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Establishing an Option-Based Portfolio Based on a Comprehensive Method

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Abstract
The problem tried to solve in this paper is how a highly efficient option-based portfolio which has rational components and good performance could be established. The approaches adopted to deal with the problem are literature review and empirical analysis methods. The former is used to determine the framework of this investigation, and the latter is used to deduce the detailed outcomes. The result obtained in this research is that the technical indicator analysis method combined with Black-Scholes option pricing model and modern portfolio theory is a good way to create an efficient investment portfolio without the systematic risk and other uncontrollable factors, and it is more accurate than a single way used in the same case. The influence of the results is it may be a better way to make a good decision in portfolio investing field.

Key words: Portfolio; Technical indicator analysis; Black-Scholes model; Modern portfolio theory

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INTRODUCTION
Investing on a portfolio is a challenging work, which includes complicated analyses and potential risks; due to the financial globalization, there are more unexpected factors in the market, so the result of such investment is either huge profits or large losses. To reduce the possible loss, an increasing number of investors prefer to establish their portfolios on the basis of diversification and logic analyses. The whole establishing process is similar to creating a mutual fund (Fulga, 2015; Kang & Montoya, 2014). As the topic required, the portfolio is option-based. Option, as a kind of financial derivative, is actually a contract sold by option writer to holder, which guarantees the holder to buy or to sell the underlying assets at a specified price within a certain period of time, while the holder could choose to execute it or not (Klingebiel & Rammer, 2014; Clayton et al., 2013). For this feature, option-based portfolio is more suitable for controlling the possible loss when comparing to a security-based portfolio. However, it is also notable that option has a higher actual cost and leverage effect, where a little amount of money is needed for the option premium as the trading taking place (Mroua & Abid, 2014; Martinsuo, 2013). As a result, the trading strategies would be discreetly formed by implementing several analyses during the processes.

This paper will demonstrate a comprehensive method of establishing and operating a portfolio under the CBOE virtual trading system. First, the keynote of the portfolio, which means a trade-off between the risk and return, would be determined. In this case, high risk and high return approach have been selected. Second, the fundamental analysis and technical analysis have been adapted to examine the investment elements. Then, some statistical analyses were performed to establish the portfolio on the basis of the keynote and investment strategies. Considering the existing possible shocks beyond the theory, the structure of portfolio might be slightly adjusted during the trading process according to circumstances.

1. THEORY AND METHOD

1.1 Black-Scholes Option Pricing Model (B-S Model)

B-S model provides financial derivative instrument which is priced according to the price volatility of underlying assets with an efficient and rational approach (Clayton et al., 2013), and the model is as shown in Formula (1).

$$\begin{cases} C = S \cdot N(d_1) - \mathrm{L}e^{-rT} N(d_2) \\ d_1 = \dfrac{\ln \dfrac{S}{L} + (r = 0.5 \cdot \sigma^2) T}{\sigma \cdot \sqrt{T}} \\ d_2 = \dfrac{\ln \dfrac{S}{L} + (r = 0.5 \cdot \sigma^2) T}{\sigma \cdot \sqrt{T}} = d_1 - \sigma \sqrt{T} \end{cases} . \quad (1)$$

In Formula (1), C is fair price of an option, S is spot price of the underlying asset, L is strike price, T is the maturity, r is risk-free continuous compounding rate, $\sigma 2$ is annual price volatility of the underlying asset, and $N(di)$ is relevant value of the standard normal cumulative distribution function (Hull, 2015).

In this report, B-S model was used to analyze whether the actual volatility of an option was underestimated or was overestimated. It helped us to judge the position direction of the section 2.3.

1.2 Modern Portfolio Theory (MPT)

MPT provides investors with a manner to establish portfolio with the minimum loss or maximum expected return (Zabarankin et al., 2014), and the model can be stated as Formula (2).

$$\begin{cases} E(p) = r_1 w_1 + r_2 w_2 + \ldots + r_m w_m \\ \sigma_{p,t+1} = (w' \sum w)^{1/2} \\ \sum = (1/T) R' R \\ w = [w_1 w_2 \ldots W_m]' \\ w_1 + w_2 + \ldots + W_m = 1 \end{cases} . \quad (2)$$

In Formula (2), the $E(p)$ is the expected return of the portfolio, Σ is the moving average covariance matrix of m assets over T time periods, w is the weight vector of the portfolio, and R is a $T \times m$ matrix of the asset returns of the portfolio (Hull, 2015). In this report, MPT was used to compute the weight of stocks at the section 2.4.

2. PROCESS OF ESTABLISHING A PORTFOLIO

2.1 Determining the Keynote of the Portfolio

After considering, the income growth short-term portfolio was set as the investment orientation, and the maturity is about six months. The primary objective is chasing a satisfying return by ensuring a large proportion of the principal. As planned, the expected return of this portfolio should be higher than that of the market portfolios.

2.2 Determining the Initial Assets Distribution of the Portfolio

According to the investment keynote and report requirements, the initial assets distribution is displayed in Table 1.

The main component of this portfolio is a basket of stock options, whose underlying assets are the stocks of rising industry with good performance. Besides, blue chips were selected to steady yields, and futures were used to hedge the potential risk. In order to obtain a diversified investment, and for simplification, the total capital has been set to $500,000.

2.3 Determining the Core Investment Combination of the Portfolio

A diversified selection within the core portfolio was aimed to reduce the potential risk, and to simultaneously achieve the investment goal as much as possible. This section has been divided into 4 phases.

2.3.1 Initial Selection

According to the keynote of the portfolio, four rising industries were selected, and they are new metal material, new energy source, new energy automobiles and new information technology industries，respectively. Based on the ranks of last year, we chose 14 stocks which have stock options, and they are EMC, DHR, TMO, MU, GE, ADM, BG, ABB, TSLA, TM, MT, PKX, PPG and RPM.

Table 1
The Initial Assets Distribution of the Portfolio

Assets	Proportion
Stock options	80%
Stocks	9%
Futures	9%
Simply cash	2%

2.3.2 Fundamental Analysis

After targeting, fundamental analyses for the underlying stocks were conducted, which includes 2 parts: annually financial data's analysis and three-year historical prices' analysis. From the first part, 8 best stocks were selected; and from the second part, the correlation among the 8 stocks was confirmed.

In the annual financial fundamental analysis, 5 indicators were played as the judgment criteria, and they are gross profit rate, return on equity, profit margin, debt to assets ratio, and net cash flow to net margin ratio, respectively. To select 8 best stocks, a point test was used for screening from these 14 stocks. At the beginning, 5 indicators were used as the benchmarks respectively to make up 5 groups of comparisons for these stocks.

Then according to each result of the 5 comparisons, we allocated points from 14 to 1 to the fourteen stocks from the top to the end. Afterwards, the total points were calculated. By ranking them in descending order, 8 stocks listed on the top were selected. They are MU, DHR, EMC, ABB, PPG, ADM, MT, and TM.

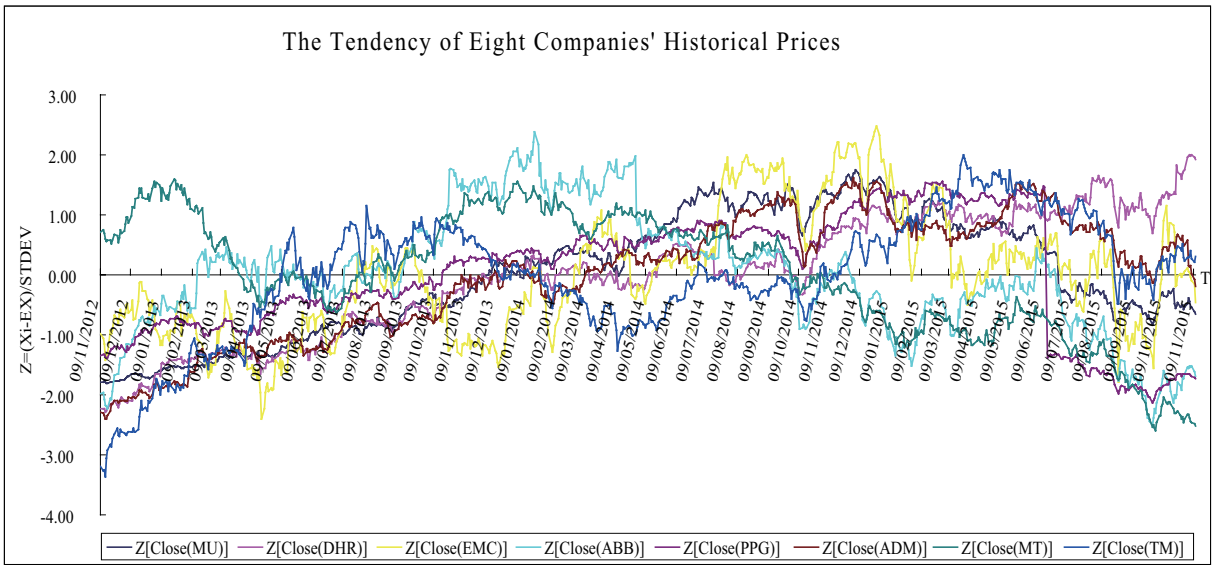

Figure 1
The Tendency of Eight Companies' Historical Prices

From the historical prices analysis, the correlations among the 8 stocks were discovered by observing the trends of their close prices over the past three years. To compare the trends, we firstly standardized the three-year close prices of the 8 stock with z-score approach by SPSS. Then a diagram of the trends of 8 stocks' historical prices could be generated (see Figure 1).

Intuitively, the correlations of these 8 lines are: Positive correlation: MT & ABB, TM & ADM & DHR & PPG; Negative correlation: EMC & ABB, TM & ABB.

According to the intuitive result, the lines' colours were reset to describe their correlations clearly (see Figure 2). The lines in same colour implie a positive correlation; the relationship between the dark blue lines and the light blue lines are negative correlations; while the yellow one indicates that it has no intuitive relationship with other lines. This result could provide us with a reference in making decisions of whether to take long or short position.

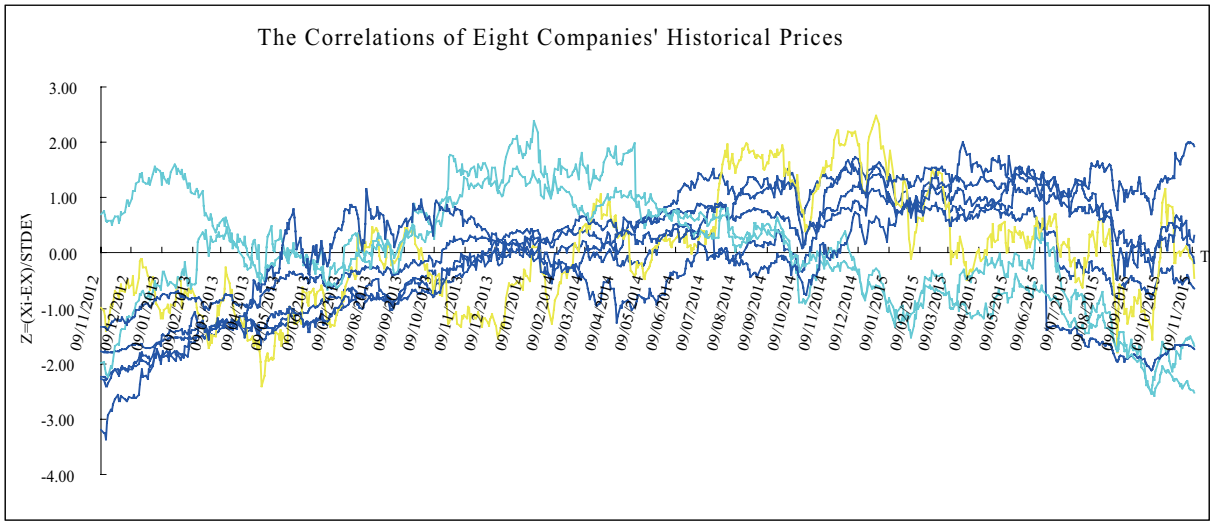

Figure 2
The Correlations of Eight Companies' Historical Prices

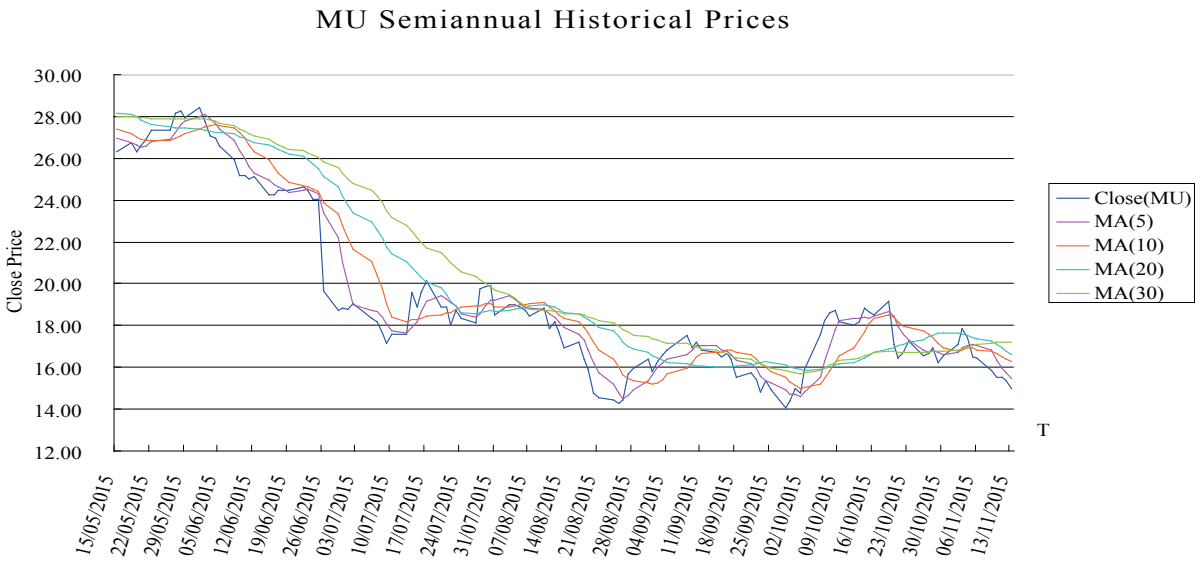

Figure 3
MU's Historical Prices on 15/05/2015-13/11/2015

2.3.3 Technical Analysis

Next, the semi-annual technical analyses were performed to confirm 4-6 final components. The simple moving average (MA) was selected as the technical indicator, and the future tendency was forecasted via observing the relationship among 5-day, 10-day, 20-day, 30-day moving average and the line of daily close prices, or MA (5), MA (10), MA (20), MA (30) and the K line for short. Considering semi-annual investment horizon of this portfolio, setting MA (5) and MA (10) are short-term MA, MA (20) are medium-term MA, and MA (30) are long-term MA.

Take MU as an example to show the processes of the technical analysis in detail in the text of this report (Figure 3).

Firstly，from 15/05/2015 to 09/07/2015, a bunch of MA presented short order, which is, the K line was running under short-term MA, and at the same time, MA (5), MA (10), MA (20) and MA (30) were arranging from bottom to top. It might be a sign of declining price and market weakness.

Table2
The Results of Technical Analysis for Other 7 Stocks

Stock code	Forecast of future trend	Max drawdown	Beta	Expected return
DHR	Downward tendency	2.43%	1.04	7.97%
EMC	Downward tendency for a short period; Rising tendency for a long period; The interval of price changing is too narrow.	13.26%	1.05	8.02%
ABB	Downward tendency for a short period; Rising tendency for a long period	26.52%	1.09	8.23%
PPG	Rising tendency for a short period; Downward tendency for a long period	132.06%	1.61	10.94%
ADM	Downward tendency for a short period; Rising tendency for a long period	40.81%	1.22	8.91%
MT	Downward tendency for a short period; Rising tendency for a long period; The interval of price changing is too narrow.	145.66%	1.90	12.46%
TM	The price would have only Mall fluctuation.	15.23%	0.54	5.36%

Secondly, from 10/07/2015 to 24/08/2015, the K line broke above the short-term MA which was slightly increasing trend, but it had not been enough power to break above the long-term MA which was still keeping decreasing tendency. At the same time, MA (5) and MA (10) did not broke above MA (20) and MA (30) successfully. These signs indicated that the stock price would continue to fall.

Thirdly, from 25/08/2015 to 28/09/2015, the short-term MA was threaded by the K line from bottom to top, and it also broke above medium-term and long-term MA with insufficient power. Meanwhile,

MA (20) and MA (30) were going down with diminishing marginal change. This could imply that the market would turn around from bear market to bull market.

Fourthly, from 29/09/2015 to 15/10/2015, the K line threaded all MA lines with enough power, and the long-term MA had a slight increasing tendency. At the meanwhile, short-term MA broke above MA (20) and MA (30), but MA (5) had a trend to form death cross with MA (10). Therefore, in a short period, the stock price may have a declining trend.

Finally, from 16/10/2015 to the future, the K line broke all MA lines, and short-term MA also fell under MA (20) and MA (30). Meanwhile, there was a tendency of short arrangement. Hence, the stock price would go down in a short period, but according to the 52-week average close price and the volume, the stock price may increase in a long term.

In short, for technical analysis and fundamental analysis, the MU's stock price was predicted to have a possible falling tendency in a short period, and a rise in long period.

Then we introduced the maximum drawdown to measure the historical maximum loss in this period. By calculation, the maximum drawdown of MU is 89.47% for half a year. After that, the MU's theoretical expected return ($E(r_{um})$) could be computed by security market line (SML). Assuming that the risk-free rate (r_f) is the annual interest rate of 10-year Treasury bill of the USA, and the expected yield of market portfolio (r_m) is the expected return of S&P 500, so r_f is 2.54% and r_m is 7.76%. According to MU's key statistics from Yahoo Finance, MU's beta coefficient is 1.86, so the MU's theoretical expected yield is 12.25%.

Similarly, the outcomes of other 7 stocks are showed in Table 2. Consequently, MU, DHR, ABB, PPG, and ADM were selected.

Table 3
The Analysis Results of the Options of DHR, ABB, PPG and ADM

Options	Maturity	*T*	Implied volatility	Historical volatility
DHR	126 days (March 18)	0.3452	blsimpv(93.54,95,0.0251,0.3452,4.60) =0.2235 (put)	0.4378
ABB	126 days (March 18)	0.3452	blsimpv(18.29,18,0.0251,0.3452,1.80)=0.3708 (call)	0.1400
PPG	98 days (February 19)	0.2685	blsimpv(100.83,95,0.0251,0.2685,6.29)=0.2629 (call)	0.5311
ADM	126 days (March 18)	0.3452	blsimpv(37.36,35,0.0251,0.3452,3.55)=0.2578 (call)	0.7208

p.s. As calculating the implied volatility, the position directions are determined by the forecasts of technical analyses. Buying put option is position direction.

2.3.4 Extending Analysis

The implied volatility of these stock options could be calculated based on equation Formula (1). Take MU as an example in detail in the text of this report. Known that the spot price (S) of MU is \$15.00, the strike price (L) of call option is \$14.00, the actual price of this option is \$2.46, and the maturity is 154 days (the last delivery day is April 16). Firstly, the risk-free continuous compounding rate is 2.51%. Then the implied volatility could be computed by Matlab, the T is 0.4219, and blsimpv (S, L, r, **T**, C) is 0.4917(Volatility). And then, by calculating, the historical volatility is 0.7901, which is larger than the implied volatility. Therefore, the current price of this option might be underestimated. That means, if an investor buys the call option, he or she would obtain profit. Similarly, the outcomes of DHR, ABB, PPG, and ADM are showed in Table 3. Especially, due to a larger gap between implied volatility and historical volatility of ADM, we used a strategy, Bull Call Spread, to hedge the potential risk. It could be described as buying 1 unit at-the-money call option, and selling out 1 unit out-of-the-money call option at the same time. To sum up, the following graph could elucidate the relationship between the option's profit and the price changing of the underlying stocks (see Figure 4), and the proportions of these options are same in the portfolio.

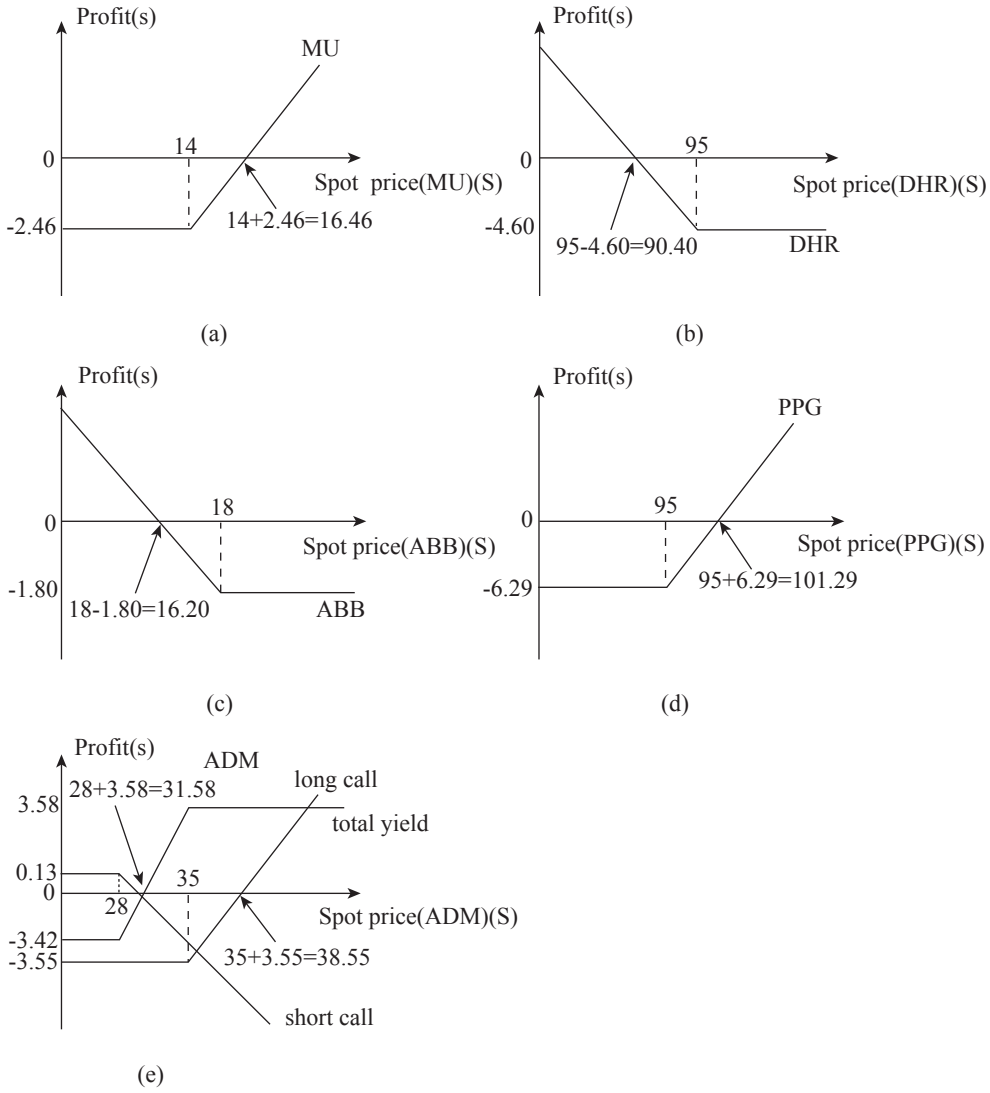

Figure 4
The Relationship Between the Profit of Option and the Price Changing of Stocks

$$\begin{cases} \sigma_{p,t+1} = [35.78 W_{wmt}^2 + 20.79 W_{HD}^2 + 2 \times (-0.5821) \times W_{wmt} W_{HD}]^{1/2} \\ W_{wmt} + W_{HD} = 1, W_{wmt}, W_{HD} > \\ 9\% \leqslant 40.00\% W_{wmt} + (-6.00\%) W_{HD} \end{cases} . \quad (3)$$

Table4
The Asset Allocation of the Portfolio

Financial assets	Components	Proportions
Options	MU	16%
	DHR	16%
	PPG	16%
	ABB	16%
	ADM	16%
Stocks	WMT	5.87%
	HD	12.13%
Simply cash	Current deposit	2%
Total	$500,000	100%

2.4 Determining Other Components of the Portfolio

The remaining elements include stocks, relevant futures and simple cash based on framework of this portfolio. But limited futures products could be bought and the cost is too large, futures were abandoned and blue chips were chosen. Due to the small proportion of capital leaving for this part, only 2 stocks were chosen, and they are WMT and HD. The beta coefficients of 2 stocks are 0.44 and 0.97 respectively. According to the portfolio's keynote, this part should be used to steady profits, which means creating profit on the basis of the minimum risk. Assuming the proportions of stocks are constant and

there are only long positions, the weight of these 2 stocks could be computed by Formula (2). Firstly, the variances and the covariance of these 2 stocks could be computed by Excel: Var(WMT) is 35.78, Var(HD) is 20.79, Cov(WMT, HD) is -0.5821. Then, there are the rates of return: R_{WMT} is 40.00%, r_{HD} is -6.00. And then, if the expected return is assumed equaling to 9%, the simultaneous equation would be in Formula (3). As the result, there are: W_{WMT} is 32.61%, W_{HD} is 67.39%. The capital allocated for the stocks is $90,000. So the capital of WMT is $29,349; HD is $60,651.

2.5 Brief Summary for the Portfolio

The elements of this portfolio have been determined (see Table 4).

3. PERFORMANCE

According to the plan stated above, this investment has been divided into 2 phases: testing stage and formal stage. For the first phase, the 20% of the total capital would be put into the market. After the trial period for 5 workdays, the positions would be pyramidally increased or reduced according to circumstances.

3.1 Testing Stage

In this phase, there was almost no unforeseen situation emerging, and this account showed a reasonable profit. MU, ABB, ADM, WMT, and HD followed the predicted trends, but the tendency of DHR and PPG were decreasing, instead of expected increasing. By the technical analyses, for DHR, all MA lines and the K line tangled together with declining volume, the K line had a trend to thread short-term MA from top to bottom, and the stock price was ever close to the 52-week highest point, hence a downward tendency could be predicted, and the original judgment was maintained; for PPG, there was a golden cross between the K line and MA lines, but the volume was fluctuant, the future tendency could not be judged clearly, so this element was given wait-and-see attitude-the forecasting trend would be predicted after present tendency finished.

3.2 Formal Stage

Based on a good performance in the trial phase, the positions were increased pyramidally (adding investment by 40%, 30%, 20%, and 10% of the remaining capital of this financial asset) for these components after finishing a previous trend. Taking DHR as an example, by technical analyses, DHR went through the previous tendency, so the position of DHR was added by 5.12% of the total capital. In this way, the portfolio has been added positions, and after that, the investment plan and the strategies would be carried out to a degree. During this period, MU and PPG showed an unexpected tendency, but only resulted in a little capital loss in this short term and when taking the transaction cost into consideration, the position directions would not be changed. However, fortunately, there was no significant policy impact to raise the systematic risk in this stage. For this reason, although the actual return was lower than the expected yield, the balance of this account was almost keeping profitable. Until now, the account has $556,729, and the return rate of this portfolio is 11.35%. Because of 6-month investment horizon as planned at the beginning, the virtual trading will continue to be operated until May in 2016.

CONCLUSION

According to this paper, it is obvious that there is a positive correlation between risk and profit in a maturely capital market, and moreover diversification and rational analyses could reduce the idiosyncratic risk efficiently. By this empirical research, a comprehensive analysis method could help investors to make a more accurate decision than a single way analysis used. Therefore, we could expect that this approach would have more wide application prospect and value in the real investment. Certainly, there is also room for growth in this field, and the method would be improved by more complex study in the future.

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