and is a comprehensive index to reflect and analyze the situation of enterprises in many aspects. I analyze the year-on-year growth rate of annual net profit of related companies in the automotive industry from 2009 to 2019. During this decade, the net profit of most companies increased steadily, and some companies have mastered cutting-edge technology because of proper corporate governance. Even in some years, some companies has produced dozens of times the net profit growth, the performance is very outstanding. However, because of the poor governance of some companies, or the whole industry is affected by the economic crisis and government macro policies and other factors, the overall level of the industry is reduced, and the growth rate fluctuates greatly. Generally speaking, the average growth rate of these companies' overall net profit is about 14%. Total assets, refer to all the assets owned or controlled by an enterprise, reflecting the size of a company.

The growth rate of total assets represents whether the company has enough potential for growth. Over the past decade, the size of automobile companies has increased year by year, and the growth rate is relatively stable, indicating a steady upward trend in the industry, with an overall average of about 23%, until the increase has slowed in the past two years.

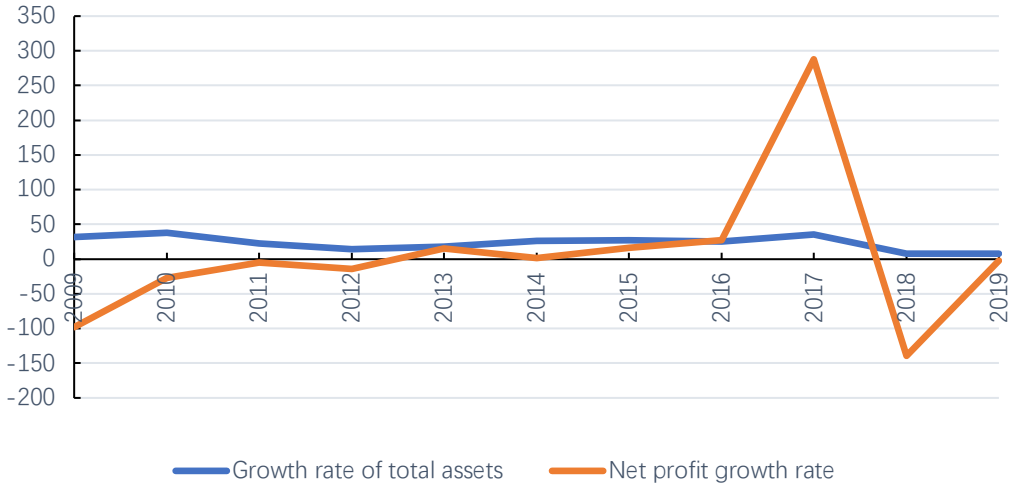

Figure 2: The growth rate of total assets and net profit in China's automobile industry.

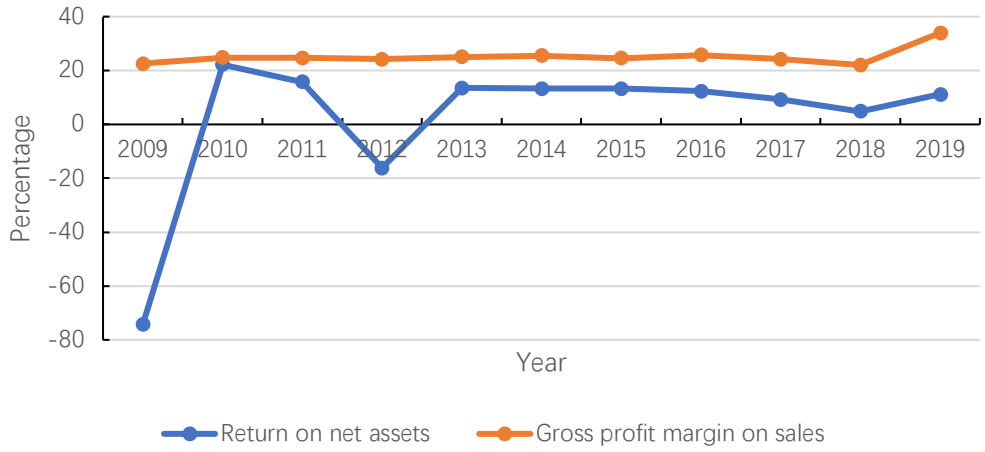

Figure 3: Return on assets and gross profit margin of Chinese automobile companies.

Return on net assets, referred to as ROE, also known as return on shareholders' equity. Index reflects the level of return on shareholders' equity and it is used to measure the efficiency of a company's use of its own capital. The higher the index value, the higher the return on investment. The index also reflects the ability of self-owned capital to obtain net income. From 2009 to 2019, except for the big decline in the return on net assets in 2009 and the decline in 2012, the rest of the years showed an upward trend, and most of them were around 10%. The stable return on net assets is a good testament to the investment value of the automotive industry, attracting more and more investors to participate in it. Gross profit is the basis of operating profit of an enterprise. Therefore, the gross profit margin of the enterprise is also an index that can not be ignored to reflect the income of the enterprise. Figure 3 shows that in the past decade, the average gross profit margin of the

automobile industry is about 25% per year, and it is relatively stable and less volatile. It is precisely because car sales are increasing every year, and there are greater upward potential and profitability, the automobile industry is worthy of our attention.

3. Efficient Portfolio

3.1. Efficient Frontier

Effective frontier, suitable for ideal investors, that is, people who are risk averse and prefer earnings. At the same level of risk, they will choose the portfolio that provides the greatest return; for the same expected return, they will choose the portfolio with the least risk. An investment portfolio that can satisfy both of these two conditions is an effective set, also known as an effective boundary or an effective frontier. In the mean-variance coordinate system, the leading edge of the combination is a parabola; in the standard deviation-mean coordinate system, it is a hyperbola. The combination on the effective boundary constitutes an effective combination. The effective frontier curve tells us that under the condition of full investment, all investors based on risk aversion should choose a portfolio on the effective frontier curve, because they meet the expected return, and the variance is minimal. Assuming there are N risky assets. r_i the return on asset i (i=1,2,3,...,N). w_i is the fraction of asset allocated to asset i.

$$w_1 + w_2 + w_3 + \ldots\ldots + w_n = \sum_{i=1}^{N} w_i = 1. \tag{1}$$

According to their weight, their return is:

$$r_p = w_1 r_1 + w_2 r_2 + w_3 r_3 + \ldots\ldots + w_n r_n = \sum_{i=1}^{N} w_i r_i . \tag{2}$$

According to their weight, their variance is:

$$\sigma^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i w_j \sigma_i \sigma_j \rho_{ij} = \sum_{i=1}^{N} w_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{j \neq i} w_i w_j \sigma_i \sigma_j \rho_{ij} . \tag{3}$$

To calculate the effective frontier, I assume that the expected return of the portfolio is a known quantity: $E(r_p) = \sum_{i=1}^{N} w_i E(r_i) = a$ .Under the above conditions, seeking to meet the constraints to minimize the risk of the asset portfolio. Variance represents the risk, that is, to achieve a given return, making the minimization formula (3).

3.2. The Characteristics of Main Listed Companies in Chinese Automobile Industry

First, I select eight categories of company stocks for analysis, named vehicle manufacturing companies, automobile research institutes, engine manufacturing companies, automobile component companies, automobile tire companies, automobile intelligent companies, automobile air-conditioning companies, and automobile braking system companies.

Among them, the vehicle manufacturing company refers to the company that produces all the in-body parts. I have selected representative companies including SAIC and Dong Feng Motor for analysis. Automobile research institutes and automotive intelligent companies, as research and development companies for cutting-edge automotive technologies, are also included. At the same

time, engines, tires, parts, air conditioners and brake systems, as indispensable parts of automobiles, their companies also have great investment value. Therefore, the areas involved in the above categories of companies, although not fully representative of the automotive industry, are all vital parts of the automotive industry and can constitute a representative investment portfolio. The selected stocks and their characteristics are showed in Table 1.

Table 1: The selected stocks and their characteristics.

Types	Code	Average monthly yield	Annualized return	Volatility	Correlation coefficient	β	Expected yield (CAPM)	Sharp ratio
Complete vehicle	600006	1.321%	15.852%	13.260%	0.363	0.689	8.512%	0.120
	601633	0.245%	2.935%	13.260%	0.431	0.819	9.554%	0.143
	002594	2.528%	30.331%	13.736%	0.338	0.665	8.317%	0.112
	600104	0.819%	9.830%	7.694%	0.658	0.725	8.799%	0.218
	000800	1.382%	16.588%	13.847%	0.547	1.084	11.672%	0.181
	000957	2.012%	24.149%	16.844%	0.272	0.655	8.243%	0.090
	000951	1.804%	21.643%	13.899%	0.616	1.227	12.812%	0.204
Scientific research institute	601965	0.874%	10.486%	10.556%	0.541	0.818	9.547%	0.179
Engine	000338	0.466%	5.591%	12.353%	0.655	1.159	12.273%	0.217
	600178	0.738%	8.858%	13.586%	0.527	1.026	11.207%	0.174
	000581	0.160%	1.925%	10.349%	0.539	0.799	9.390%	0.178
Component	600699	2.337%	28.044%	14.689%	0.243	0.511	7.086%	0.080
	601777	0.381%	4.570%	15.780%	0.521	1.178	12.424%	0.172
	000559	1.443%	17.318%	15.820%	0.334	0.756	9.046%	0.110
	002703	0.281%	3.368%	16.405%	0.387	0.908	10.266%	0.128
	000030	0.111%	1.330%	10.312%	0.591	0.873	9.982%	0.195
Tires	002085	1.844%	22.132%	18.449%	0.240	0.634	8.071%	0.079
Automobile intelligence	300176	1.882%	22.579%	20.183%	0.288	0.832	9.654%	0.095
Vehicle air conditioner	002454	0.487%	5.844%	12.688%	0.485	0.882	10.056%	0.161
Braking system	002590	1.590%	19.079%	19.204%	0.491	1.351	13.808%	0.162

3.3. The Construction of Efficient Portfolio

Table 2 reflects the minimum variance of the portfolio and the optimal weight of each stock in the portfolio under a given return. Here, variance represents volatility as well as risk. It can be seen that as the expected return continues to rise from 6%, the risk faced by the portfolio is also increasing. The weight can be positive or negative. Among them, a positive number means that the investor should buy the stock, while a negative number means that the stock should be sold. By comparing the weights under different expected returns, it is found that the lower the expected return is, the more stocks with lower returns should be held, and the fewer stocks with higher returns should be held.

Figure 4 is the effective frontier portfolios. The coordinates of the horizontal axis represent the magnitude of the risk, while the coordinates of the vertical axis represent the expected return. The

red dot in the figure is the leftmost point in the entire efficient frontier, representing the least risky portfolio of all possible portfolios. It can be seen that the portfolio faces a risk of 0.51% and a return of 6.5%. The portfolio under the red dot is ineffective, because their expected return is not the largest when the risk is the same, so rational investors will not choose these portfolios, but the combination of red dot and above.

Table 2: The risk and weight of portfolio under the given return.

Expect Return	0%	2%	4%	6%	8%	10%	12%	14%	16%	18%	20%	22%
Standard Deviation	9.50%	8.27%	7.57%	7.18%	7.23%	7.78%	8.70%	9.89%	11.31%	12.83%	14.44%	16.02%
Deviation	0.90%	0.68%	0.57%	0.52%	0.52%	0.61%	0.76%	0.98%	1.28%	1.65%	2.08%	2.57%
600006	-0.83%	0.32%	2.97%	4.94%	6.80%	8.76%	10.67%	12.59%	14.34%	16.23%	18.11%	20.26%
601633	2.54%	11.22%	15.43%	21.40%	27.66%	33.97%	40.25%	46.54%	53.24%	59.61%	65.89%	71.68%
002594	-0.70%	0.18%	0.05%	0.45%	0.82%	1.21%	1.59%	1.97%	2.32%	2.69%	3.06%	3.49%
600104	-3.76%	5.13%	21.93%	34.65%	47.55%	60.33%	73.15%	85.97%	99.00%	111.84%	124.76%	137.25%
000800	0.45%	-2.35%	-0.11%	-0.37%	-0.66%	-0.92%	-1.19%	-1.47%	-1.75%	-2.02%	-2.30%	-2.57%
000957	-0.16%	0.71%	1.26%	1.97%	2.67%	3.38%	4.09%	4.80%	5.50%	6.21%	6.91%	7.62%
000951	-1.22%	0.08%	-1.16%	-1.18%	-1.13%	-1.13%	-1.11%	-1.09%	-0.96%	-0.93%	-0.90%	-1.02%
601965	-3.24%	0.88%	1.23%	3.39%	5.54%	7.81%	10.02%	12.23%	14.41%	16.63%	18.81%	21.05%
000338	-3.03%	6.14%	-2.70%	-1.91%	-2.02%	-1.47%	-1.15%	-0.83%	-1.92%	-1.84%	-1.75%	0.43%
600178	-2.84%	-1.36%	0.79%	2.73%	4.51%	6.39%	8.24%	10.09%	11.65%	13.44%	15.27%	17.48%
000581	25.87%	13.63%	15.64%	11.12%	7.99%	1.80%	-3.02%	-7.83%	-9.35%	-13.75%	-18.09%	-27.10%
600699	-0.51%	1.14%	1.84%	3.01%	4.18%	5.36%	6.53%	7.71%	8.87%	10.04%	11.20%	12.40%
601777	0.35%	6.04%	-6.74%	-10.28%	-13.63%	-17.22%	-20.74%	-24.26%	-27.23%	-30.62%	-33.99%	-38.38%
000559	-0.08%	-2.70%	-1.11%	-1.66%	-2.13%	-2.69%	-3.21%	-3.73%	-4.13%	-4.64%	-5.12%	-5.81%
002703	4.59%	8.90%	-2.05%	-6.05%	-9.20%	-12.91%	-16.42%	-19.92%	-22.17%	-25.47%	-28.82%	-33.91%
000030	80.19%	48.95%	55.69%	43.51%	29.42%	18.46%	6.12%	-6.23%	-22.44%	-35.31%	-48.20%	-55.64%
002085	0.19%	-0.27%	0.91%	1.26%	1.63%	1.98%	2.34%	2.70%	3.05%	3.41%	3.77%	4.14%
300176	-0.57%	-0.95%	0.49%	1.01%	1.54%	2.07%	2.60%	3.12%	3.67%	4.21%	4.74%	5.23%
002454	2.95%	7.12%	-2.68%	-5.56%	-8.36%	-11.26%	-14.10%	-16.93%	-19.93%	-22.82%	-25.71%	-28.22%
002590	-0.21%	-2.82%	-1.69%	-2.43%	-3.18%	-3.92%	-4.66%	-5.40%	-6.16%	-6.90%	-7.65%	-8.37%

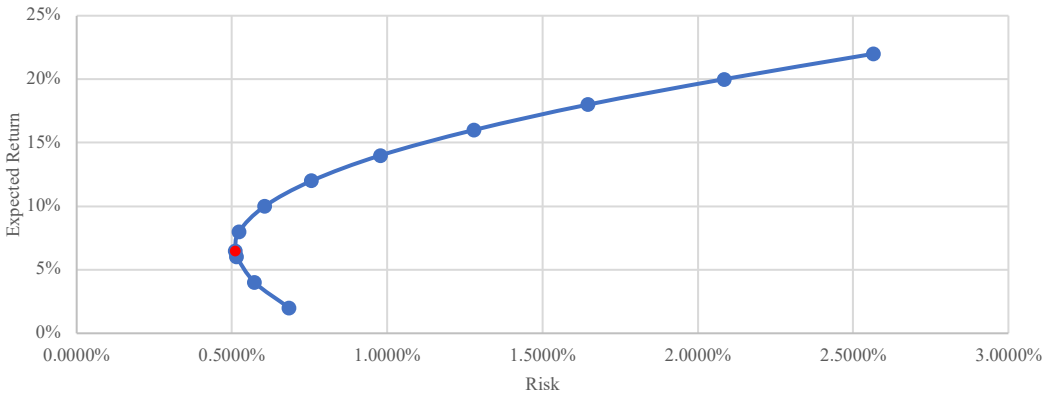

Figure 4: Efficient portfolio.

4. Conclusion

Under the background of the good development of the automobile industry all over the world, this paper studies how to invest in the shares of Chinese automobile companies. First of all, I make a statistical analysis of the annual car sales in the past ten years and the historical data such as the net interest rate, year-on-year growth rate of total assets and return on assets of automobile companies. the development trend, profitability and investment value of the automobile field are summarized in multi-dimensions. Subsequently, I select nearly 20 stocks, representing the representative subdivision related companies, such as automobile manufacturing company, tire manufacturing company, braking system manufacturing company, automobile intelligent research and development company and so on. Through the summary of the historical data of the earnings performance of these stocks in the past few years and the comparison with the market index represented by Shanghai and Shenzhen 300, I get the weight of the selected stocks in the investment portfolio under the given expected return. and build an effective frontier. I assume that the investors in the market are risk-averse investors, that is to say, in the case of the same risk, these investors will give priority to the portfolio with higher returns. Finally, I get the least risky portfolio through mathematical calculation and the analysis of software tools. And I show that in order to achieve the expected return on the portfolio, investors should specify in the stock basket how much each stock should buy or sell, how much it should buy or sell. It is hoped that this paper can help investors who want to invest in the automotive industry or have already entered the field, quickly understand the general situation of the industry, and have a detailed understanding of the method of allocating portfolio through the effective frontier.

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