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CREDIT RATING MATTERS IN CONTRARIAN RETURN –EVIDENCE FROM THE JAPANESE EQUITY MARKET–

Daisuke Sasaki Koichi Miyazaki
University of Electro-Communications

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Abstract Although previous research has reported that the momentum strategy is effective in the US equity market, the contrarian strategy is effective in the Japanese equity market. The current research illuminates the relationship between the return found with the contrarian strategy (contrarian return) and credit rating in the Japanese equity market. We empirically verify the relationship between these, as well as the relationship between the factors explaining credit rating and the contrarian return. Furthermore, dividing the expected contrarian return into three components following Lo and MacKinlay (1990), we closely examine the relationship between each component and the credit rating. In the analyses on the contrarian return, the influence by the business cycle is also discussed. Lastly, we examine whether the contrarian return still exists after removing the return generated by market risk factor.

Keywords: Finance, statistics, equity market, credit rating, contrarian strategy

1. Introduction

De Bondt and Thaler [7,8] focus on the nature of equity price that overreacts to market information, finding that the contrarian strategy (long period) is effective in equity investment and that buying loser equity and selling winner equity exploits extra return. In addition, Lo and MacKinlay [18] note that not only overreaction to information, which is captured by auto-covariance, but also lead-lag effect, which is caused by difference in speed of the reaction and estimated by cross-auto-covariance, can comprise the profit source of the contrarian strategy (very short period).

One of the most famous studies to insist on the effectiveness of the momentum strategy over the contrarian strategy in the US equity market is that by Jegadeesh and Titman [13]. Their research shows that the return attained by the momentum strategy (buying winner portfolios and selling loser portfolios) is statistically significant and economically meaningful. Jegadeesh and Titman [14] also empirically verify that the momentum return is observed throughout the 1990s and evaluated several explanations for the profitability of the momentum strategy (short period). They support the behavioral model, explaining that the momentum return is caused by the delayed overreaction. On the other hand, Fama and French [10] conclud that the profitability of the momentum strategy is simply the capital asset pricing model (CAPM)-related anomaly that cannot be explained by the three-factor model of Fama and French [9].

Lewellen [17] mentions that portfolios by firm size and/or B/M are well-diversified and the momentum returns of these portfolios result from systematic risk. Thus, for the explanation of the momentum returns of these portfolios, we should focus not on the company-specific returns, but rather on macroeconomic factors. Karolyi and Kho [16] examine the return generation model to explain the profitability of the momentum return proposed by

Jegadeesh and Titman [13], based on a new bootstrap simulation method. They point out the importance of the expected return for the entire market and of macroeconomic variables, which dynamically change over time. Chordia and Shivakumar [5] verify that the momentum return is larger in periods of economic expansion and is not observe in periods of economic recession. Avramov and Chordia [1] find that momentum return is related to the miss-pricing component of the model that varies with business cycle-related variables, such as discount government bond yield, short-long yield spread, and credit spread. Avramov and Chordia [2] also indicate that investors using business cycle-related variables could be successful using the momentum strategy without considering economic phase.

If we observe the strong relationship between the momentum strategy and economic cycle, it is natural to examine the relationship between credit risk, which changes dynamically with economic cycles, and the momentum strategy. Avramov, Chordia, Jostova and Philipov [3] provide some answers. From their analysis of the US equity market, they find that the momentum return appears only in high credit-risk companies and is not observable in low credit-risk companies. The explanatory power of the credit rating for the momentum return is robust for the information uncertainty proposed by Jiang, Lee and Zhang [15] and Zhang [19]. Empirical analysis illuminating the relationship between the momentum strategy and credit rating is first attempted by Avramov, Chordia, Jostova and Philipov [3]; it is essential to continue this line of research by creating new methods of analysis and applying them to other equity markets.

As we mentioned above, the empirical analyses related to the momentum strategy have been conducted mostly on European or US equity markets. Regarding the empirical analyses on Japanese equity market, we have Gunaratne and Yonezawa [11], Iihara, Kato, and Tokunaga [12] and Chou, Wei and Chung [6] among others. Examining listed equities in the Tokyo Stock Exchange from 1955 through 1990, Gunaratne and Yonezawa [11] compare returns of extreme loser portfolios with those of extreme winner portfolios and observe reversal returns such that the former outperformed the latter by an annual 11% on a risk-adjusted extra-return basis. They also conclude that this kind of extra return is not attributable to the overreaction of the investors. Examining listed equities in the Tokyo Stock Exchange from 1975 through 1997, Iihara, Kato, and Tokunaga [12] find 1-month short period reversal strategy generates statistically significant return. Chou, Wei and Chung [6] verify that the contrarian strategy either in very short periods (one month) or very long periods (more than two years) is effective in the Japanese equity market, in contrast to the European or US equity markets.

The purpose of our research is to illuminate the relationship between the contrarian strategy and credit rating in the Japanese equity market. In general, from the previous researches mentioned above, we see that the momentum strategy is effective in the US equity market, while the contrarian strategy is effective in the Japanese equity market. It will be interesting to examine the relationship between investment strategy and credit rating when the effective investment strategies are opposite one another. It is also interesting and important to verify whether the credit rating matters in the momentum/reversal return for non US equity markets, and to examine the robustness of this relationship in the different equity markets.

In this research, we empirically examine the relationship between credit rating and the contrarian return. However, our verification method, object, and approach are different from those of Avramov, Chordia, Jostova, and Philipov [3]. Regarding the verification method, we apply Wilcoxon's signed rank test to verify whether the contrarian return differs by rating at a statistically significant level. One of our analyses aim at examining whether it is indispensable to adopt credit rating to explain contrarian return. In other words, we statistically test the hypothesis that even the factor explaining credit rating may explain the contrarian return. Our approach to clarify the relationship between the contrarian return and the credit rating is first to divide the contrarian return into its components, then to closely examine the relationship between each component and credit rating. Furthermore, we also analyze how the relationship is influenced by the business cycle.

The organization of this article is as follows. In Section 2, we describe the data and framework of our analysis. In Section 3, we verify the relationship between credit rating and the contrarian return and also the relationship between the factors explaining the credit rating and the contrarian return. In Section 4, by dividing the expected contrarian return into three components following Lo and MacKinlay [18], we closely examine the relationship between each component and the credit rating. In Section 5, we examine whether the statistically significant contrarian return still exists after removing the return generated by market risk factor. In the last section, we summarize and present our concluding remarks.

2. Data and Framework of Analysis

In this section, we describe the data and framework of our analysis. To examine the contrarian returns for the 10 years from June 1998 to May 2008, we use monthly data (firm-specific financial data is annual) for the 11 year-period from May 1997 to May 2008, incorporating the window period for the contrarian strategy. Because the number of the Japanese firms that acquire their credit ratings from major rating agencies such as Moody's, S&P, and Fitch is insufficient for our analysis, we adopt the credit rating provided by the Japanese rating agency R&I. Even if we use credit ratings by R&I, the number of firms whose corporate bonds have credit ratings for the entire study period is not large. Thus, in our data we include the equity issued by the listed firms whose corporate bonds have credit ratings for more than half the period under investigation. As a result, the equities analyzed in this research are 373 listed equities; the number of equities in each credit rating and the number of equities in each credit rating group are shown in Figure 1 and Figure 2, respectively.

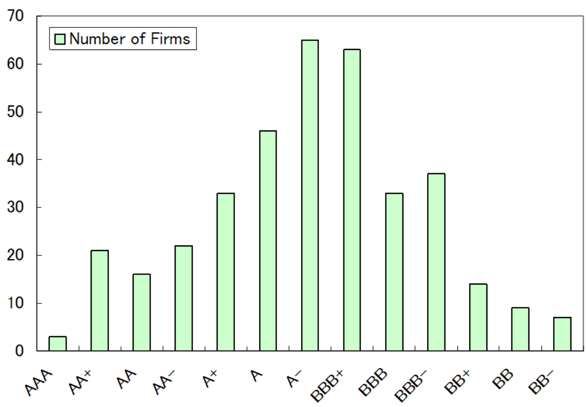

Figure 1: Number of firms in each credit rating

We basically adopt cross-sectional analysis for our method. If the purpose of our research is simply to follow the relationship between credit rating and the contrarian return, it would be desirable to analyze the relationship by incorporating the dynamics of each firm's credit rating. However, in this research, analyzing the relationship between credit rating and the statistics that comprise the origin of the contrarian return, such as auto-covariance, variance

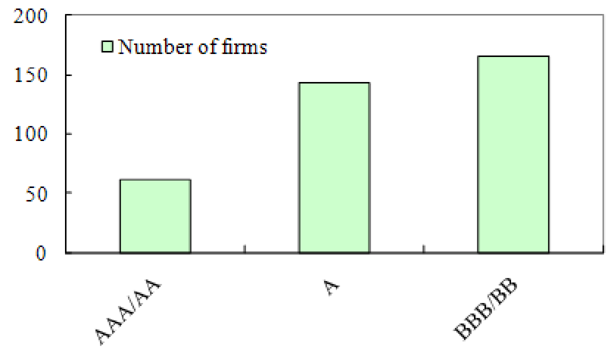

Figure 2: Number of firms in each credit rating group

of the expected return, and cross-auto-covariance, is another major object of our analysis. If we change dynamically the period of equity price data for the derivation of statistics, in accordance with the dynamic change in the credit rating, the numbers of equity price data for a firm differ among credit ratings while the numbers of the equity price data for each credit rating also differ among the firms. As a result, the derived equity statistics become unstable and unreliable. To avoid such a difficulty, we adopt cross-sectional analysis assuming that the credit rating of each firm is constant throughout the period. The constant credit rating of each firm is derived as follows. For each firm, we first ascertain the credit rating by R&I on a monthly basis. Second, we transform the credit rating into a corresponding number (AAA=1, AA+=2,. . . , BB-=13). Third, we compute the average of the monthly numbers for the total period and rounded off the average to an integer. Lastly, we transform the acquired integer into the credit rating. We term this newly derived constant credit rating as the credit rating for the firm. The credit rating represents the average credit of a firm during the period. Due to the credit rating, our cross-sectional analysis is able to capture the relationship between the credit rating and the contrarian return.

We conduct all of our analyses by grouping all the credit ratings into groups of three, such as AAA/AA, A, and BBB/BB. This grouping enable us to capture the general tendency of the reversal return by credit rating while avoiding extreme contrarian returns resulting from the low number of firms belonging to a given credit rating. The original 13 levels of credit rating and newly introduced credit rating groups are shown in Figure 1 and Figure 2, respectively.

A contrarian strategy is an investment strategy aiming at the reverse of the equity price and entails selling past winner equities and buying past loser equities. The design for the period of the contrarian strategy is set by specifying the window period, which is the period of identifying the winner equity and loser equities, and the verification period, which is the period for the evaluation the performance of the contrarian strategy. In this research, we set the evaluation period of the contrarian strategy as one month and rebalanced the portfolio monthly. For the verification of the speed of the reversal, we specify the window period for the contrarian strategy as one month from time $t - k$ to time $t - k + 1$ for $k = 1, \ldots, 12$, where time t is the time to attempt the contrarian strategy and k is the number of months to date back from time t. Thus, the strategies adopted in our analyses are part of those in De Bondt and Thaler [7] and Jegadeesh and Titman [13], which decide the portfolio based on the past J-month return and hold the portfolio in K-month periods. The design for the portfolio of the contrarian strategy is set as follows. In each credit rating group, determined as shown above, we categorize the individual equities into 10 subgroups by their returns in the window period. We construct 10 kinds of portfolio corresponding to the 10 subgroups. Every portfolio is an equal weight portfolio, consisting of an equal weight of the individual equities in the subgroup. We label the 10 kinds of portfolio as P1(Loser), P2, $\cdots$, P10(Winner). The design for the contrarian strategy is to buy P1 and sell P10 at time t and clear them at time $t+1$.

3. Credit Rating and Contrarian Return

In this section, we first verify whether the credit rating explains the contrarian return in the Japanese equity market. Second, we specify the factors involved in deciding the credit rating and examine how much each factor is able to explain the contrarian return. These analyses enable us to ascertain the effectiveness of credit rating as an indicator to explain the contrarian return.

3.1. Credit rating and contrarian return

3.1.1. Methods of our analysis

Here, we describe the method used to analyze whether the credit rating explains the contrarian return, that is, how the contrarian return differs at statistically significant levels according to rating.

First, we simply examine the contrarian return for each credit rating group. In more detail, for each group AAA/AA, A, BBB/BB, ALL and the lag period $k = 1, \ldots, 12$, we derive the average monthly return with the contrarian strategy and its t-value; these are summarized in Table 1. The table shows the overall results, including the credit rating group for which the contrarian strategy is the most effective and the profitable design of the period (period k that generates a large contrarian return) in the contrarian strategy.

Second, using Wilcoxon's signed rank test, we verify whether the contrarian return differs according to rating at statistically significant levels. To examine whether the contrarian return differs across the three credit rating groups (AAA/AA, A and BBB/BB) or not, we should preferably resort to multiple hypothesis testing. However, it is very difficult to apply the standard multiple hypothesis testing to clarify the difference among the three kinds of time-series contrarian returns period by period, which may not follow normal distribution. Thus, instead of applying the multiple hypothesis testing, we repeatedly conduct the Wilcoxon's signed rank test on three pairs of two credit rating groups such as AAA/AA and A, AAA/AA and BBB/BB, A and BBB/BB. When we conduct all kinds of pair-wise hypothesis testing mentioned above instead of applying the multiple hypotheses testing, we have to be careful for the unintentional increase in the probability of the type I error due to the multiplicity. Bonferroni proposes a simple but conservative method to overcome the problem. The proposed method is to make the significance level of all the pair-wise hypothesis tests strict to be one N-th (N is the number of hypothesis testing) of the significance level of the original multiple hypothesis testing. In our case, $N = 3$ and we have only to conduct the Wilcoxon's signed rank test on the three pairs with $\alpha/3\%$ significance level instead of applying the multiple hypothesis testing with $\alpha\%$ significance level (usually, 1% or 5% is chosen as $\alpha\%$). When all of the three pair-wise hypothesis tests are rejected with $\alpha/3\%$ significance, we are able to say that the original multiple hypothesis testing is rejected with $\alpha\%$ significance level. One of the three pair-wise hypotheses is not rejected with $\alpha/3\%$ significance, we are not able to insist that the contrarian return differs across the three credit rating groups with $\alpha\%$ significance level. However, even in this case, we try to derive some implication between the contrarian return and the credit rating from the rejected pair-wise hypotheses. In the first analysis, our main purpose is to grasp the big picture, thus we apply t-tests without checking the normality of the contrarian return. Wilcoxon's signed rank test is a non-parametric test, freeing us from the normality assumption in the application of the statistical test to the contrarian return. In the statistical test, we examine whether the differences in contrarian return between the two groups (e.g., AAA/AA and A; AAA/AA and BBB/BB; A and BBB/BB) are at statistically significant levels or not. The second analysis is attempted for the lag parameter k that generates the statistically significant contrarian return. We denote the difference in the i-th period contrarian return between one credit rating group (e.g., AAA/AA) and the other credit rating group (e.g., A) as X_i, where the i-th period is one month, i.e., from $(i-1)$-th month to i-th month assuming that the starting time of the verification period is the 0-th month. In this setting, Wilcoxon's signed rank, which gives the test statistics, is given by Equation (1):

$$T = \sum_{i=1}^{n} \mathrm{sgn}(X_i) R|X_i|, \tag{1}$$

where $R|X_i|$ is the rank for X_i counted from the smallest among $|X_1|, \ldots, |X_n|$ and n is the number of months in the verification period of the contrarian return. Under the null hypothesis that no difference is observed in the contrarian return between the two credit rating groups, half of the values of X_i, $\{1, 2, \ldots, n\}$ are expected to be positive and the other half of them are expected to be negative. The rank assumes integer value as $\{1, 2, \ldots, n\}$ and follows a uniform distribution. Thus, when the test statistic deviates significantly from 0, the null hypothesis is rejected and it is concluded that the contrarian return between the two rating groups are statistically significantly different. In the actual application of the statistical test, we use Z-statistics in Equation (2), which consists of Wilcoxon's signed rank T and follows standard normal distribution:

$$Z = \frac{|T - E(T)| - 1/2}{\sqrt{\mathrm{Var}(T)}}. \tag{2}$$

Third, we analyze the origin of the contrarian return in more detail for the lag parameter k generating the significant difference in the contrarian return between the two rating groups identified in the first and second analyses. For each credit rating group, we construct 10 kinds of portfolios P1 (Loser) through P10 (Winner) for the one-month window period from time $t-k$ to $t-k+1$ and evaluate the one-month return on each portfolio from time t to time $t+1$. We then take the average of the one-month returns in the verification period. Given the division of the contrarian strategy portfolios into two groups, we are able to identify whether our contrarian return is generated mainly from the loser or winner portfolios.

Fourth, we examine the sensitivity of the contrarian return to the economic conditions for the lag parameter k generating the significant difference in the contrarian return between the two rating groups identified in the first and second analyses. In other words, we identify how much the contrarian return in a booming economy differs from that during recession. In this analysis, using the date of business cycle announced by cabined office, we define the recession periods as the periods from June 1998 to March 2003 and from July 2007 to May 2008, and the period of economic boom is identified as the period from April 2003 to June 2007. After separating the verification periods into the booming economic period and the recession period, we attempt the first analysis and then move on to conduct Wilcoxon's signed rank test for the second analysis.

3.1.2. Results and implications

The results of the first analysis are shown in Table 1. When $k = 1$ (month) is the designated period of the contrarian strategy, the average return in AAA/AA credit rating group is 1.61%

(t-value 3.37, 1% significant level) and the average return in A credit rating group is 1.05% (t-value 2.19, 5% significant level). On the other hand, when the period of the contrarian strategy is longer, e.g., $k = 8$ or $k = 10$, the average return in BBB/BB credit rating group is 0.89% (t-value 2.10, 5% significant level) in $k = 8$ and 0.89% (t-value 2.22, 5% significant level) in $k = 10$. This result implies a general tendency: in the Japanese equity market a short period of reversal is observed in the high credit rating group, while it takes a relatively longer period for the low credit rating group to induce the reversal phenomenon.

Table 1: Average monthly return (t-value) of contrarian strategy by credit rating group

k	AAA/AA	A	BBB/BB	ALL	k	AAA/AA	A	BBB/BB	ALL
1	1.61%	1.05%	-0.36%	0.43%	7	0.18%	0.03%	0.63%	0.26%
	(3.37**)	(2.19*)	(-0.77)	(1.00)		(0.38)	(0.08)	(1.45)	(0.71)
2	-0.47%	-0.19%	-0.23%	-0.29%	8	0.12%	0.78%	0.89%	0.79%
	(-0.93)	(-0.41)	(-0.48)	(-0.65)		(0.25)	(1.77)	(2.10*)	(2.14*)
3	0.71%	-0.18%	-0.20%	-0.11%	9	-0.29%	-0.35%	0.04%	-0.23%
	(1.60)	(-0.40)	(-0.43)	(-0.27)		(-0.64)	(-0.86)	(0.11)	(-0.65)
4	0.54%	0.32%	0.26%	0.25%	10	0.06%	0.62%	0.89%	0.67%
	(1.14)	(0.76)	(0.57)	(0.65)		(0.15)	(1.72)	(2.22*)	(1.99*)
5	0.02%	-0.23%	-0.23%	-0.30%	11	0.09%	-0.15%	0.31%	0.04%
	(0.04)	(-0.57)	(-0.54)	(-0.81)		(0.23)	(-0.40)	(0.74)	(0.11)
6	-0.09%	-0.38%	0.34%	0.12%	12	0.52%	0.19%	-0.39%	-0.24%
	(-0.20)	(-0.85)	(0.90)	(0.36)		(1.19)	(0.52)	(-0.92)	(-0.72)
# of Firms	62	145	166	373	Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05				

The results of Wilcoxon's signed rank test for $k = 1, 8, 10$, which designate the period of statistically significant contrarian returns, are shown in Table 2. As Table 2 shows, for $k = 1$, the null hypothesis is rejected with a 0.1% confidence level in the case of the difference in the contrarian return between the AAA/AA credit rating group and the BBB/BB credit rating group, and with a 1% confidence level between the A credit rating group and the BBB/BB credit rating group. However, the Z-value of the Wilcoxon's signed rank test on the difference of the contrarian returns between AAA/AA credit rating group and A credit rating group is 1.05 and 15% significance level. This results suggests that the original multiple hypothesis testing is not rejected even if we adopt 5% as the significance level of α%. Thus, we are not able to insist that the contrarian return differs across the three credit rating groups with α% significance level. The implication from the results of the three pair-wise hypothesis tests is that the credit rating partly explains the contrarian return when it is used as the comparison of the BBB/BB credit rating group with more superior credit rating groups. In general, we see the tendency that the better the credit rating, the higher the contrarian return, though it is not statistically significant. However, for $k = 8, 10$, the null hypothesis is not rejected even with a 5% confidence level between any two credit rating groups, and we are therefore not able to conclude that the credit rating explains the contrarian return. Thus, focusing on the case of $k = 1$, we examin in more detail the relationship between short contrarian return and the credit rating.

For $k = 1$, the average monthly returns on portfolios P1 through P10 in the verification period are shown in Table 3. The setting of $k = 1$ implies that portfolio P1 is the worst loser portfolio and portfolio P10 is the best winner portfolio for the previous month. To render the contrarian strategy effective, the return on P1 has to be high and the return on P10 has to be low. Thus, in Table 3, the return on the portfolios should have been in descending order from highest to lowest. As shown in Table 3, for the AAA/AA and A credit

Table 2: Z-value of Wilcoxon's signed rank test for $k = 1, 8, 10$ (month)

k	AAA/AA ⇔ A	A ⇔ BBB/BB	AAA/AA ⇔ BBB/BB
1	1.05	3.42**	4.11***
8	1.59	0.00	1.19
10	1.01	0.99	1.46

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

rating groups, returns on portfolio P1 through P10 are generally in descending order, but for the BBB/BB credit rating group they are not. Thanks to our division of the contrarian strategy, we are able to identify where the origin of the major difference in the contrarian return between AAA/AA and AA credit rating groups and BBB/BB credit rating group in the case of $k = 1$. For the AAA/AA and A credit rating groups, which are able to generate the contrarian return, the returns on the loser portfolios are as large as 1.61% and 1.05%, respectively. However, the return on winner portfolio P10 in the AAA/AA credit rating group is only slightly negative (-0.05%) and the one return in the A credit rating group is not negative but positive (0.47%). From these results, we can see that the short contrarian return in our research mainly came from the loser portfolio.

Table 3: Average monthly returns on portfolios P1 through P10 in the case of $k = 1$ (month)

	AAA/AA	A	BBB/BB	ALL
P1–P10	1.61%	1.05%	-0.36%	0.43%
P1	1.56%	1.52%	0.52%	1.10%
P2	0.81%	0.88%	0.82%	0.73%
P3	0.30%	0.82%	0.83%	0.91%
P4	0.42%	0.61%	0.67%	0.65%
P5	0.47%	0.56%	0.95%	0.78%
P6	0.32%	0.41%	0.84%	0.63%
P7	0.24%	0.34%	0.68%	0.48%
P8	0.29%	0.73%	0.27%	0.53%
P9	0.27%	0.58%	0.52%	0.38%
P10	-0.05%	0.47%	0.88%	0.67%

The results for contrarian return by credit rating group in booming economic and recession periods are provided in Table 4 and the results of the Wilcoxon's signed rank test are shown in Table 5. Table 4 shows that the short contrarian return differed to some extent by credit rating group in both the booming economic period and the recession period. Examining Table 4 more closely, it is apparent that (1) the short contrarian returns in the AAA/AA and A groups are larger in the recession period than in the booming economic period, and (2) for the BBB/BB credit rating group, the contrarian return in the recession period is not observable. Result (2) is in line with the previous research by Avramov, Chordia, Jostova, and Philipov [3] who find that the momentum strategy is effective for lower credit ratings in a booming economy in the USA. From the results of Wilcoxon's signed rank test shown in Table 5, we see that the differences of the contrarian returns among credit rating groups are larger in the booming economic period than in the recession period. However, even in the booming economic period, we do not find a statistically significant difference in the short contrarian return between the AAA/AA credit rating group and the A credit rating group.

Table 4: Contrarian return by credit rating group in booming economic and recession periods

		AAA/AA	A	BBB/BB	ALL
Booming	Mean	1.31%	0.60%	-0.76%	-0.02%
	t value	(2.51*)	(1.10)	(-1.49)	(-0.04)
Recession	Mean	2.51%	2.39%	0.83%	1.78%
	t value	(2.70**)	(2.48*)	(0.76)	(1.81)

Signif. Codes: 0 '**' 0.01 '*' 0.05

Table 5: Z-value of Wilcoxon's signed rank test in booming economic and recession periods in the case of $k = 1$

	AAA/AA ⇔ A	A ⇔ BBB/BB	AAA/AA ⇔ BBB/BB
Booming	1.14	3.13**	3.93***
Recession	0.10	1.43	1.45

Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

3.2. Factors to explain credit eating and the contrarian return

3.2.1. Method of analysis

From the analysis in Section 3.1, we see that for $k = 1$, the contrarian return and also the explanatory power of the credit rating for the contrarian return are both large. Hereafter, we call the contrarian strategy of the period $k = 1$ as the short period contrarian strategy and its return as the short period contrarian return. In this section, we examine whether the credit rating really matters in the short period contrarian return. More specifically, we analyze the possibility that even the factors involved in deciding the credit rating may matter in the short period contrarian return.

In order to explain the credit rating, we consider four variables. Three variables are quantitative and one is qualitative, aimed at capturing the magnitude of the credit risk. However, all four can be quantified. For the three quantitative variables we adopted three parameters related to the Merton model, which is widely used to derive default probability such as (1) the drift of the firm's value process, (2) the volatility of the firm's value, and (3) the capital ratio. The qualitative factor is the size of the firm. We choose this qualitative factor based on the concept that some firms are considered "too big to fail;" i.e., if the size of the firm is extremely big, the government will be forced to rescue the firm because of the substantial social damage that would result from its default. This means that firm size could be a critical factor in explaining credit risk.

First, we empirically verify that the above four factors really explain credit rating using the ordered probit model. In the ordered probit model, Y_i is the integer value of the credit rating for firm i and $Y_i = \{\text{AAA/AA} = 1,\ \text{A} = 2,\ \text{BBB/BB} = 3\}$. The integer value of the credit rating Y_i is assumed to be explained by the imaginary factor Y_i^*, which is modeled by Equation (3):

$$Y_i^* = \alpha + \beta_1\mu(V_i) + \beta_2\sigma(V_i) + \beta_3(E_i/V_i) + \beta_4(E_i) + \varepsilon_i, \tag{3}$$

where $\mu(V_i)$, $\sigma(V_i)$, (E_i/V_i) and (E_i) are the drift of the firm i value process, the volatility of the value of firm i, the capital ratio of the firm i, and the size of firm i, respectively. Thus, the imaginary factor Y_i^* consists of the parts explained by the above four variables as well as the error term ε_i. In the ordered probit model, the error term ε_i is assumed to follow a normal distribution. For details on the ordered probit model, refer to Borooah [4].

We use monthly data for the above four variables in our empirical analysis. The firm's value is the sum of the debt value and the capital value of the firm. We compute the debt value for each month by linear interpolation of the corresponding debt values in the financial statements of the two accounting years, and the equity value of each month by multiplying monthly equity price and the number of total shares of the firm at the accounting year ending just before the month. We substitute the size of the firm for the total market value of the equity. One reason for this is that groupings such as large capitalization and small capitalization are usually based on the total market value of the equity; another reason is that if we were to use the firm value itself for the size of the firm, the undesirable negative correlation with the capital ratio would occur in the regression analysis.

Second, using each above variable instead of the credit rating, we attempt analyses similar to the first and second analyses described in Section 3.1. We also examine the explanatory power of each individual variable for the short period contrarian return. For the analyses, adopting each factor as a criterion, we separate all the equity into three groups: upper 30%, middle 40%, and bottom 30% based on the credit rating grouping described above and then attempt to verify the short period contrarian returns as in the analysis described in Section 3.1. In order to directly compare the explanatory power for the short period contrarian return between the four factors and the credit rating more conveniently, we separate all the equities into three groups, upper 30%, middle 40%, and bottom 30%, utilizing the 13 levels of the credit ratings. We conduct the first analysis on the three groups in addition to the analysis on groups such as AAA/AA, A and BBB/BB, as describe in Section 3.1. In the second analysis, using Wilcoxon's signed rank test, we examine whether the differences between groups for each variable generated statistically significant differences for the short period contrarian returns.

3.2.2. Results and implications

Results of the analysis based on the ordered probit model are shown in Table 6. The R-squared value is relatively high at 0.59, and the credit ratings are well explained by the above four factors. From the results of the likelihood test on each factor, all of the coefficients of the variables except that of the drift of the firm are deviated from zero with 0.1% confidence level and also satisfy the requirement for the sign of the coefficients. The positive coefficient implies that the larger the value of the explanatory variable, the larger the value of the credit rating, and, in short, the lower the credit rating. The coefficient for the volatility of the firm value is positive, meaning that the larger the volatility of the firm's value (i.e., the higher the business risk), the lower the credit rating. The coefficient for the capital ratio is negative, implying that the higher the capital ratio, the higher the credit rating. Furthermore, the coefficient for the size of the firm is also negative, suggesting that the larger the size of the firm (i.e., the greater the social impact at default), the higher the credit rating. Therefore, these three factors are all important in explaining the credit rating.

The results of the analyses of the short period contrarian returns for the three groups differentiated by each variable are provided in Table 7. Table 7 shows that statistically significant contrarian returns are not observed in any group differentiated by the variables of capital ratio and drift of the firm value. Regarding the groups differentiated by the variables of the size of the firm and the volatility of the firm's value, the statistically significant contrarian returns appear in the groups related to the high credit rating, i.e., groups of large firms and groups showing low volatility in firm value.

This raises the question of whether the groups differentiated by these two variables matter in the short period reversal return. Examining Table 7 by closely focusing on these

Table 6: Results of the analysis based on the ordered probit model

	Value	Std.Error	t value	LR
Drift of Corporate Value	-0.82	17.77	-0.05	-6.86
Volatility of Corporate Value	29.10	3.78	7.69***	70.2 1 ***
Equity Ratio	-2.17	0.45	-4.88***	21.64***
LN(Market Capitalization)	-1.01	0.08	-12.25***	219.94***
R-squared	0.59			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

two factors, we see that for the groups ranked by firm size, the short period contrarian return of the upper 30% group is higher than that of the middle 40% group, but that of the middle 40% group is lower than that of the bottom 30% group. Thus, the size of the firm is not the crucial factor in the short period contrarian return. For groups ranked by the volatility of the firm value, the short period contrarian return of the upper 30% group is higher than that of the middle 40%; also, the middle 40% group is higher than that of the bottom 30% group. In general, the volatility of the firm value seems to matter in the short period contrarian return. However, looking at the results for the credit rating, the explanatory power of the credit rating to the short period contrarian return looks much higher than that of the volatility of firm value. To clearly capture the difference in the explanatory power between the two, the results of the Wilcoxon's signed rank test are shown in Table 8. Table 8 shows that no combination of the groups differentiated by any factor is able to explain the difference in the short period contrarian return. On the other hand, we can recognize that the credit rating matters in the short period contrarian return, for groups AAA/AA, A and BBB/BB, and the groups divided into upper 30%, middle 40%, and bottom 30%. Based on the above results, we conclude that any single variable related to the credit rating is not so influential in the short period contrarian return by itself, but that the above four variables in combination (credit rating) matter in it.

Table 7: Results of the analyses of the short period contrarian returns for the three groups differentiated by size, leverage, drift of corporate value, volatility of corporate value and credit rating

Sort by	Size(Market Capitalization)			Leverage(Equity ratio)		
	Large	Medium	Small	Low Risk	Medium Risk	High Risk
Mean	1.22%	0.21%	0.63%	0.51%	0.26%	0.66%
t value	(2.10*)	(0.40)	(1.36)	(0.88)	(0.57)	(1.34)

Sort by	Drift of Corporate Value			Volatility of Corporate Value		
	Low	Medium	High	Low Risk	Medium Risk	High Risk
Mean	0.70%	0.57%	0.15%	1.11%	0.57%	0.06%
t value	(1.32)	(1.16)	(0.30)	(2.78**)	(1.27)	(0.11)

Sort by	Credit Rating			Credit Rating		
	AAA/AA	A	BBB/BB	Low Risk	Medium Risk	High Risk
Mean	1.61%	1.05%	-0.36%	1.45%	0.34%	-0.36%
t value	(3.37**)	(2.19*)	(-0.77)	(2.96**)	(0.66)	(-0.71)

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

Table 8: Results of the Wilcoxon's signed rank test

Size(Market Capitalization)			Z value	Leverage(Equity Ratio)			Z value
Large	⇔	Medium	1.60	Low Risk	⇔	Medium Risk	1.04
Medium	⇔	Small	0.66	Medium Risk	⇔	High Risk	1.02
Large	⇔	Small	1.10	Low Risk	⇔	High Risk	0.38

Drift of Corporate Value			Z value	Volatility of Corporate Value			Z value
Low	⇔	Medium	0.04	Low Risk	⇔	Medium Risk	1.31
Medium	⇔	High	1.37	Medium Risk	⇔	High Risk	0.18
Low	⇔	High	1.00	Low Risk	⇔	High Risk	1.42

Credit Rating			Z value	Credit Rating			Z value
AAA/AA	⇔	A	1.05	Low Risk	⇔	Medium Risk	2.54*
A	⇔	BBB/BB	3.42**	Medium Risk	⇔	High Risk	1.44
AAA/AA	⇔	BBB/BB	4.11***	Low Risk	⇔	High Risk	3.41**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

4. Credit Rating and the Components of the Contrarian Return

4.1. Method of analysis

In this section, we describe the method of our analysis for closely examining the relationship between the credit rating and the three statistical components of the short period contrarian return proposed by Lo and MacKinlay [18]. First, we note the difference in the design of the portfolio between our contrarian strategy and the contrarian strategy in Lo and MacKinlay [18]. As described in Section 2, our design for the portfolio in the contrarian strategy is to buy P1 and sell P10 at time t and clear the position at time $t+1$. Lo and MacKinlay's [18] plan for the portfolio in the contrarian strategy is to sell equities that outperformed the market return in the period from time $t-k$ to time $t-k+1$ at time t

with the weight proportional to the extra return, and buy the equities that outperformed the market in the same fashion. In this research, our focus is on the short period reversal return and therefore we empirically examine the case of $k = 1$. In their plan for the portfolio, most of the equities have some weight in the contrarian strategy and therefore their contrarian return would be moderate in comparison to our contrarian strategy. Although we recognize the difference between the two contrarian strategies, for convenience we use the three statistical components following Lo and MacKinlay [18] to examine the relationship between the credit rating and the components of our contrarian return, assuming that their components also represent our components.

To the goal, first, we empirically verify that our contrarian return set as $k = 1$ is rationalized by the Lo and MacKinlay [18] contrarian return that could be decomposed into three statistical components. In more detail, we ascertain whether the statistical significance on the expected return of our contrarian strategy is close to that on the expected return of the corresponding Lo and MacKinlay [18] strategy. Secondly, we discuss which statistical component significantly contributes to the contrarian return in each credit rating group.

Here, we introduce the notations, basically following Lo and MacKinlay [18]. Difference from the notation of Lo and MacKinlay [18] contrarian strategy is that the weighted average individual equity return of each credit rating group (R_m) could not be the market return because all the individual equities in the market are categorized into the three credit rating groups. We name an individual equity belonging to a credit rating group as i ($i = 1, \ldots, N$). We denote the return on equity i ($i = 1, \ldots, N$) in the period from time t to time $t+1$ as R_{it} and the $N \times 1$ return vector consists of the returns as $R_t \equiv [R_{it}, \ldots, R_{Nt}]'$. The expectation of the return vector R_t, the average of its components and k-th auto-covariance are denoted as

$$E[R_t] = \mu \equiv [\mu_1, \ldots, \mu_N]', \qquad \mu_m = \frac{1}{N}\sum_{i=1}^{N}\mu_i, \qquad \Gamma_k = E[(R_{t-k} - \mu)(R_{t-k} - \mu)'],$$

respectively. The weight in the contrarian strategy is set at

$$\omega_t(k) = -\frac{1}{N}(R_{t-k} - R_{mt-k}).$$

Under the setting, the contrarian return ($\pi_t(k)$) is formulated as

$$\pi_t(k) = \sum_{i=1}^{N}\omega_{it}(k)R_{it}$$

and its expectation $E[\pi_t(k)]$ is divided into the following three statistical components: C_k, O_k and $\sigma^2(\mu)$.

$$E[\pi_t(k)] = C_k - O_k - \sigma^2(\mu), \tag{4}$$

where,

$$C_k \equiv \frac{1}{N^2}[\imath'\Gamma_k\imath - \mathrm{tr}(\Gamma_k)], \qquad O_k \equiv \left(\frac{N-1}{N^2}\right)\mathrm{tr}(\Gamma_k),$$

$$\sigma^2(\mu) \equiv \frac{1}{N}\sum_{i=1}^{N}(\mu_i - \mu_m)^2, \qquad \imath \text{ is } N \times 1 \text{ vector of ones.}$$

C_k is the sum of the components of the auto-covariance matrix other than the diagonal components, i.e., the sum of cross-auto-covariance; O_k is the sum of the diagonal components in the auto-covariance matrix, that is, the sum of the auto-covariance; and $\sigma^2(\mu)$ (constant without depending on the lag k) is the variance of the expected return of each equity and may be interpreted as cross-sectional volatility. Equation (4) implies that the larger the value of C_k and the smaller the values of O_k and $\sigma^2(\mu)$, the larger the contrarian return.

First, we conduct the analyses on whole the period. The expected return of Lo and MacKinlay [18] contrarian strategy is listed in Table 9. Comparing Table 9 with Table 1 ($k = 1$), we empirically verify that our contrarian return is rationalized by the Lo and MacKinlay [18] contrarian return. Then, we derive the value of each statistical component in the short period contrarian return for three credit rating groups, e.g., AAA/AA, A and BBB/BB, then summarize the results in Table 10. Based on Table 10, we examine which component mainly generates the short period contrarian return in the Japanese equity market and how these components are related to credit rating.

Second, we also conduct the analyses splitting the period into the booming economic and recession periods. The expected return of Lo and MacKinlay [18] contrarian strategy by economic condition is listed in Table 11. Comparing Table 11 with Table 4, we empirically verify that our contrarian return is rationalized by the Lo and MacKinlay [18] contrarian return.

4.2. Results and implications

The results of the first analysis are shown in Table 9 and Table 10. The expected return of Lo and MacKinlay [18] contrarian strategy on whole the period is listed in Table 9. Table 9 shows us that t-values of the expected returns of Lo and MacKinlay [18] contrarian strategy for AAA/AA and A credit rating groups are statistically significant with 1% and 5% confidence levels, respectively. Table 1 ($k = 1$) tells us that t-values of the expected returns of our contrarian strategy for AAA/AA and A credit rating groups are also statistically significant with 1% and 5% confidence levels, respectively. Thus, in general, our expected contrarian return is something like the Lo and MacKinlay [18] expected contrarian return.

Table 9: Contrarian return of Lo and MacKinlay strategy by credit rating group

	AAA/AA	A	BBB/BB	ALL
Mean	0.032%	0.035%	0.021%	0.027%
t value	(2.76**)	(2.52*)	(1.30)	(1.80)

Signif. Codes: 0 '**' 0.01 '*' 0.05

As shown in Table 9, the contrarian returns on the AAA/AA and A groups are generally larger than that on the BBB/BB group. Focusing on the components of the contrarian return in Table 10, the cross-auto-correlation of the BBB/BB group is larger than those of the AAA/AA and A groups, while the auto-covariance of the BBB/BB group is positive, in contrast to the negative auto-covariances of the AAA/AA and A groups. Referring to the division of the expected contrarian return in Equation (4), it is suggested that the contrarian return on the BBB/BB group mainly originates from the cross-auto-covariance, while those of the AAA/AA and A groups are generated not only from the cross-auto-covariance but also from the auto-covariance. The cross-sectional volatility ($\sigma^2(\mu)$) is much smaller than the other two components and the differences among credit ratings are also minor; therefore, the effect on contrarian return is negligible.

Table 10: Results of the components of the contrarian return

	AAA/AA	A	BBB/BB
$E[\pi_t(k)]$	0.032%	0.035%	0.021%
C_k	0.013%	0.021%	0.044%
O_k	-0.020%	-0.017%	0.019%
$\sigma^2(\mu)$	0.002%	0.003%	0.003%

The results of the second analysis are shown in Table 11. The expected returns of Lo and MacKinlay [18] contrarian strategy in the booming economy and recession are listed in Table 11. First, we focus on the expected contrarian return in the recession period. Comparing Table 11 with Table 4, we find that t-values both with 1% statistically significant confidence level for the expected returns of Lo and MacKinlay [18] contrarian strategy in AAA/AA and A credit rating groups are close to those with respectively 1% and 5% statistically significant confidence level for the corresponding expected returns of our contrarian strategy. Furthermore, t-value 2.06 with 5% statistically significant confidence level for the expected return of Lo and MacKinlay [18] contrarian strategy for all the credit rating groups is also close to that of 1.81 for the corresponding expected return of our contrarian strategy. Next, we move to the expected contrarian return in the booming economic period. In Table 11, we find that the expected return of Lo and MacKinlay [18] contrarian strategy is not statistically significant even in 5% confidence level in any credit rating group, though that of AAA/AA credit rating group is relatively high.

Table 11: Contrarian return of Lo and MacKinlay strategy by credit rating group in booming economic and recession periods

		AAA/AA	A	BBB/BB	ALL
Booming	Mean	0.019%	0.016%	-0.001%	0.007%
	t value	(1.52)	(1.14)	(-0.06)	(0.53)
Recession	Mean	0.066%	0.098%	0.081%	0.088%
	t value	(2.93**)	(2.93**)	(1.89)	(2.06*)

Signif. Codes: 0 '**' 0.01 '*' 0.05

Thus, the expected return of our contrarian strategy is, in general, similar to that of the Lo and MacKinlay [18] contrarian strategy in both of the economic conditions.

5. The Market-Risk-Adjusted Contrarian Return by Credit Rating

5.1. Method of analysis

In this section, we mention why the market-risk-adjusted contrarian return (the return not due to the market risk) has to be discussed and then provide statistical method to examine the existence of it.

From the results attained above, we find that the expected contrarian returns are statistically significant in high credit rating groups such as AAA/AA and A, and also that the reason of it is due to the large negative auto-covariance in the credit rating groups. Before we conclude that the credit rating matters in the expected contrarian return, we have to discuss the possibility that the contrarian strategies in the high credit rating groups unintentionally take some market risk. In other words, we have to examine the possibility that the contrarian returns in the high credit rating groups could be explained by the following

CAPM (Capital Asset Pricing Model).
(CAPM)

$$R_t^i - r_t^f = \beta^i(R_t^M - r_t^f) + \varepsilon_t, \qquad (t = 0, 1, \ldots, T), \tag{5}$$

where R_t^i, r_t^f and R_t^M are the returns at time t of portfolio i, risk-free asset and market portfolio, respectively. And β^i and ε_t represent the beta risk (systematic risk) of the portfolio i and the error term (unsystematic risk), respectively.

Hypothesis that the contrarian returns in the high credit rating groups could be explained by the beta risk (systematic risk) is restated in statistical modeling as the one that the extra returns $R_t^i - r_t^f$ of the contrarian returns are explained by the returns $\beta^i(R_t^M - r_t^f)$ due to the systematic risk. More specifically, the contrarian returns are explained by CAPM when the intercept α^i is not deviated from 0 and the coefficient β^i is deviated from 0 both with statistically significant confidence level in the regression analysis based on the following equation (6), which is the extension of the equation (5) so as to incorporate intercept α^i.
(The regression model for the test)

$$R_t^i - r_t^f = \alpha^i + \beta^i(R_t^M - r_t^f) + \varepsilon_t, \qquad (t = 0, 1, \ldots, T). \tag{6}$$

In the empirical analyses, we adopt one-month CD rate as the risk-free rate to set the maturity of it equal to the investment horizon of the contrarian strategy.

5.2. Results and implications

The results of the regression analysis for the portfolio returns of our contrarian strategy and Lo and MacKinlay [18] contrarian strategy are provided in the upper and lower rows of Table 12, respectively. First, we focus on the result for the portfolio return of our contrarian strategy. The result for AAA/AA credit rating group tells us that t-value of the intercept α is 3.084 and 1% statistically significant confidence level, while t-value of the coefficient related to the market risk is -0.220 and not statistically significant. The result suggests that the expected return of our contrarian strategy for AAA/AA group is scarcely generated by the market risk and not explained by CAPM. Regarding A credit rating group, the result shows us that t-value of the intercept α is 1.885, while t-value of the coefficient related to the market risk is 0.877 and not statistically significant. The implication of the result is that the expected return of our contrarian strategy for A group is also scarcely generated by the market risk and not explained by CAPM. The other evidence that the contrarian returns for the high credit rating groups are not explained by CAPM is the result that the expected returns of the contrarian strategies set as $k = 1$ for AAA/AA and A credit rating groups (1.61% and 1.05% in Table 1, respectively) are relatively close to the corresponding α-values (1.475% and 0.897% in Table 12, respectively).

Second, we discuss about the result for the portfolio return of Lo and MacKinlay [18] contrarian strategy. The result for AAA/AA credit rating group tells us that t-value of the intercept α is 2.147 and 5% statistically significant confidence level, while t-value of the coefficient related to the market risk is -0.538 and not statistically significant. The result implies that the expected return of our contrarian strategy for AAA/AA group is scarcely generated by the market risk and not explained by CAPM. However, considering that the t-value of the expected contrarian return for AAA/AA credit rating group is 2.76 in Table 9, we see that the statistical significance is slightly decreased by adjusting the market risk. On the other hand, regarding the A credit rating group, t-value of the intercept α for is not so small as 1.594 but is decreased from 2.52 (5% statistically significant confidence level) in Table 9 and the statistical significance with 5% confidence level disappears. The t-value of the coefficient related to the market risk is 0.319 and not statistically significant.

Thus, we conclude that the contrarian return for A credit rating group is not explained by CAPM, however, the statistical significance of the market-risk-adjusted contrarian return for A credit rating group is less than that for AAA/AA credit rating group.

Table 12: The Risk-Adjusted Contrarian Return by Credit Rating Group

	AAA/AA		A		BBB/BB		ALL	
	α	Market	α	Market	α	Market	α	Market
coefficient	1.475 %	-0.022	0.897 %	0.086	-0.516 %	0.118	0.285 %	0.057
t value	3.084**	-0.220	1.885	0.877	-1.099	1.212	0.661	0.633
coefficient	0.030 %	-0.002	0.024 %	0.001	0.0001	0.000	0.017 %	-0.001
t value	2.147*	-0.538	1.594	0.319	0.480	-0.003	1.218	-0.281

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05

6. Summary and Concluding Remarks

In this research, inspired by the work of Avramov, Chordia, Jostova, and Philipov [3], we attempt to analyze how much the credit rating is able to explain the short period contrarian return in the Japanese equity market. Our methods of analysis are different from those of previous research. We basically divide the short period contrarian return into several components and examined the relationship between the components and credit ratings using a statistical model. Our main results regarding the relationship between the credit rating and the contrarian return in the Japanese equity market are as follows:

First, the short period contrarian return mainly comes from the loser portfolio and can be partly explained by the credit rating. The short period contrarian return is large for high credit rating equity portfolios in recession periods, while the momentum return is observed for low credit rating equity portfolios in booming economic periods.

Second, any one of the factors used to explain credit rating, standing alone, is insufficient to explain the short period contrarian return. When we use the credit rating in a comparison of the BBB/BB credit rating group with much superior credit rating groups, it explains the short period contrarian return.

Third, for low credit rating equity portfolio, the contrarian return seems to be generated from the cross-auto-covariance and, for high credit rating equity portfolio, it mostly comes from the auto-covariance.

Fourth, the expected returns of our contrarian strategy for high credit rating groups such as AAA/AA and A groups are scarcely generated by the market risk and explained not by CAPM.

Our results supplement the research of Avramov, Chordia, Jostova, and Philipov [3], both in terms of method of analysis and the market under analysis. We hope that this research illuminates the relationship between the contrarian return and the credit rating.

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Koichi Miyazaki
Department of Systems Engineering
University of Electro-Communications
1-5-1 Chofugaoka, Chofu, Tokyo, 182-8585, Japan