

Full Length Research Paper

Equality investment strategy evaluation during the financial crisis: Using TOPSIS approach

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During the financial crisis time, fear has taken over the mood of investors. There are so many uncertainties during a crisis. This time, the financial crisis came with a credit crunch. At such time, the contrarian investors were looking for better investment objectives which may increase profits in the future by mean reversion effect. But how can they be confident that the chosen investment objectives can survive the credit crunch or the crisis. The study addressed a case of a Taiwanese bank selecting an appropriate combination of equalities by Markowitz's Mean-Variance Method in portfolio management to deal with market risk in the crisis. The Technique for order preference by similarity to ideal solution method (TOPSIS) was also used to deal with credit risk during the credit crunch in this financial crisis. In setting the criteria weight setting and selecting the best strategy, the opinions of experts were fully considered - from bank counselors in academia and the members of the bank asset and liability management committee who are management from the Loan, Business, and Risk management departments, who are all experienced in their professional fields. This study proved that financial institutions could use TOPSIS in-group decision in the investment sector.

Keyword: Financial crisis, Markowitz, Mean-variance, TOPSIS.

INTRODUCTION

A local US sub-prime problem caused one of the largest investment banks, Lehman Brothers, to fall into bankruptcy on September 15th, 2008. The effect was enormous and it became a global financial crisis due to contagion among markets.

Barber and Odean (2008) find that both extremely positive and extremely negative returns lead to significant

buying behavior of investors. In Taiwan during the financial crisis period, the buying behavior of both individuals and institutional investors were less emotional (Yu and Hsieh, 2010). Most investors are reluctant to purchase cheaper equities due to future uncertainty. For momentum investors, purchasing assets at a lower price is against their principal of "following the trend".

But for the contrarian investors, it is good timing to invest during a time of crisis, when most investors overreact to the market. They can purchase the assets at a price lower. The contrarian investors' trading strategy focused on, "lean against the wind", but this financial crisis came with a credit crunch, which brought credit uncertainty for the chosen investment objectives.

The returns on the stock markets are generally regarded as the leading indicator of the future economic situation. If the investors purchased assets when the crisis was at a confirmed end, then the investors would lose the chance of buying at a cheaper price.

Unlike previous crises, the 2008 crisis occurred in the

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Abbreviations: TOPSIS, Technique for order preference by similarity to ideal solution method; BIS, Bureau of Industry and Security; CFOs, Chief Financial Officers; MCDM, method of multiple criteria decision making; MV, mean-variance criterion; MCDM, multiple criteria decision making; TSE, Taiwan Stock Exchange; ALCO, Asset and Liability Committee; ROE, return on equity; EMH, efficient market hypothesis.

midst of a credit crisis of historic breadth and depth. Many firms were under financial constraint by the banks due to much bank capital being deducted by their toxic assets, which became liquidity insufficient during the current crisis. The banks are not able to loan to firms like they used to, and are not able to maintain their capital ratio under Bureau of Industry and Security (BIS) regulation. Murillo, John and Campbell (2010) surveyed 1050 Chief Financial Officers (CFOs) in the US, Europe and Asia.

They found evidence indicating that the constrained firms planned deeper cuts in capital, employment and technology; furthermore, the firms have to bypass attractive projects or sell more assets to fund the operation. Sudheer and Amiyatosh (2011) provide evidence that the adverse capital shocks to banks negatively affects borrower performance. Firms that relied mostly on banks for capital experienced a greater decline in capital expenditure and profitability than did other firms. In this case, during the financial crisis, the traditional factors such as the mean and variance of historical returns data did not quite meet the requirements for setting up a good investment strategy. The purpose of this study is aimed at commercial banks which addressed a strategy to invest in the stock market during the financial crisis using both the mean and standard deviation for the market risk, and the technology for order preference by similarity to ideal solution (TOPSIS) method for credit risk.

The formation of trading strategy by a Taiwanese commercial bank

There generally exist four parts to the formation of financial assets allocation strategy: appropriate timing, the allocations of funds, trading strategy, and portfolio selection.

The failure of Lehman Brothers in 2008 has made the global stock markets drop a lot, and caused a lot of chain reactions in other asset markets globally. Many governments have joined together to offer some policy incentives or loosen monetary policy, trying to restore the

peoples' confidence and prevent further decline. At the time of the crisis, all the positive and negative news flowed into the markets. There is no knowing if the current policy incentives were useful, or if the current economic situation is declining further. Neither is it known whether the investment objectives can survive or boom after the financial crisis. There are too many uncertainties during a crisis period.

Trying to minimize the effect of uncertainties, the investors had to adopt a totally different approach; combining not only market risk concerns, but also concerns of credit risk concerns for the trading objectives in the crisis period.

This study aimed to introduce TOPSIS, a method of multiple criteria decision making (MCDM), and weights each expert's opinion equally.

METHODS AND DATA COLLECTION

The Mean-Variance criterion (MV)

Markowitz (1952) proposed The Mean-Variance criterion (MV) to set up the investment portfolio selection to reduce the systematic risk.

Yang (2004) A portfolio refers to a collection of more than one category of securities or assets. Portfolio theory discusses how investors should form portfolios through establishing investment strategies to maximize rates of return under a fixed-risk situation, or to minimize risks under a fixed-return situation.

The expected return on portfolios is:

$$E(R_p) = \sum_{i=1}^n W_i E(R_i) \quad (1)$$

$$\left(\sum_{i=1}^n W_i = 1 \right)$$

Where W_i is the weight of target security i in the portfolio. $E(R_i)$ is the expected return of target security i in the portfolio. That is, the expected return on portfolios is the weighted mean of expected return of securities.

The risks of portfolios δ_p^2 are:

$$\begin{aligned} \delta_p^2 &= E \left\{ \left[W_a \tilde{R}_a + W_b \tilde{R}_b - W_a E(R_a) - W_b E(R_b) \right]^2 \right\} = E \left\{ \left[W_a \tilde{R}_a - W_a E(R_a) + W_b \tilde{R}_b - W_b E(R_b) \right]^2 \right\} \\ &= E \left\{ \left[W_a (\tilde{R}_a - E(R_a)) + W_b (\tilde{R}_b - E(R_b)) \right]^2 \right\} \\ &= E \left\{ W_a^2 (\tilde{R}_a - E(R_a))^2 + 2W_a W_b (\tilde{R}_a - E(R_a)) (\tilde{R}_b - E(R_b)) + W_b^2 (\tilde{R}_b - E(R_b))^2 \right\} \\ &= W_a^2 E \left[\left[\tilde{R}_a - E(R_a) \right]^2 \right] + 2W_a W_b E \left[(\tilde{R}_a - E(R_a)) (\tilde{R}_b - E(R_b)) \right] + W_b^2 E \left[\left[\tilde{R}_b - E(R_b) \right]^2 \right] \\ &= W_a^2 \delta_a^2 + 2W_a W_b \delta_{ab} + W_b^2 \delta_b^2 \quad (2) \end{aligned}$$

If a portfolio consists of N securities, the number of variances will be squared- N , which includes N variances and $N(N-1)$ covariances.

$$\begin{aligned} \delta_p^2 &= W_1^2 \delta_1^2 + W_2^2 \delta_2^2 + \dots + W_n^2 \delta_n^2 + 2W_1W_2\delta_{12} + 2W_1W_3\delta_{13} + \dots + 2W_nW_{n-1}\delta_{n(n-1)} \\ &= W_i^2 \sum_{i=1}^n \delta_i^2 + W_iW_j \sum_{i=1}^n \sum_{\substack{j=1 \\ i \neq j}}^n \delta_{ij} \end{aligned} \tag{3}$$

If a portfolio includes N securities, and represents the average covariance, the equation is presented as follows:

$$\begin{aligned} \delta_p^2 &= \left(\frac{1}{N}\right)^2 \sum_{i=1}^n V + \left(\frac{1}{N}\right)\left(\frac{1}{N}\right)N(N-1)\bar{\delta}_{ij} \\ &= \left(\frac{1}{N}\right)^2 NV + \frac{N^2 - N}{N^2} \bar{\delta}_{ij} \\ &= \left(\frac{1}{N}\right)^2 V + \left(1 - \frac{1}{N}\right) \bar{\delta}_{ij} \end{aligned} \tag{4}$$

If $N \Rightarrow \infty, \left(\frac{1}{N}\right) \Rightarrow 0, \delta_p^2 = 0, V + (1-0)\bar{\delta}_{ij} = \bar{\delta}_{ij}$ in other words, if a portfolio is comprised of an extremely large number of securities, the variance effect of individual security almost vanishes; the majority of the variances in the portfolio are covariances. Therefore, investors can diversify the potential risks of securities through holding different categories of securities; however, the common risks among securities cannot be diversified.

TOPSIS method

TOPSIS method is presented in Chen and Hwang (1992), with reference to Hwang and Yoon (1981). The basic principle is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution. This approach has been successfully applied in many fields. (Tzeng et al., 2002, 2005; Mahmoodzadeh et al., 2007).

The decision maker wants to solve a multiple criteria decision making (MCDM) problem. A MCDM problem can be concisely expressed in matrix format as;

	C_1	C_2	...	C_n
A_1	f_{11}	f_{12}	...	f_{1n}
A_2	f_{21}	f_{22}	...	f_{2n}
A_m	f_{m1}	f_{m2}	...	f_{mn}
W	$[w_1, w_2, \dots, w_n]$			

where A_1, A_2, \dots, A_j are possible alternatives among which decision makers have to choose, C_1, C_2, \dots, C_j are criteria with

which alternative performance are measured, f_{ij} is the rating of alternative A_i with respect to criterion C_j , w_j is the weight of criterion C_j .

The TOPSIS procedure consists of the following six steps:

(1) Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as;

$$r_{ij} = f_{ij} \sqrt{\frac{1}{\sum_{j=1}^J f_{ij}^2}} \quad J = 1, \dots, J; \quad i = 1, \dots, n.$$

r_{ij} refer the normalized values of each performance measure, f_{ij} refers the i alternative at j criteria.

(2) Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as;

$$v_{ij} = w_j r_{ij} \quad J = 1, \dots, J; \quad i = 1, \dots, n.$$

(3) Determine the ideal (A^*) and negative-ideal (A^-) solution.

$$\begin{aligned} A^* &= \{v_1^*, \dots, v_n^*\} \\ &= \{(j \max v_{ij} | i \in I'), (j \min v_{ij} | i \in I'')\}, \\ A^- &= \{v_1^*, \dots, v_n^*\} \\ &= \{(j \min v_{ij} | i \in I'), (j \max v_{ij} | i \in I'')\}, \end{aligned}$$

Where I' is associated with benefit criteria and I'' is associated with risk criteria.

(4) Calculate the separation measures using the n -dimensional Euclidean distance. The separation of each alternative from the ideal solution D_j^* is given as;

$$D_j^* = \sqrt{\sum_{i=1}^n (v_{ij} - v_i^*)^2}, \quad j = 1, \dots, J.$$

Similarly, the separation from the negative-ideal solution D_j^- is given as;

Table 1. shows the contents of each portfolio, means, and standard deviations.

S/No.	stock	stock	Mean (Returns)	Standard deviation (Risk)
1	S1101	S1216	-0.046	2.4721
2	S1101	S1301	-0.21195	2.2145
3	S1101	S2002	-0.1978	2.2422
4	S1101	S2330	-0.593	2.2538
5	S1216	S1301	0.02305	2.0823
6	S1216	S2002	0.0372	2.1074
7	S1216	S2330	-0.358	2.1297
8	S1301	S2002	-0.12875	1.7979
9	S1301	S2330	-0.52395	1.8301
10	S2002	S2330	-0.5098	1.8735

$$D_j^- = \sqrt{\sum_{i=1}^n (v_{ij}^- - v_i^-)^2}, j = 1, \dots, J.$$

(5) Calculate the relative closeness to the ideal solution C_j^- . The relative closeness of the alternative a_j with respect to A^* is defined as;

$$C_j^- = D_j^- / (D_j^* + D_j^-), j = 1, \dots, J.$$

(6) Finally, rank the preference order.

Data collection

For this study, we gather the daily close stock price from Reuters from July 2nd, 2007, to December 31st, 2008. Totally 377 observations were used and using $100 \cdot \log(PStt/PStt-1)$ as the returns of the stocks. The data of average cash dividend rate, the return on equity (ROE), the current ratio, and the debt to net worth ratio of the last three years (2004, 2005, and 2006) were gathered from Taiwan Stock Exchange (TSE).

A practical case

The mid capital commercial bank A is a financial institution in Taiwan. At the beginning of 2009, the president of bank A was under budgetary pressure from the Board. During the financial crisis period, he believed that the relationship with shareholders at good firms is more beneficial to bank A than solely as a loan provider. From his past experience, he thought that the bank could hold a few good stocks for a period of time during the current financial crisis. The returns will be much higher than those of fixed income securities. He tried to form an asset allocation plan to fulfill his 2009 budget, not only with fixed income securities but with investment positions in stocks. He asked the Treasury Department to form a stock selection plan and made a proposal to the Asset

and Liability Committee (ALCO) to discuss and ask an academic counselor to find a method for choosing the best portfolio from the proposal, with other criteria for concern like credit constrained brought by the current financial crisis.

The traders of the Treasury Department used to buy and sell stocks over the short term (usually holding their trading positions for only several weeks). To avoid systematic risk, they decided to choose five stocks in the stock index (TW50) from five major industries which are cement, food manufacturing, chemical manufacturing, steel and electronic industry. Each stock is that of the leading firm in their respective industry. The stock quotes are: S1101, S1216, S1301, S2002 and S2330. They form the portfolio with two stocks of equal weight. To reduce uncertainty, they formed the portfolio based on two factors: the expected returns (mean of the portfolio returns) and the risk (the standard deviation of the portfolio). They gathered the stock price from Reuters and calculated the returns and volatility of the portfolio from July 2, 2007, to December 31, 2008. In total, 10 portfolios were formed by this method. illustrated at Table 1.

The academic counselor suggested using the TOPSIS approach as an evaluation of equality investment strategy. In establishing the criteria, six principles toward the target firms were established through numerous discussions among the ALCO members: revenue, standard deviation of the equity return, cash dividend rate, ROE, current ratio, and the debt to net worth ratio. They regard revenue as cash generating power of the firm; standard deviation of the equity return as the market risk; cash dividend rate standards for the yields of the investment objectives which is in comparison with the bank's funding cost, ROE as the profitability of the firm, current ratio as the firm's ability to repay its short term loan which stands for the chance of the firm to pass the credit crunch and debt to net worth ratio as the measurement of the firm's leverage.

Table 2 illustrates the returns, the standard deviation of each portfolio from July 2, 2007 to December 31, 2008,

Table 2. The combination yield, standard deviation, average cash dividend, ROE, current ratio and debt to net worth ratio of each portfolio.

No.	com yield	com SD	cash dividend rate	ROE	current ratio	debt to net worth ratio
1	-0.05	2.47	1.38	10.97	169.59	56.47
2	-0.21	2.21	3.37	16.09	241.08	46.58
3	-0.20	2.24	2.51	17.19	204.46	37.49
4	-0.59	2.25	2.26	17.28	350.44	30.05
5	0.02	2.08	3.08	16.11	197.52	56.30
6	0.04	2.11	2.21	17.20	160.90	47.20
7	-0.36	2.13	1.96	17.29	306.88	39.77
8	-0.13	1.80	4.21	22.32	232.39	37.32
9	-0.52	1.83	3.96	22.41	378.37	29.88
10	-0.51	1.87	3.09	23.51	341.75	20.79

Table 3. The criteria weight differs by department. It reflects the weight given by each department or position from their professional fields.

Criteria	Senior management	Business department	Academic counselor	Risk management department	Loan department	Average
com yield	0.35	0.29	0.15	0.11	0.21	0.222
com SD	0.12	0.08	0.3	0.33	0.09	0.184
cash dividend rate	0.25	0.22	0.1	0.08	0.17	0.164
ROE	0.06	0.15	0.05	0.08	0.11	0.09
current ratio	0.11	0.15	0.2	0.15	0.19	0.16
Debt to net worth ratio	0.11	0.11	0.2	0.25	0.23	0.18

the average cash dividend rate, the ROE, the current ratio, and the debt to net worth ratio of the last three years (2004, 2005, and 2006). The data collected from TSE. The members of ALCO could assign the relative importance (weight) of each criterion. The members are the heads of the Business, Loan, and Risk Management Departments; an academic counselor; three vice presidents; and the president. The average values of weights are illustrated differs by department. It reflects the weight given by each department or position from their professional fields. Table 3 shows the weight normalized decision matrix used by Equation (1).

In order to determine the ideal and non-ideal solutions, the next step is to utilize equations (2) and (3); the results are $A^+ = (0.052, 0.022, 0.025, 0.012, 0.023, \text{ and } 0.025)$; and $A^- = (-0.003, 0.016, 0.008, 0.005, 0.010, \text{ and } 0.009)$. Subsequently, we employed Equations (4) and (5) to calculate the separation of each alternative solution from the ideal solution. We then obtained TOPSIS ranking lists through Equation (6), and the results are presented in Table 4.

The results of Table 5 indicate that alternative 9 may be considered the best for maximizing the expected benefits concerning the credit crunch and the risk for bank A.

DISCUSSION

The Efficient Market Hypothesis (EMH) assumes all the investors are rational and the rational would give the security a fair value with the integrated market news. Since 1980, there are strands of literature, which indicate lots of market situation that cannot be explained by EMH. Lee et al. (1999) found the Asymmetric Information exist among the big individual investors, small individual investors and institutional investors. The Asymmetric Information makes different investors doing different trading pattern at the same news going public. At the crisis time, it is hardly hearing any good news. If the investors making the trading strategy by the current released news or forecast by the economists, a feeling of fear and pessimist would exist at the market. The investors were not able to make sound judgment even the equalities were under their value.

At past crisis, the institutional investors made the equality trading strategy based on the type of crisis they faced. For example, at the period of Asian Crisis 1997, most institutional investors focused on the export industries because of the vast devaluation of the local currency against USD.

Table 4. Shows the weight normalized decision matrix used by Equation (1).

No.	com yield	com SD	cash dividend rate	ROE	current ratio	debt to net worth ratio
1	0.0041	0.0217	0.0081	0.0055	0.0105	0.0253
2	0.0188	0.0194	0.0197	0.0080	0.0149	0.0209
3	0.0175	0.0196	0.0147	0.0086	0.0127	0.0168
4	0.0525	0.0197	0.0132	0.0086	0.0217	0.0135
5	-0.0020	0.0182	0.0180	0.0080	0.0122	0.0252
6	-0.0033	0.0185	0.0130	0.0086	0.0100	0.0211
7	0.0317	0.0187	0.0115	0.0086	0.0190	0.0178
8	0.0114	0.0158	0.0246	0.0111	0.0144	0.0167
9	0.0464	0.0160	0.0232	0.0112	0.0234	0.0134
10	0.0451	0.0164	0.0181	0.0117	0.0212	0.0093

Table 5. Separation measure and ranking of each alternative.

S/No.	c+	c-	Ranking
1	0.738556	0.261444	9
2	0.50475	0.49525	5
3	0.608729	0.391271	7
4	0.263225	0.736775	2
5	0.697897	0.302103	8
6	0.802079	0.197921	10
7	0.455749	0.544251	4
8	0.572257	0.427743	6
9	0.225162	0.774838	1
10	0.327939	0.672061	3

The financial crisis started since the collapse of Lehman Brothers on 2008. With the contagion effect, the banking sector is quite affected by the collapse of Lehman Brothers. It brought a greater amount of systemic risk and affected not only the banking sector but also the non-banking sectors. Bordo and Haubrich (2009) conclude with the severe financial events are associated with severe recessions. The financial crisis this time associated with credit crunch and no one knows what kind of industries would be survived this crisis. In such case, an investment strategy this time dealt not only with equalities price movement but also with the credit issue of the equalities.

The Treasury Department of the financial sector at Taiwan dealt with lot of financial issue like the interest rate or the foreign exchange issue. With credit issue, their judgment was always based on the credit rating by the credit agencies. But with the lots sudden downgraded CDO at 2007, the credit rating became not that confident by the Treasury Department. An investment strategy with sound credit concern should be emphasizes this time, which makes it totally different from the previous trading strategy. Yu and Hsieh (2010) confirm the buying behavior is mitigated by the financial crisis of 2007.

The Treasury Department of Bank A makes an

investment strategy based on Mean-Variance approach. Before the crisis, the best option is judged with only two factors: mean is the expected yield and variance stands for the risk. This kind of strategy was popular among the financial institutions before the 2007 financial crisis. The credit concern of the investment securities has become important during the crisis.

We use the TOPSIS Method as equality investment strategy evaluation during the financial crisis. Through numerous discussions, the ALCO members established six principles toward the target firms: revenue, standard deviation, and cash dividend rate, ROE, current ratio, and the debt to net worth ratio. After establishing the criteria, the members of ALCO then assign the relative importance (weight) of each criterion. With the criteria setting to aid for the better investment strategy, we have chosen the most suitable investment strategy for this crisis from the Treasury Department's proposals.

This study aimed to introduce TOPSIS, a method of MCDM, and weighs each expert's opinion equally.

Conclusion

Before the 2008 financial crisis, the Treasury Department

of the financial institution set up the investment strategy with two main factors: yield and risk. The previous studies used standard deviation of the portfolio as risk and mean return of the portfolio as yield. To seek for higher returns and lower risk, it evolves two types of investors: momentum investors and contrarian investors. The momentum investors would liquidate all the long positions and sell the short position as the pulling back of the Stock Exchange Index at the financial crisis. The contrarian investors would buy the securities at their lows but not sure if the investment objectives can survive at the credit crunch time. According to Yang et al. (2006), they find the institutional investors at Taiwan would be momentum trading at purchasing and become contrarian at selling securities. At the time of the financial crisis, the buying behavior of both institutions and individual investors became less emotional than used to be (Yu and Hsieh, 2010). In such the financial intuitional investors would take negative attitude toward buying stocks at crisis period. This kind of attitude would not be helpful at choosing the investment objectives, which are lower than their true value.

At the beginning of 2009 - which was already three months after the collapse of Lehman Brothers - the president of Bank A thought that it might be a good time to invest in the stock market, since there was less market risk; but, considering the credit issue at credit crunch time, it was even more important to set up good criteria to choose good credit quality objectives. Based on the advice of the bank's counselor, Bank A used the TOPSIS method to conduct an Equality Investment Strategy Evaluation with some credit criteria.

With professional advice of experts and from senior management, the related departments, and academics, the portfolio returns, standard deviations, and debt to net worth ratios have been of greatly concern to the members of the ALCO committee.

Considered with portfolio returns, cash dividend rates, and the current ratio, alternative 9 is relatively strong among its alternatives.

At the financial crisis period, the Treasury Department faced a lot of uncertainties and the trading pattern has become less motional at the crisis time (Yu and Hsieh, 2010). To minimize the effect of uncertainties, the investors had to adopt a totally different approach; combining not only market risk concerns, but also concerns of credit risk concerns for the trading objectives in the crisis period. In such case, a different investment strategy approach at the financial crisis period is necessary for the investors. There are a lot of studies using TOPSIS as a solution for group decision making. Most of previous

literatures, the experts choose the investment strategy based on past quantitative data. Hsu and Tsou (2009) use TOPSIS at selecting the best investment objectives at the portfolio.

However, there are many quantitative and qualitative factors affecting the success of the investment strategy during the financial crisis. Limited studies had used TOPSIS at choosing investment strategy during the financial crisis. This study empirically proved that the TOPSIS method can be applied to the financial field with MCDM issues at financial crisis period. When decision makers meet with uncertainty, few suitable portfolios based on the MCDM can be formed, and they can choose their own best portfolio based on their criteria.

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