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Credit rating and managerial behavior in investment decision making: Evidence from the Korean market

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ABSTRACT

This study finds, using data from Korea that, as rating levels for corporate bonds improve, firms tend to increase capital investment, but this positive relationship is attenuated at or near-BBB ratings. At the upper end of speculative grade, there is an incentive to make active investment decisions because of the opportunity to be upgraded to investment grade. This paper found that BB+ firms show such behavior. Conversely, at the lower end of investment grade, there is an incentive to make conservative investment decisions due to the threat of a downgrade to speculative grade. Thus, the threat of a downgrade to speculative-grade provides managers conservative investment decision incentives. The greater the threat, the stronger the impact of investment-grade cut-offs. This paper is an early study to explore how investment-grade cut-offs affect managerial behavior in investment decision-making.

1. Introduction

Credit rating agencies play an essential role in the debt market, and credit ratings are an important determinant of corporate financial decisions (Graham and Harvey, 2001; Harford and Uysal, 2014; Kisgen, 2009, 2019; Kim and Shin, 2017; Bedendo and Siming, 2018; Aktas et al., 2021). This study is particularly interested in the role of credit rating agencies in emerging markets. The role of credit rating agencies in the financial market is active when credit rating agencies have access to private information that is not accessible from the stock market (Jorion et al., 2005). In general, there is less corporate information disclosure in developing countries than in developed countries such as the United States. However, there are few studies on the role of credit rating agencies in emerging markets, even though credit rating agencies play a more critical role in emerging economy financial markets. The South Korean market is excellent for examining the interests here.

Our objective is to show that investment-grade cut-offs affect firms' investment decisions. Managers of near-BBB (hereinafter referring to BBB+, BBB, BBB−) rated firms strive to maintain their credit ratings (investment grade status) because a downgrade to a speculative grade penalizes many corporate stakeholders. The near-BBB firm managers are cautious about their investment decisions because they fear the threat of a downgrade. Therefore, management mitigate irrational investment decisions or makes conservative investment decisions.

The negative effect of rating downgrades on firms' financial policies and value is well established. Such a downgrade reduces shareholder value (Bedendo and Siming, 2018), corporate investment (Almeida et al., 2017), and leverage (Kisgen, 2009). Notably, rated firm stakeholders do not want downgrades (Kisgen, 2019). We focus on the effect of investment-grade cut-offs on investment decisions. A downgrade to a speculative-grade leads to negative market reaction (Ryu et al., 2013; Jeong and Chung, 2014), higher corporate lending rates (Sul and Jung, 2017), and more significant debt reduction (Kisgen, 2009) than other downgrades. Therefore, when rated firm managers have a minimum or target credit rating (Graham and Harvey, 2001; Kisgen, 2009), firms with credit ratings at or near BBB (i.e., near-BBB firms) do not target the BB+ or speculative-grade (i.e., below BBB−). However, studies on the impact of investment grade–speculative grade (IG–SG) cut-offs on corporate decisions are scarce.

The results here appear relevant to underinvestment problems (Myers, 1977), which occur through conflicts between shareholders and creditors. The downgrade to speculative-grade is

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important for managers, creditors, and shareholders, and all these three stakeholders of near-BBB firms strive to maintain their investment-grade status.

Our findings show that investment grade cut-offs reduce managers' overinvestment preferences or overconfidence. We also consider precautionary savings (Han and Qiu, 2007) as another basis for the behavior of managers observed in near-BBB firms. The threat of a downgrade to speculative grade makes managers conservative and risk-averse, hence the tendency for precautionary motives (Xu et al., 2019). The findings here did not support precautionary motives.

This study adds new insights to the literature on credit ratings and corporate investment decisions (Graham and Harvey, 2001; Harford and Uysal, 2014; Almeida et al., 2017; Aktas et al., 2021; Kisgen, 2019). To the best of our knowledge, there is no direct evidence that near-BBB firms reduce investments compared to their credit rating levels. This study provides evidence that managers adjust their decisions to manage credit ratings. In particular, our results imply that firms with near-BBB categories do not target the speculative-grade. Therefore, this study adds new evidence that rated firms have target or minimum ratings (Graham and Harvey, 2001; Kisgen, 2009). Such research is especially difficult to find in emerging markets. This paper also contributes to behavioral finance being an early study on how investment grade cut-offs affect managers' behavior in investment decision-making.

The remainder of this paper is organized as follows. Section 2 reviews related studies and presents our hypotheses. Section 3 describes our empirical methodology and sample data. Section 4 presents the results of our empirical analyses. Finally, Section 5 conducts some robustness tests, Section 6 discusses the results and Section 7 concludes the study.

2. Literature review and hypotheses

2.1. Literature review

The managers of rated firms consider credit ratings when making debt decisions (Graham and Harvey, 2001; Kisgen, 2009), financial policies (Campello et al., 2010; Kisgen, 2019), and investment decisions (Harford and Uysal, 2014; Almeida et al., 2017; Kim and Shin, 2017; Aktas et al., 2021). Many studies use credit ratings as a proxy for financial constraints (Faulkender and Petersen, 2006; Aktas et al., 2021) and the ability to access public debt markets (Campello et al., 2010; Harford and Uysal, 2014; Karampatsas et al., 2014). A lower debt capacity (lower ratings) can prevent firms from realizing the full potential of their investment opportunities.

Bedendo and Siming (2018) show the negative effect of a downgrade on stock price. The literature on the Korean market reaction to changes in credit ratings has found that the impact is stronger for downgrades than for upgrades (Jeong and Chung, 2014; Kim and Shin, 2017; Ryu et al., 2013; Sul and Jung, 2017). A downgrade affects corporate debt decisions, but rating upgrades do not have an effect (Kisgen, 2009). Kim and Shin (2017) show that the cumulative default rate of firms increases slowly from AAA to BBB but increases sharply from BB+. Sul and Jung (2017) analyze the relationship between credit ratings and corporate lending rates, finding that, as credit rating is downgraded, the corporate lending rate increases but also that the effect of upgraded ratings leading to decreased lending rates is not significant. Aktas et al. (2021) and Kisgen (2019) argue that managers are reluctant to experience downgrades because downgrades harm managers' reputation and future job positions. Therefore, the three stakeholders of rated firms (i.e., managers, shareholders, and creditors) are afraid of downgrades, and managers of rated firms strive to manage a minimum rating (Graham and Harvey, 2001; Kisgen, 2009).

In addition, the penalty for a downgraded credit rating is more pronounced when the rating changes to speculative-grade. Jeong and Chung (2014) show that the negative effect of a credit rating downgrade on the market reaction is almost four times larger when a credit rating is downgraded from investment-grade to speculative-grade market. Kim and Shin (2017) show that the negative effect of a downgrade on the change in capital investment is more pronounced when the rating changes to speculative-grade. Besides, Kisgen (2009) finds that the debt reduction of firms that downgrade from investment-grade to speculative-grade is twice as large as that of other downgraded firms. Thus this study focuses on the threat of a downgrade to speculative-grade (i.e. the effect of investment-grade cut-offs).

2.2. Hypotheses

Firms with higher ratings are financially less constrained than firms with lower ratings. In other words, firms with high bond ratings have a high debt capacity or low external financing cost. Therefore, as ratings improve, rated firm managers tend to increase capital expenditure. However, a downgrade of rating penalizes rated firms, especially the loss of investment-grade status that harms corporate value and managers' reputations. Therefore, near-BBB firms' stakeholders fear a downgrade to speculative grade, and managers of near-BBB firms are reluctant to make risky investments. These behaviors make managers' investment decisions conservative compared to their debt capacity (or credit rating levels). Although near-BBB firms have better creditworthiness than speculative-rated firms; they do not increase their investment quantity to the extent of their better debt capacity. This leads to the following main hypotheses:

H1. As a firm's rating level improves, firms increase capital investment, but this positive relationship is reduced when the rating level is in the near-BBB interval.

Following agency theory, managers can make value-decreasing investment decisions or inefficient investment decisions to maximize utility. Rated firms have access to the public debt market, and their high ability to borrow debt can cause agency costs (Harford and Uysal, 2014). Agency problems (Jensen, 1986) predict that managers with high discretion are more likely to conduct value-decreasing investments, such as empire building or overinvestment activities. Therefore, rated firms' managers are likely to make overinvestment decisions. Empire building is a well-documented agency cost, and managers' empire-building behavior causes overspending in capital expenditure or overinvestment. A manager with an empire-building preference increases excess capital expenditure (Chen et al., 2012) or makes investment decisions to increase firm size (Hope and Thomas, 2008). M&A is an investment decision that is often used as a means to achieve empire-building (Trautwein, 1990), and the M&A decisions of managers with empire-building preferences are value-decreasing (Titman et al., 2004; Masulis et al., 2007). Kim and Kim (2020) document that, in Korea, rated firms are more active than non-rated firms and suggest that firms with high ratings can cause agency costs such as overinvestment. This evidence suggests that the investment decisions of rated firm managers are likely to be overinvestment, and these are either unprofitable or likely to destroy firm value. Value-decreasing or unprofitable investment decisions jeopardize future corporate cash flows and increase downgrade probability. When the managers of rated firms have overinvestment preferences such as empire building, the threat of a downgrade to speculative grade provides managers with an incentive to reduce overinvestment and makes other stakeholders monitor the managers' investment decisions.

H2a. The threat of a downgrade to speculative grade prevents managers from overinvestment decisions when managers have over-investment preference.

Schrand and Zechman (2012) suggest that managerial over-confidence affects overall corporate decisions. Optimistic managers cause over-investment (Huang et al., 2011) or value-decreasing investment (Heaton, 2002; Mohamed et al., 2020), or make unprofitable investment decisions (Fairfield et al., 2003). Optimistic managers overestimate their future cash flows and underestimate the risk of those cash flows (Malmendier and Tate, 2008; Ben-David et al., 2013). However, the threat of a downgrade to speculative grade, which gives more penalties than other downgrades, will prevent optimistic managers from under-estimating future cash flow risk. Consequently, when near-BBB firm managers are overconfident, the effect of investment-grade cut-offs on investment decisions is active.

H2b. The threat of a downgrade to speculative grade prevents optimistic/overconfident managers from overinvestment decisions.

This paper's primary concern is that a downgrade to speculative-grade provides penalties, and this phenomenon affects management investment decisions. The greater the loss due to a downgrade, the more conservative and risk-averse managers are. Managers who fear a downgrade to speculative grade consider corporate investment decisions carefully and take a conservative or risk-averse attitude. The managers' traits expressed in risk-averse and conservative decisions are deeply related to precautionary motives (Xu et al., 2019). The precautionary motive (or precautionary savings) theory suggests that firms reserve their cash resources to prepare for financing frictions (Opler et al., 1999). Xu et al. (2019) suggest that female CFOs who are conservative and risk-averse hold more cash following the precautionary savings theory. Therefore, investment grade cut-offs endear in managers who fear a downgrade to speculative grade the precautionary motive, and as a result, managers can reduce capital expenditure or overall investment activities. Following this logic, Hypothesis 1 is based on precautionary motives.

Corporate investment declined during the financial crisis (Campello et al., 2010; Duchin et al., 2010). Sun and Wang (2015) document that firms reserved cash during the financial crisis, and their evidence supports that conjecture that firms with precautionary motives reserve cash during financial crises. They suggest that firms' precautionary motives increase in a financial crisis. In macroeconomics, precautionary motives are active when households want stable consumption and are concerned about future income (Caballero, 1990). During the global financial crisis (2008–2009), firms had a negative shock to their external sources of finances (Duchin et al., 2010), and firms had a higher incentive to hold cash because of the difficulty to raise external capital (Sun and Wang, 2015). During financial crises, external financing is costly and restricted, increasing the precautionary motive (Opler et al., 1999). Therefore, if a threat of downgrade to speculative grade provides near-BBB firms with precautionary motives, the effect of investment grade cut-offs on capital investment is more significant in crises periods than in other periods.

H3a. Following the precautionary motive, the negative effect of investment grade cut-offs on investment is significant during a financial crisis.

Precautionary saving is a vital determinant of corporate cash holdings, and firms with a precautionary motive hold cash (Han and Qiu, 2007; Sun and Wang, 2015; Xu et al., 2019). A downgrade to speculative grade penalizes firm stakeholders. Investment grade cut-offs may make managers conservative and risk-averse. Managers' conservative or risk-averse attitudes increase precautionary motives (Xu et al., 2019). Harford and Uysal (2014) suggest that firms that want to mitigate their refinancing risk save cash flows to increase cash holdings. The more debt firms use, the higher the probability of default, and the more default risk is highly related to decreased credit ratings. Therefore, managers who see the probability of a downgrade as a substantial threat can save current cash flow to prepare for future financing. Thus, investment-grade cut-offs provide near-BBB firms' managers with a precautionary motive, and as a result, the investment grade cut-offs affect firms' cash holdings.

H3b. Investment grade cut-offs increase the cash holdings of near-BBB firms.

3. Empirical design

3.1. Sample selection

This study uses the FnGuide database for credit rating data as well as financial and accounting data. We selected public firms with credit ratings from 2001 to 2017. We also exclude firms in the financial and insurance industries (Korean Standard Statistical Classification 64–66), firms with missing financial and accounting data, and firms with fewer than 150 price observations of the firm's stock in the fiscal year (Kim, 2016). This is commonly done due to concerns that too few observations could lead to parameter estimation biases. Besides firms with too few stock price observations could be very illiquid stocks, or such a case suggests some events or shocks to the company such as firms that have only just been listed in that year or firms suspended for various reasons such as flouting trading rules, etc. The final dataset comprises 333 firms with 2633 firm-year observations.

3.2. Variables

In the South Korean market, studies use tangible assets as a proxy for property, plant, and equipment (PPE) and capital expenditure, calculated as the sum of tangible assets and their depreciation (Kim and Shin, 2017). This study uses growth in tangible assets (i.e., [change in tangible assets + depreciation]/lagged tangible assets) as a proxy for a firm's capital investment following Kim and Shin (2017).

Corporate investment activities are highly related to firms' financial constraints. When near-BBB firms do not increase their investment despite debt-capacity improvement, financial constraints not represented by credit ratings may be affected. This study controls for firms' financial constraints using the Kaplan and Zingales (1997) index (KZ index), a widely used proxy for firms' financial constraints. We compute the KZ index following Lamont et al. (2001). This study also added several control variables, following the literature. Lee et al. (2012) analyze the relationship between firms' investment activities and the financial index in the Korean market. They find that the return on assets (ROA) and growth rate of sales have significant positive effects on investment activity, and that leverage has a significant negative effect. Lee (2007) finds that the growth rate of sales and operating cash flows positively affect investment activity. Ban et al. (2012) find that R&D expenditure has a positive effect on investment activity. Among studies conducted elsewhere, To et al. (2018) analyze the effect of financial analysts on firms' investment decisions, using control variables for size, leverage, market-to-book (M/B) ratio, asset growth, cash flow, and ROA. Aivazian et al. (2005) find that firms' cash flows are important for capital expenditure. Further, a firm's dividend policy can affect its investment decisions (Fazzari et al., 1988; Brav et al., 2005). Therefore, we control for firm size, leverage, growth opportunity, cash, sales, ROA, dividends, and R&D expenditure in our empirical model. The variables are defined in Appendix A.

3.3. Methodology

We create a dummy variable, *Interval Dummy*, which is equal to one if a firm's rating belongs to a specific interval; otherwise, it is zero. For each table and model, we indicate what this interval dummy refers to. Following the main hypothesis (H1) of this study, the effect of credit ratings on rated firms' capital investment is positive, whereas the joint effect of credit rating and the dummy variable representing a grade at or near BBB is negative. In Eq. (1), rating levels ($Rating_{i,t-1}$) have a positive effect on investment ($Invest_{i,t}$), whereas the interaction variable between rating levels and the interval dummy variable ($Interval\ Dummy_{i,t-1} * Rating_{i,t-1}$) have a negative effect on investment ($Invest_{i,t}$) only when the interval contains the near-BBB interval. The regression model used for hypothesis testing was as follows:

$$\begin{aligned} Invest_{i,t} = {} & \beta_0 + \beta_1 Rating_{i,t-1} + \beta_2 Interval\ dummy_{i,t-1} \\ & + \beta_3 Interval\ dummy_{i,t-1} * Rating_{i,t-1} \\ & + \gamma Control\ variables_{i,t-1} \\ & + \varphi Year\ and\ Industry\ Dummy_{i,t-1} + \epsilon_{i,t}, \end{aligned} \quad (1)$$

This study's second hypothesis predicts that investment grade cut-offs prevent managers from overinvestment preference or overconfidence in over-investment. We measure managerial over-investment or overconfidence using four proxies. The first measure is based on growth opportunities, following Biddle et al. (2009). Lin et al. (2021) use this measure as a proxy for investment efficiency, which is also often used in Korea (Kim and Yang, 2019). Biddle et al. (2009) use the industry-adjusted investment residual from a regression of total investment on sales growth. We estimate the residual (*residual investment* in Eq. (2b)) for each industry year based on the two-digit Korean Standard Industrial Classification (KSIC) code for all industries with at least 20 observations in a given year. The total investment calculates the net increase in tangible and intangible assets scaled by lagged total assets, following Lin et al. (2021). The *residual investments* are sorted into quartiles by year, and the observations in the top quartile are classified as firms with overinvestment preference (*Overinvest1*). The other observations in the bottom quartile are classified as firms with non-overinvestment preferences.

$$Investment_{i,t+1} = \beta_0 + \beta_1 Salesgrowth_{i,t} + \epsilon_{i,t+1} \quad (2a)$$

$$Residual\ Investment_{i,t} = Investment_{i,t} + \mathrm{E}\left(Investment_{i,t}\right) \quad (2b)$$

The second measure is based on capital expenditure following Ahmed and Duellman (2013). Ahmed and Duellman (2013) use an industry-adjusted capital expenditure, which is calculated as the corporate capital expenditure deflated by lagged total assets minus the industry median. We classify firms with above industry-median capital expenditure scaled by lagged total assets as an overinvestment group (*Overinvest2*).

The third measure is based on the cash and cash equivalent ratio (=cash and cash equivalent/total assets). Richardson (2006) documents that firms with high levels of free cash flow tend to overinvest, and Hubbard (1998) suggests that investment expenditure has a positive relationship with free cash flow. Harford and Uysal (2014) suggests that cash-rich firms are more active in acquisitions than other firms, but their acquisition is likely to decrease. Therefore, firms with high cash and cash equivalent ratios are likely to overinvest. We sort the firms based on the cash and cash equivalent ratio across industry and year, and the highest 50% of firms are classified as those with overinvestment preference (*cash rich*).

The fourth measure relates to managerial overconfidence. Schrand and Zechman (2012) measure overconfidence using five components related to firm-level investing and financing activities. However, their fourth component, which is related to convertible debt or preferred stock, is difficult to use for our research setting. In Korea, the number of firms issuing convertible bonds has only recently increased. Kwak (2012) analyzes the market reaction to the issue of convertible bonds. In Kwak's (2012) empirical setting, from 2001 to 2009, an average of 26 firms issued convertible bonds but there are approximately 1,900 listed companies in Korea. In Jang and Yoon's (2020) empirical results, the number of convertible bonds issued (not number of issuing firms) increased from 12 in 2013 to 324 in 2017. Our sample period is from 2001 to 2017. In addition, Kim (2016) suggests that preferred stock is hardly considered a risky bond in Korea. Therefore, this study modifies the overconfidence measure of Schrand and Zechman (2012).

The first component we use is the estimated residual of the industry-adjusted excess investment from regressing asset growth on sales growth. If the estimated residual is greater than the industry median by year, the firms are prone to overconfidence.

The second component is related to acquisition activities. Schrand and Zechman (2012) use the net cash expenditure for acquisition, but the available data are very restricted in Korea (Kim, 2016). We change the second component to whether or not the firms have acquired other firms. The free cash flow hypothesis (Jensen, 1986) suggests that managers with empire-building preferences are likely to undertake bad M&As. In the managerial behavior field, optimistic managers overpay for the target (Black, 1988) and overconfident CEOs undertake value-decreasing acquisitions (Malmendier and Tate, 2008). Managerial overconfidence positively affects merger activities (Malmendier and Tate, 2008). Therefore, the acquirer is likely to have an overconfidence or empire-building preference. This study adds a strong condition to the acquirer's share of the target to select the acquisition case related to increasing the size and scope of managers' power. The M&A deals must meet the following conditions: the deals had to have a reported transaction value of more than 1 million dollars; acquirers had to own less than 10% of the target before the deal occurred, and more than 70% thereafter; and the bidder and target had to have different parent firms. These acquirers are likely to be overconfident.

The third component is the debt-to-equity ratio, and we sort the debt-to-equity ratio across the year and industry. If the debt-to-equity ratio is greater than the median value, then the firms are prone to overconfidence. The other firms with a debt-to-equity ratio less than the median value are classified as non-overconfident.

The final component of our measure is dividend policy. Managers with overconfidence preserve cash resources to prepare for future investment opportunities, and as a result, there is a negative relationship between managers' overconfidence and dividend payouts (Ben-David et al., 2013; Cordeiro, 2009). If the firms do not pay dividends, then the firms are prone to managerial overconfidence.

Consequently, we judge that firms have overconfidence if they exhibit three or four of these components (*overconfidence*). In sum, this study measures managers' overinvestment or overconfidence using four proxies (*Overinvest1, Overinvest2, Cash rich, Overconfidence*). This study explores whether the effect of investment-grade cut-offs on capital investment is greater when the firm's manager has an overinvestment preference or overconfidence.

4. Empirical results

4.1. Summary statistics

Table 1 shows the summary statistics of the variables used in this study. To curb the effect of outliers that are likely to

Table 1
Summary statistics.

Variables	N	Mean	Median	Std	Min	Max
Invest	2633	0.1101	0.1038	0.1710	−0.3220	0.4400
KZ_index	2633	6.6827	4.0984	7.9637	−8.7882	27.9113
Size	2633	26.8033	26.696	1.7860	23.8500	30.0400
Leverage	2633	0.5953	0.6064	0.1750	0.0870	2.2150
M/B ratio	2633	1.0050	0.9223	0.3078	0.6380	1.8701
Cash_incre	2633	0.0041	0.0020	0.0295	−0.0562	0.0682
ROA	2633	0.0173	0.0231	0.0600	−0.148	0.1130
Salesgrow_ratio	2633	0.0873	0.0624	0.2000	−0.2620	0.5880
R&D_ratio	2633	0.0039	0.0008	0.0060	0.000	0.0220
Dividend_ratio	2633	0.0957	0.0701	0.1020	0.000	0.3510

All variables are defined in Appendix A.

Table 2
Pearson correlations among the variables.

	Invest	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Rating	0.227									
	(0.000)									
(2) KZ index	−0.251	−0.402								
	(0.000)	(0.000)								
(3) Size	0.176	0.723	−0.426							
	(0.000)	(0.000)	(0.000)							
(4) Leverage	−0.211	−0.366	0.477	−0.107						
	(0.000)	(0.000)	(0.000)	(0.000)						
(5) M/B ratio	0.148	0.062	−0.349	0.372	−0.012					
	(0.000)	(0.002)	(0.000)	(0.000)	(0.532)					
(6) Cash_incre	0.069	0.042	−0.031	0.043	−0.038	0.011				
	(0.000)	(0.031)	(0.117)	(0.027)	(0.050)	(0.588)				
(7) ROA	0.310	0.528	−0.292	0.330	−0.446	0.023	0.147			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.247)	(0.000)			
(8) Salesgrow_ratio	0.178	0.111	−0.121	0.045	−0.056	0.035	0.137	0.266		
	(0.000)	(0.000)	(0.000)	(0.021)	(0.004)	(0.075)	(0.000)	(0.000)		
(9) R&D_ratio	0.127	0.079	−0.171	0.173	−0.115	0.194	0.008	0.042	0.015	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.670)	(0.032)	(0.437)	
(10) Dividend_ratio	0.135	0.402	−0.253	0.177	−0.373	0.024	0.001	0.380	0.028	0.027
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.222)	(0.962)	(0.000)	(0.151)	(0.161)

p-values are reported in parentheses.

affect the empirical results, this study follows the literature and adjusts the extreme value at the 5% level (top and down). The results obtained using the winsorized data at 5%, 3% and 1% (top and down) are similar to those obtained using the raw data. Our results are presented using data winsorized at 5% (top and down).

Table 2 reports the Pearson correlations among the variables. First, *Invest* has significantly positive correlations with *Rating, Size, Cash_incre, ROA, Salesgrow_ratio, R&D_ratio*, and *Dividend_ratio* but a negative correlation with *Leverage*. The positive correlation between capital investment (*Invest*) and credit rating (*Rating*) is relevant to our hypothesis. This result is similar to that of Kim and Shin (2017).

However, Table 2 shows that credit rating (*Rating*) seems to have a strong correlation with other variables. Specifically, the Pearson correlation between credit rating and firm size is 0.723. This value is above the threshold of 0.5. This occurs because credit rating agencies conduct financial analyses using financial and accounting data to evaluate a firm's credit status. Thus, considering the potential multicollinearity problem, we calculate the variance inflation factor (mean = 1.596 and maximum = 3.079). Given that the result are way below the rule of thumb of 10, we consider that these correlations are suitable for the analyses in this study.

Our main proposal is that the relationship between firms' investment activity and credit ratings vary depending on the credit rating interval. Table 3 presents the credit rating distribution of the samples used in the empirical test as well as the summary statistics for capital investment (*Invest*) by credit rating.

In Table 3, we divide credit ratings into four intervals following the definitions of issuer ratings by the Korea Investors Service (an affiliate of Moody's investor service). The "Very High" interval ranges from AAA to AA−, indicating a very strong capacity for timely repayment. The "Stable" interval ranges from A+ to BBB−, which indicates a strong capacity for timely repayment but warns that adverse changes in circumstances may impair the firms' capacity. The "Uncertain" interval ranges from BB+ to B−, indicating that capacity is uncertain. The "Default" interval ranges from CCC to D, indicating a high credit risk or insolvency. The observations are concentrated in the "Stable" interval. The speculative-grade accounts for 18.23% of the sample. The mean and median of *Invest* seem to increase relatively steadily as credit ratings improve, whereas its standard deviation decreases steadily.

4.2. Do the investment-grade cut-offs affect firms' capital investment?

In model (1) of Table 4, the coefficient of credit rating (*Rating*) is 0.0057, which is statistically significant suggesting that as credit ratings increase, capital investments of firms increase. However, this study argues that the positive effect of credit ratings on capital investment is reduced when rated firms are in the near-BBB interval. This study therefore creates various interval dummy variables that indicate investment-grade cut-offs neighborhood intervals. The definitions of the interval dummy variables in models (2)–(7) are that the credit ratings belong to BBB− to BB+, BBB to BB+, BBB+ to BB+, BBB+ to BBB−, BBB+ to BB−, and BBB+ to BB respectively. We include the interaction term to moderates the relationship between credit rating and the investment decision in firms. The interaction term examines how this relationship changes within specific ranges of credit ratings. The aim is to ascertain whether or not the relationship between

Table 3
Distribution of credit ratings.

Grade	Credit rating	Observation	Distribution (%)	Mean	Std.	Median
INVESTMENT	Very high (obs: 630, ratio: 23.93%)					
	AAA	85	3.23	0.1997	0.1074	0.1780
	AA+	99	3.76	0.1422	0.1151	0.1161
	AA	178	6.76	0.1515	0.1191	0.1469
	AA−	268	10.18	0.1555	0.1415	0.1405
	Stable (obs: 1523, ratio: 57.84%)					
	A+	264	10.03	0.1470	0.1387	0.1299
	A	291	11.05	0.1126	0.1719	0.1060
	A−	314	11.93	0.1007	0.1456	0.0895
	BBB+	221	8.39	0.0942	0.1664	0.0884
	BBB	260	9.87	0.0929	0.1685	0.0722
	BBB−	173	6.57	0.1049	0.1917	0.1071
SPECULATIVE	Uncertain (obs: 413, ratio: 15.69%)					
	BB+	104	3.95	0.0937	0.2047	0.1031
	BB	113	4.29	0.0575	0.2198	0.0485
	BB−	81	3.08	0.0728	0.1533	0.0502
	B+	39	1.48	−0.0177	0.2338	0.0112
	B	33	1.25	0.0499	0.2895	0.0385
	B−	43	1.63	0.0308	0.2356	0.0435
	Default (obs: 67, ratio: 2.54%)					
	CCC	39	1.48	0.0169	0.2376	0.0134
	CC	4	0.15	−0.1738	0.1377	−0.1867
	C	16	0.61	0.0186	0.1644	0.0412
	D	8	0.3	−0.0773	0.2566	−0.0438

Distributions of intervals over the full sample are reported in parentheses.

credit rating and investment decision changes based on the differing ranges of credit ratings. That is to say, the interaction term uncovers if the relation between credit rating and investment decision is dependent on the range or interval of the credit rating.

In model (2) of Table 4, the interval dummy represents firms in the range BBB− to BB+, and the coefficient of the interaction variable (Rating*Interval) is −0.015, but it is not statistically significant. The results of Models (3) and (4) of Table 4 support Hypothesis 1. In model (3) of Table 4, the interval indicates whether the credit ratings belong to BBB, BBB−, and BB+. The coefficient of the interaction variable is −0.0217 and statistically significant at the 10% level. In model (4) of Table 4, the interval indicates whether the credit ratings belong to BBB+, BBB, BBB−, and BB+. The coefficient of the interaction variable is −0.0183 and statistically significant at the 1% level. Interestingly, while the interval variable of model (4) includes both speculative-grade (BB+) and investment-grade (BBB−, BBB, BBB+), the positive relationship between credit rating level and corporate investment decreases. Thus, following Hypothesis 1, the coefficient of the interaction variable between the interval dummy variable and credit ratings is negative and statistically significant when the interval dummy indicates a near-BBB interval. However, the joint effects of credit rating levels and rating intervals disappear when the interval widens or contains only the lower-grade investment-grade cut-offs. In model (6) of Table 4, the interval indicates whether the credit ratings belong to BB− to BBB+. The coefficient of the interaction variable was −0.006, which was not statistically significant. In model (7) of Table 4, the interval indicates whether the credit ratings belong to BB to BBB+. The coefficient of the interaction variable was 0.008, which was not statistically significant. Thus, credit ratings and corporate investment have a positive relationship, but that relationship decreases in the neighborhood of BBB grade.

For the control variables, this study predicts that *Size, M/B ratio, Cash_incre, ROA, Sales*, and *R&D* have positive effects, but *KZ_index* and *leverage* have negative effects on firms' investment activity, following the literature. These results are in line with our expectations, but they are significant only for *KZ_index, M/B ratio, ROA*, *Salesgrow_ratio*, and *R&D_ratio*. Previous studies on the South Korean market show the following effects of these features on investment activity: the growth rate of sales is positive (Lee, 2007), leverage is negative (Lee et al., 2012), and R&D expenditure is positive (Ban et al., 2012). However, our result for ROA differs from that of Lee et al. (2012), who show a negative effect. We argue that firms with high profitability are more likely to invest in new projects than are lower-profitability firms.

Overall, these findings provide new evidence on the importance of credit rating levels in corporate investment decisions. In particular, the threat of a downgrade to a speculative-grade reduces corporate capital investment. This finding suggests that managers display different investment decisions depending on their firm's current ratings.

If our hypotheses are supported, the negative coefficient of the interaction variable (rating*interval) would not be found in the other intervals. The definitions of the interval dummy variables in models (1)–(6) of Table 5 are that the credit ratings belong to AAA to AA−, AA+ to A+, A+ to A−, A+ to BBB+, BB+ to B+, and BB+ to B−, respectively. The coefficients of the interaction variables (Rating*Interval) were positive in all of these models.

With reference to the main results, in Model 1 of Table 4, all things being equal, the fixed asset growth rate (our proxy for capital investment) of the sample firms is 0.0057 on average with a unit increase in credit rating. However, one can observe in Model 4 of Table 4 for example that the impact of rating on the dependent variable is statistically significant with a coefficient of 0.0058, but within the range BBB+ to BB+, as the rating increases, investment tends to decrease. That is, the interaction between rating and the interval dummy shows a statistically significant effect of −0.0183. When calculating the total effect of the three independent variables (rating, interval dummy, and interaction variable) related to credit rating in Model 4 of Table 4 for example, it is 0.0812, 0.0688, 0.0813, 0.0938, 0.1063, and 0.0522 from A− to BB respectively (refer to Appendix B). Consequently, BB+ shows a much higher growth in investment than lower rating levels, which gradually decreases in the near-BBB interval, and then increases again from A−. Thus, we argue

Table 4
Effect of investment grade cut-offs on capital investment.

Interval:	None (1)	BBB−BB+(2)	BBB BB+(3)	BBB+BB+(4)	BBB+BBB−(5)	BBB+BB−(6)	BBB+BB (7)
Constant	0.3827***	0.3370***	0.3323***	0.3367***	0.3688***	0.3157***	0.3202***
	(0.0895)	(0.0842)	(0.0851)	(0.0859)	(0.0895)	(0.0926)	(0.0882)
Rating	0.0057***	0.0058***	0.0058***	0.0058***	0.0058***	0.0063***	0.0061***
	(0.0020)	(0.0020)	(0.002)	(0.0020)	(0.0020)	(0.0020)	(0.002)
Interval Dummy		0.2010	0.2692*	0.2313***	0.2115**	0.0833*	−0.045
		(0.2297)	(0.1431)	(0.0814)	(0.1011)	(0.0493)	(0.0792)
Rating * Interval Dummy		−0.0150	−0.0217*	−0.0183***	−0.0171**	−0.0060	0.008
		(0.0213)	(0.0125)	(0.0067)	(0.0082)	(0.004)	(0.0079)
KZ index	−0.0022***	−0.0023***	−0.0023***	−0.0023***	−0.0023***	−0.0023***	−0.0023***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0007)
Size	−0.0085**	−0.0070*	−0.0069*	−0.0070*	−0.0081**	−0.007	−0.0070
	(0.0041)	(0.0039)	(0.004)	(0.004)	(0.0041)	(0.0042)	(0.004)
Leverage	−0.0160	−0.0170	−0.0180	−0.0180	−0.0170	−0.021	−0.0190
	(0.033)	(0.0332)	(0.0333)	(0.0335)	(0.0333)	(0.0341)	(0.0337)
M/B ratio	0.0409***	0.0408***	0.0409***	0.0407***	0.0414***	0.0405***	0.0406***
	(0.0148)	(0.0147)	(0.0146)	(0.0147)	(0.0147)	(0.0147)	(0.0147)
Cash_incre	0.1160	0.1250	0.1270	0.1270	0.1200	0.1270	0.1270
	(0.1114)	(0.1106)	(0.1108)	(0.1109)	(0.1115)	(0.1112)	(0.1106)
ROA	0.5805***	0.5711***	0.5699***	0.5690***	0.5727***	0.5639***	0.5652***
	(0.0861)	(0.0862)	(0.0861)	(0.0863)	(0.0859)	(0.0864)	(0.0865)
Salesgrow_ratio	0.0728***	0.072***	0.0718***	0.0717***	0.0722***	0.0728***	0.0724***
	(0.0212)	(0.0212)	(0.0212)	(0.0211)	(0.0213)	(0.0211)	(0.0212)
R&D_ratio	1.1778*	1.1348*	1.1300*	1.1401*	1.1732*	1.1467*	1.1350*
	(0.6199)	(0.6163)	(0.6186)	(0.6192)	(0.6211)	(0.6279)	(0.6214)
Dividend_ratio	−0.0520	−0.0470	−0.0470	−0.048	−0.053	−0.042	−0.0430
	(0.0372)	(0.0367)	(0.0365)	(0.0371)	(0.0375)	(0.0368)	(0.0369)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2633	2633	2633	2633	2633	2633	2633
Adjusted *R*-sqr	0.1801	0.1835	0.1836	0.1835	0.1810	0.1815	0.1829

The table is a pooled OLS regression of the dependent variable, *invest,* on credit rating, various interval dummies, the interaction term, *rating * interval dummy,* and a set of control variables. The columns examine different intervals representing near-BBB credit ratings. All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.
***denote statistical significance at the 1% level.
**denote statistical significance at the 5% level.
*denote statistical significance at the 10% level.

in this paper that if the credit rating of near-BBB interval companies is downgraded to speculative grade due to investment failure, the fall in their corporate value, rise in cost of raising capital, and the associated managerial (career, reputation) costs are greater than downgrades in other intervals for which reason all major stakeholders such as shareholders, creditors and managers of near-BBB interval companies are reluctant to experience a downgrade to speculative grade. Preceding research related to this was introduced earlier in the paper. Put differently, the results of Model 4 in Table 4 for example shows a tendency for near-BBB firms not to increase investment relative to the firms' credit capacity, but conversely BB+ firms appear to aggressively increase investment relative to their credit level and capacity. BB+ companies, which are at the top of speculative grade will remain in speculative grade even if their investment fail, but have the possibility of getting upgraded to investment grade if the investment is successful. Thus in contrast to near-BBB firms, for BB+ firms, the gains from a successful investment outweigh the losses from a failed investment. As a result, BB+ companies are likely to invest aggressively.

Overall, Tables 4 and 5 show that the joint effect of credit rating levels and rating interval on corporate investment is negative and statistically significant only in the near-BBB interval. Thus, this study concludes that the threat of a downgrade to speculative-grade affects firms' investment decisions significantly only when the firm's rating level is in the near-BBB interval. This conclusion suggests that investment-grade cut-offs affect corporate decision making.

4.3. Real threat of a downgrade

This paper's central argument is that near-BBB firm managers are cautious about investment decisions because they fear the threat of a downgrade. The critical point is whether there is a possibility of a downgrade. We observe credit rating agencies' rating outlooks and watches, which provide additional information about the probability of a rating change. Therefore, when credit rating agencies review downgrades, the manager feel a real threat of a downgrade.

This study uses the bond rating history service of the KIS-Value database for rating outlooks and credit watches.[1] The rating outlook assesses the possibility of rating changes in the mid-term. The positive outlook indicates that the rating may be an upgrade, and a stable outlook indicates that the rating will not change.

[1] The firms' financial and accounting data were obtained from the FnGuide database. To collect the rating outlook and watch list, we search our sample firms directly in the bond rating history service of KIS-Value. Some firms are excluded from the data collection because there is no data on them as the rating agency provides a rating outlook or watch for only applicable firms.

Table 5
Regression results using other intervals.

Interval:	AAA AA−(1)	AA+A+(2)	A+A−(3)	A+BBB+(4)	BB+B+(5)	BB+B−(6)
Constant	0.4538***	0.3947***	0.4029***	0.4170**	0.3726***	0.3532***
	(0.1033)	(0.0949)	(0.0915)	(0.0928)	(0.089)	(0.0902)
Rating	0.0047**	0.0053**	0.0062***	0.0064***	0.0054***	0.0059***
	(0.0021)	(0.0021)	(0.002)	(0.002)	(0.002)	(0.002)
Interval Dummy	−0.1350	0.0090	−0.1478*	−0.0850	−0.2303**	−0.1140
	(0.1194)	0.0823)	(0.0883)	0.0593)	(0.1082)	(0.1355)
Rating * Interval Dummy	0.0090	0.0000	0.0090	0.0050	0.0265**	0.0150
	(0.0069)	(0.0049)	(0.0058)	0.004)	(0.0121)	(0.0149)
KZ index	−0.0023***	−0.0022***	−0.0024***	−0.0024***	−0.0022***	−0.0022***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
Size	−0.0106**	−0.0089**	−0.0094**	−0.0097**	−0.0081**	−0.0076*
	(0.0044)	(0.0042)	(0.0041)	(0.0042)	(0.0041)	(0.0041)
Leverage	−0.0080	−0.0130	−0.0100	−0.0080	−0.0170	−0.0170
	(0.033)	0.0334)	(0.0329)	0.033)	0.033)	(0.0333)
M/B ratio	0.0400***	0.0396***	0.0389***	0.0381**	0.0409***	0.0395***
	(0.0147)	(0.0149)	(0.0149)	(0.0149)	(0.0147)	(0.0147)
Cash_incre	0.1180	0.1150	0.1240	0.1230	0.1170	0.1210
	(0.1113)	(0.1114)	(0.1111)	0.111)	0.1113)	(0.1111)
ROA	0.5950***	0.5829***	0.5927***	0.5892***	0.5751***	0.5772***
	(0.086)	(0.0857)	(0.086)	(0.086)	(0.086)	(0.0865)
Salesgrow_ratio	0.0731***	0.0726***	0.0718***	0.0717***	0.0747***	0.0729***
	(0.0212)	(0.0213)	(0.0212)	(0.0211)	(0.0213)	(0.0212)
R&D_ratio	1.2195*	1.1951*	1.1737*	1.2158*	1.1308*	1.1536*
	(0.6242)	(0.6224)	(0.6303)	(0.6345)	(0.617)	(0.6201)
Dividend_ratio	−0.0480	−0.0530	−0.0490	−0.0480	−0.0500	−0.0460
	(0.0372)	(0.0378)	(0.0372)	0.0374)	.0367)	(0.0368)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes
N	2633	2633	2633	2633	2633	2633
Adjusted *R*-sqr	0.181	0.1797	0.1816	0.1822	0.1824	0.1809

The table is a pooled OLS regression of the dependent variable, *invest*, on credit rating, various interval dummies, the interaction term, *rating * interval dummy*, and a set of control variables. The columns examine different intervals outside the range of near-BBB credit ratings. All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.
***denote statistical significance at the 1% level.
**denote statistical significance at the 5% level.
*denote statistical significance at the 10% level.

However, the Nice Investor Service specifies that a stable outlook does not indicate a firm's operating stability. A negative outlook indicates that a rating may be a downgrade, and a developing outlook indicates that it is impossible to determine how the ratings will change.

A credit watch is a case in which it is necessary to review current ratings due to significant events or changes in information about firms' creditworthiness. A positive watch indicates that the current rating may be upgraded, and a negative watch indicates that the current ratings may be downgraded. An evolving watch means that the current rating may be upgraded or downgraded.

Table 6 reports the distribution of rating outlook and credit watch across rating levels. It shows that the total number of rating outlook is 2,163, and the percentage of outlook relative to the sample of model 1 is 82.15%(=2163/2633). The number of negative outlook is 140 in Table 6. The total number of rating watch is 81, and the negative watch observation is 52 in Table 6.

Table 7 reports the regression results regarding how investment-grade cutoff affect corporate investment decisions across the outlook list. Columns (1) to (5) of Table 7 show the sub-sample analysis results for the sample with a negative outlook. In column (1) of Table 7, the coefficient of rating is 0.0310 and statistically significant at the 1% level. Therefore, the positive relationship between credit rating levels and corporate investment appears in the negative outlook sample as well as in the full sample (column (1) of Table 4). Columns (2) to (4) show the joint effect of credit rating levels and a neighborhood of investment-grade cut-offs on corporate investment. The interval dummy variables in columns (2) to (4) indicate that the credit ratings belong to BBB+ to BB+, BBB to BB+, and BBB− to BB+. The coefficients of interaction variable are all negative and statistically significant in columns (2) to (4) of Table 7.

In column (5) of Table 7, the results show that the joint effect of credit rating levels and near-BB interval is positive. The coefficient of the interaction variable was 0.1393, which was statistically significant. This result indicates that firms with near-BB ratings exhibit a positive relationship for the interaction term, unlike firms with near-BBB intervals. Consequently, near-BBB firms for whom credit rating agencies have announced a possible rating downgrade tend to be conservative in their capital investments due to the threat of a downgrade to speculative-grade more than other firms.

Column (6) of Table 7 shows the results for the sub-sample with a positive outlook. The coefficient of the interaction variable is −0.05 and statistically insignificant. Firms with a positive outlook do not feel the threat of downgrades because credit rating agencies predict an upgrade. The effect of the threat of a downgrade to speculative-grade on corporate investment does not appear in firms that are likely to be upgraded.

Column (7) of Table 7 shows the results for the sub-sample with a stable outlook. The coefficient of the interaction variable

Table 6
Distribution of rating outlook and watch list.

	Rating outlook				Rating watch		
	Positive	Stable	Developing	Negative	Positive	Evolving	Negative
AAA	0	73	0	0	0	0	0
AA+	2	85	0	6	0	0	2
AA	3	160	0	3	0	0	3
AA−	9	228	0	4	0	0	3
A+	11	213	0	11	0	1	4
A	15	219	0	13	3	3	2
A−	13	244	0	24	1	3	6
BBB+	6	148	0	18	1	1	3
BBB	9	173	0	14	1	4	5
BBB−	7	106	0	16	0	5	3
BB+	1	61	0	5	1	2	5
BB	4	66	1	5	0	2	3
BB−	3	54	0	3	0	0	2
B+	0	22	0	4	0	1	3
B	0	24	0	5	0	0	1
B−	0	29	0	7	0	0	5
CCC	0	29	0	1	0	0	2
CC	0	3	0	0	0	0	0
C	0	2	0	1	0	0	0
D	0	0	0	0	0	0	0
Total	83	1939	1	140	7	22	52

The table shows the distribution of firms by credit rating. The left panel represents firms put on a *rating outlook* whether positive, stable, developing or negative, while the right panel shows firms put on a *rating watch*, whether positive, evolving or negative.

is −0.0262 and statistically significant at the 1% level. However, the magnitude of the coefficient is smaller than that of other sub-samples with negative outlooks.

According to the Nice Investors Service, a primary credit rating agency in Korea, a negative outlook corresponds to operational instability of a firm. Therefore, the effect of the threat of a downgrade to speculative-grade is more vital in firms with more significant threats.

Note that Table 6 shows that the number of negative watch samples was 52, and the number of positive watch samples was 7. These observations are a small number of samples for the use of various control variables, and the results may not be reliable given this, so we do not run and present results using the rating watch sample.

In Korea, Lee and Kim (2017) show a negative correlation between credit ratings and default risk. They used the K-score, distance-to-default, hazard model, and credit rating as the default prediction model and analyzed the correlation between each model. The credit ratings had the strongest correlation with the Korean K-score. Altman et al. (1995) proposed a K-score model using a discriminant analysis. The K-score is used as a model to predict Korean companies' bankruptcy probability, and the smaller the value of the K-score, the higher the bankruptcy risk. Therefore, we expect that among rated firms with the same credit rating, firms with a small K-score will have a more significant downgrade threat than those with a high K-score. This paper divides the sample into the bottom 50% and top 50% groups based on the K-score in each credit rating. Groups in which the K-score belongs to the bottom 50% have a greater risk of default than those in the top 50%.

Table 8 presents the results of analyzing the effect of investment-grade cut-offs on capital investment in sub-samples classified by K-score. In columns (1) to (4) of Table 8, we analyze the group in which the K-score is the bottom 50% of each credit rating. In columns (1) and (2), the interval dummy variable indicates that the rating belongs to BBB+ to BBB− and BBB+ to BB+ respectively. The coefficients of the interaction variable between the interval dummy variable and credit ratings are negative and statistically significant. However, the coefficient of the interval variable is 0.0432 and statistically significant at the 5% level in column (3) of Table 8. In column (3) of Table 8, the interval variable indicates that the rating belongs to BBB+ to B+. In column (4) of Table 8, the interval dummy indicates that the rating belongs to A+ to BBB+, and the coefficient of the interaction variable is positive and statistically insignificant.

In columns (5) to (8) of Table 8, we use the sub-sample with the top 50% K-score. The coefficients of the interaction variable are statistically insignificant in all columns except column (8). In column (8) of Table 8, the coefficient of interaction variables is 0.0113 and statistically significant at the 10% level. All these results are consistent with our expectations.

We also observe in Table 8 that BB+ firms are associated with a higher increase than the average increase in their investments following credit rating upgrades. When calculating the total effect of the three independent variables (rating, interval dummy, and interaction variable) related to credit rating in Model 2 of Table 8 for example, one obtains 0.0798, 0.0566, 0.0784, 0.1002, and 0.0513 from A− to BB respectively (refer to Appendix B). Therefore, similar to the results of Table 4, BB+ firms show a greater increase than the average investment-increasing trend according to credit rating level, but after that, the near-BBB interval appears to be associated with a lower investment growth than the average trend. Thus, we conclude that the threat of a downgrade to speculative grade affects firms' investment decisions. In particular, the greater the threat, the stronger the impact of investment-grade cut-offs. Conversely, the opportunity to move from speculative grade to investment grade due to investment success encourages companies to make active investment decisions. Particularly for BB+ firms, the expected benefits (increased reputation of the manager, lower cost of capital raising, and increase in shareholder value) accruing from successful investment and thus an upgrade to investment grade is higher than the expected loss when the credit rating is lowered due to investment failure.

4.4. Managers' overinvestment preference or overconfidence and investment grade cut-offs

This study has found that investment grade cut-offs reduce capital investment in near-BBB firms compared to their credit

Table 7
Results using outlook list sample.

Outlook sample:	Negative					Positive	Stable
Interval:	None (1)	BBB+BB+(2)	BBB BB+(3)	BBB−BB+(4)	BB+B+(5)	BBB+BB+(6)	BBB+BB+(7)
Constant	0.7750	0.6720	0.6930	0.5660	0.9060	3.4312***	0.3237***
	(0.6238)	(0.6151)	(0.5688)	(0.5714)	(0.5984)	(0.961)	(0.1122)
Rating	0.0310***	0.0324***	0.0355***	0.0358***	0.0289**	0.0667**	0.0058*
	(0.011)	(0.0109)	(0.0115)	(0.0115)	(0.0124)	(0.0257)	(0.0031)
Interval Dummy		0.7939**	0.8924***	0.7643***	−1.0909***	0.5930	0.3370***
		(0.3113)	(0.2137)	(0.2079)	(0.3723)	(0.5881)	(0.1215)
Rating * Interval Dummy		−0.0641**	−0.0708***	−0.0601***	0.1393***	−0.0500	−0.0262***
		(0.0254)	(0.0178)	(0.0173)	(0.0438)	(0.0472)	(0.0099)
KZ index	−0.0050	−0.0060	−0.0050	−0.0059*	−0.0060	−0.0020	−0.0028***
	(0.0042)	(0.0043)	(0.0034)	(0.0034)	(0.0037)	(0.0059)	(0.0008)
Size	−0.0350	−0.0330	−0.0350	−0.0320	−0.0380	−0.1738***	−0.0050
	(0.0246)	(0.0239)	(0.0226)	(0.0227)	(0.0238)	(0.0463)	(0.0053)
Leverage	0.1340	0.1460	0.1310	0.1700	0.1710	0.3130	−0.0602*
	(0.1564)	(0.1589)	(0.1451)	(0.1467)	(0.1588)	(0.2703)	(0.0359)
M/B ratio	−0.0940	−0.0870	−0.1140	−0.0880	−0.1410	0.3124**	0.0343**
	(0.1273)	(0.1263)	(0.1168)	(0.1226)	(0.1235)	(0.1381)	(0.0166)
Cash_incre	0.2420	0.3800	0.3130	0.1750	0.2570	0.9590	0.1180
	(0.7138)	(0.7206)	(0.6612)	(0.6429)	(0.7126)	(0.8099)	(0.1269)
ROA	−0.8063*	−0.9409**	−0.9615**	−0.7706**	−0.7892**	1.3910	0.5357***
	(0.4056)	(0.3753)	(0.3791)	(0.3813)	(0.3629)	(0.9089)	(0.1082)
Salesgrow_ratio	0.3439**	0.3317**	0.3265**	0.3522**	0.3369**	0.0620	0.0503**
	(0.1513)	(0.1453)	(0.1463)	(0.1442)	(0.1348)	(0.1047)	(0.0237)
R&D_ratio	3.1590	3.1290	3.2560	2.7130	3.3640	1.2190	0.7370
	(4.144)	(4.1448)	(4.1146)	(4.1984)	(4.1944)	(5.8384)	(0.7269)
Dividend_ratio	0.2290	0.2630	0.3530	0.3040	0.3802	0.1360	−0.0520
	(0.2332)	(0.2399)	(0.2493)	(0.2408)	(0.2434)	(0.3194)	(0.0466)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	140	140	140	140	140	83	1939
Adjusted *R*-sqr	0.1649	0.1782	0.2296	0.2367	0.2386	0.0315	0.1839

The table is a pooled OLS regression of the dependent variable, *invest*, on credit rating, various interval dummies, the interaction term, *rating * interval dummy*, and a set of control variables using the sample of *rating outlook* firms. The columns examine different intervals representing near-BBB credit ratings and intervals outside the range of near-BBB credit ratings. All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.

***denote statistical significance at the 1% level.

**denote statistical significance at the 5% level.

*denote statistical significance at the 10% level.

rating levels. Hypothesis 2 suggests that the threat of a downgrade to speculative grade prevents managers from overinvesting decisions. It predicts that the effect of investment-grade cut-offs on investment is more active when managers have overinvestment preferences or overconfidence. We measure managerial overinvestment preference and overconfidence using four proxies (see Section 3.3).

Table 9 reports the regression results whether the investment-grade cut-offs have a different impact on investment between the overinvestment (or overconfidence) group and non-overinvestment (or non-overconfidence) group. The interval dummy variable indicates whether ratings belongs to BBB+ to BB+. In column (1) and column (2) of Table 9, we present the regression results about two groups classified by *Overinvest1*. In column (1), the coefficient of the interaction variable between *Rating* and *Interval Dummy* is 0.008, and it is statistically not significant. In column (2), the coefficient of the interaction variable is −0.0343, and it is statistically significant at the 5% level. These results indicate that the effect of investment-grade cut-offs on capital investment is active when the firms tended to overinvest in $t-1$ year. In column (3) and column (4) of Table 9, we report regression results about two groups classified by *Overinvest2*, and the results are similar to the results of column (1) and (2). The effects of investment grade cut-offs are only statistically significant when the firms have tended to overinvest. In column (5) and (6) of Table 9, we find that the near-BBB firms which are cash-rich tend to reduce their capital investment despite their improved ratings. In column (6), the coefficient of interaction variable is −0.0218 and it is statistically significant at the 5% level. These results are consistent with hypothesis 2 and support the conjecture that the investment grade cut-offs prevent the near-BBB firms' managers from overinvesting decisions. The near-BBB firms with overinvestment preference (*Overinest1*-Yes and *Overinvest2*-Yes) or a high likelihood of overinvestment (*Cash rich*-Yes) make more conservative investment decisions than those with non-overinvestment preference (*Overinvest1*-No and *Overinvest2*-No) or a low likelihood of overinvestment (*Cash rich*-No). In column (7) and (8) of Table 9, we compare whether the regression results depend on overconfidence groups (*Overconfidence*-No vs *Overconfidence*-Yes). In column (7), the coefficient on the interaction variable is −0.0141 and it is statistically significant at the 10% level. In column (8), the coefficient on the interaction variable

Table 8
Result of Pooled OLS using samples divided by K-score (default risk) rank.

K-score sample:	Bottom 50%				Top 50%			
Interval:	BBB+BBB−(1)	BBB+BB+(2)	BBB+B+(3)	A+BBB+(4)	BBB+BBB−(5)	BBB+BB+(6)	BBB+B+(7)	A+BBB+(8)
Constant	0.026	−0.017	0.092	0.055	0.4862***	0.4606***	0.471***	0.5317***
	(0.2011)	(0.1969)	(0.1946)	(0.2012)	(0.1279)	(0.1247)	(0.1297)	(0.132)
Rating	0.0054*	0.0057*	0.005	0.0063**	0.0082***	0.0081***	0.0081***	0.0085***
	(0.0031)	(0.0032)	(0.0033)	(0.0031)	(0.0028)	(0.0027)	(0.0028)	(0.0028)
Interval Dummy	0.2780	0.3400***	−0.3913**	−0.068	0.193	0.188	−0.133	−0.1747*
	(0.1704)	(0.1214)	(0.164)	(0.0956)	(0.1484)	(0.1175)	(0.1331)	(0.0926)
Rating * Interval Dummy	−0.023*	−0.0275***	0.0432**	0.0030	−0.015	−0.015	0.017	0.0113*
	(0.0139)	(0.01)	(0.0186)	(0.0065)	(0.0121)	(0.0097)	(0.0148)	(0.0064)
KZ index	−0.0017*	−0.0018*	−0.0018*	−0.0018*	−0.0028***	−0.0029***	−0.0028***	−0.0029***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size	−0.006	−0.005	−0.007	−0.008	−0.0119**	−0.011*	−0.0113*	−0.0138**
	(0.0054)	(0.0053)	(0.0054)	(0.0053)	(0.006)	(0.0059)	(0.0061)	(0.0062)
Leverage	−0.037	−0.039	−0.036	−0.026	−0.001	0.000	0.004	0.013
	(0.0509)	(0.0522)	(0.0511)	(0.0512)	(0.0478)	(0.0471)	(0.0462)	(0.0474)
M/B ratio	0.0856***	0.0846***	0.0832***	0.0807***	0.015	0.014	0.011	0.008
	(0.0263)	(0.0262)	(0.0259)	(0.0265)	(0.0205)	(0.0204)	(0.0205)	(0.0207)
Cash_incre	0.161	0.173	0.168	0.173	0.045	0.045	0.037	0.036
	(0.1541)	(0.1557)	(0.1561)	(0.1541)	(0.1606)	(0.1595)	(0.1588)	(0.1613)
ROA	0.4472***	0.4303***	0.4445***	0.4638***	0.635	0.641***	0.643	0.6549***
	(0.1327)	(0.1326)	(0.1325)	(0.1344)	(0.1209)	(0.1206)	(0.1201)	(0.119)
Salesgrow_ratio	0.092***	0.0917***	0.0955***	0.094***	0.038	0.038	0.039	0.037
	(0.0266)	(0.0264)	(0.0271)	(0.0265)	(0.0316)	(0.0313)	(0.031)	(0.031)
R&D_ratio	0.451	0.456	0.417	0.559	1.377	1.292	1.335	1.4714*
	(0.962)	(0.9638)	(0.9626)	(0.9727)	(0.8681)	(0.8547)	(0.8647)	(0.8823)
Dividend_ratio	−0.063	−0.053	−0.070	−0.053	−0.058	−0.056	−0.051	−0.057
	(0.0569)	(0.0567)	(0.0557)	(0.057)	(0.0553)	(0.0551)	(0.0548)	(0.0548)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1311	1311	1311	1311	1322	1322	1322	1322
Adjusted *R*-sqr	0.145	0.15	0.15	0.147	0.211	0.213	0.212	0.212

The table is a pooled OLS regression of the dependent variable, *invest*, on credit rating, various interval dummies, the interaction term, *rating * interval dummy*, and a set of control variables by dividing the sample into the bottom 50% and top 50% firms based on the *K-score (default risk)*. The columns examine different intervals representing near-BBB credit ratings and intervals outside the range of near-BBB credit ratings. All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.

***denote statistical significance at the 1% level.

**denote statistical significance at the 5% level.

*denote statistical significance at the 10% level.

is −0.0292, and it is statistically significant at the 10% level. The investment grade cut-offs tend to reduce the capital investment of firm with near-BBB interval, and the impact is twice as large in the overconfidence group as that in firms whose managers are not overconfident.

Consequently, the results in Table 9 suggest that the threat of a downgrade to speculative-grade influences managers to make conservative investment decisions for the next year when the firms overinvest or the managers have over-investment preferences. We also find that investment grade cut-offs are more affected by managers with overconfidence. Therefore, investment grade cut-offs provide near-BBB firms' managers an effective investment incentive to prevent overinvestment. This paper suggests that the threat of a downgrade to speculative grade makes managers make investment decisions more conservative and risk-averse.

However, BB+ companies appear to make active investment decisions because it is better for managers, creditors, and shareholders when their firm is upgraded to investment grade through successful investment than to remain speculative grade due to investment failure. For example, if we calculate the total effect of the three independent variables (rating, interval dummy, and interaction variable) related to credit rating in Model 1 of Table 9, we obtain 0.1372, 0.1133, 0.1378, 0.1623, 0.1868 and 0.0882 from A− to BB respectively (refer to Appendix B). Thus, BB+ firms aggressively increase investment, and the near-BBB interval firms gradually decrease investment, which starts increasing again from A−.

4.5. Do investment grade cut-offs provide managers the precautionary motive?

In columns (5) and (6) of Table 9, the effect of investment grade cut-offs on reducing corporate investment compared to their debt capacity or creditworthiness was stronger in cash-rich firms than in non-cash-rich firms. Following precautionary motives, firms save their cashable assets to prepare for future financial constraints (Opler et al., 1999). Thus, the results of columns (5) and (6) in Table 9 do not support the prediction that managers who fear the downgrade to speculative grade reduce their capital investment according to precautionary motives.

Table 10 reports the regression results whether the investment grade cut-offs provide the near-BBB firms' managers with

Table 9
Result of Pooled OLS using the measures for overinvestment and overconfidence.

	Overinvet1		Overinvest2		Cash rich		Overconfidence	
	No (1)	Yes (2)	No (3)	Yes (4)	No (5)	Yes (6)	No (7)	Yes (8)
Constant	0.2740	0.0040	0.1751*	0.6192***	0.1910	0.4598***	0.2921***	0.1990
	(0.2076)	(0.1774)	(0.0961)	(0.0875)	(0.1338)	(0.1206)	(0.0979)	0.1951)
Rating	−0.0030	0.0098**	0.0059***	0.0000	0.0064**	0.0048**	0.0055**	0.0101*
	(0.0043)	(0.0045)	(0.0019)	(0.0022)	(0.0031)	(0.0024)	(0.0022)	(0.0057)
Interval Dummy	−0.1130	0.4318***	−0.0520	0.1624**	0.1720	0.2834**	0.1771*	0.3776*
	(0.2341)	(0.1603)	(0.083)	(0.0802)	(0.1086)	(0.1278)	(0.0924)	(0.2011)
Rating * Interval Dummy	0.0080	−0.0343**	0.0040	−0.0130*	−0.0140	−0.0218**	−0.0141*	−0.0292*
	(0.0191)	(0.0138)	(0.0068)	(0.0066)	(0.0089)	(0.0105)	(0.0076)	(0.0164)
KZ index	−0.0045**	0.0020	0.0000	−0.0010	0.0000	−0.0050	−0.0025***	0.0000
	(0.0021)	(0.0018)	(0.0006)	(0.0008)	(0.0008)	(0.0011)	(0.0008)	(0.0013)
Size	−0.0010	−0.0060	0.0020	−0.0120***	−0.0020	−0.0104*	−0.0050	−0.0162**
	(0.009)	(0.0084)	(0.0042)	(0.0043)	(0.0061)	(0.0054)	(0.0045)	(0.0072)
v Leverage	0.0020	−0.0180	−0.0340	−0.0200	−0.0580	0.0260	−0.0250	−0.0130
	(0.0874)	(0.0688)	(0.0309)	(0.0294)	(0.0401)	(0.0448)	(0.0391)	(0.0663)
M/B ratio	0.0090	0.0703**	0.0030	0.0333***	0.0539***	0.0180	0.0440***	0.0500
	(0.0536)	(0.032)	(0.0172)	(0.012)	(0.0182)	(0.0243)	(0.0169)	(0.0337)
Cash_incre	0.7595*	0.0680	0.0480	0.0820	0.0940	0.1060	0.0550	0.1800
	(0.3975)	(0.2734)	(0.1151)	(0.1173)	(0.1697)	(0.1335)	(0.1388)	(0.2017)
ROA	0.6302***	0.8013***	0.3744***	0.0580	0.6129***	0.4823***	0.5547***	0.8035***
	(0.2365)	(0.1981)	(0.0875)	(0.0838)	(0.119)	(0.1276)	(0.0967)	(0.2559)
Salesgrow_ratio	0.1219**	0.0260	0.0625***	0.0140	0.0855***	0.0517*	0.0553**	0.1366***
	(0.0518)	(0.0493)	(0.0204)	(0.0187)	(0.028)	(0.0289)	(0.0222)	(0.045)
R&D_ratio	−1.5630	2.1524*	0.3010	−0.5930	2.3141***	−0.7820	0.4440	4.4176***
	(1.8962)	(1.1433)	(0.6956)	(0.5903)	(0.8611)	(1.0885)	(0.6826)	(1.4053)
Dividend_ratio	−0.0590	−0.0080	0.0130	−0.0907**	−0.0390	−0.0520	−0.0380	−0.075
	(0.0837)	(0.0843)	(0.0362)	(0.0446)	(0.0512)	(0.0576)	(0.0443)	(0.067)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	397	451	1469	1164	1452	1181	1909	724
Adjusted *R*-sqr	0.1252	0.2469	0.2912	0.2868	0.1892	0.1906	0.1865	0.1855

The table is a pooled OLS regression of the dependent variable, *invest*, on credit rating, the *interval dummy* representing firms in the near-BBB interval (BBB+ to BB+), the interaction term, *rating * interval dummy*, and a set of control variables. The sample is classified based on various proxies for overinvestment and overconfidence (*Overinvest1, Overinvesr2, Cash rich, Overconfidence*). All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.

***denote statistical significance at the 1% level.

**denote statistical significance at the 5% level.

*denote statistical significance at the 10% level.

precautionary motives. Hypothesis 3a predicts the investment grade cut-offs reduce the near-BBB firms' investment compared to their creditworthiness during the financial crisis (2008–2009). In model (1) and model (2) of Table 10, the regression results do not support Hypothesis 3a. In model (1), the coefficient on interaction variable between rating level and near-BBB intervals is 0.020, and it is not statistically significant.

To test our hypothesis 3b, we create two measure for corporate cash holdings following Xu et al. (2019). *Cashholding1* is the cash and cash equivalent scaled by net asset, and net asset is calculated as total asset minus cash and cash equivalent. *Cashholding2* is the ratio of cash and cash equivalents to total assets. Models (3) and (4) of Table 10 report the effect of investment grade cut-offs on corporate cash holdings. In model (3), the coefficient on interaction variable is −0.001 and it is not statistically significant. The results of model (4) are similar to model (3); these results do not support our Hypothesis 3b.

Consequently, the threat of a downgrade to speculative grades does not provide managers with a precautionary motive. Thus, the results suggest that the effect of investment-grade cut-offs on corporate investment is not based on precautionary savings.

5. Robustness checks

5.1. Endogeneity issue

Credit rating agencies use sophisticated methodologies to evaluate managerial, affiliate, industry, business, and financial risks. They measure the creditworthiness of a firm through credit ratings. Therefore, companies have other characteristics that are difficult to observe, depending on the credit rating intervals. The rated firms with credit ratings in the BBB interval may have different characteristics and investment opportunities from firms in the other intervals. This study tackles the endogeneity issue using propensity score matching.

This study used the near-BBB interval (BBB+, BBB, and BBB−) sample (treatment group) and matched it with the A interval (AA−, A+, and A) sample and BB interval (BB+, BB, and BB−) sample (control group). We use several variables to narrow the differences in unobservable features that exist between credit ratings. In the matching procedure, we use asset structure (= tangible asset/total assets), capital structure (= market value of equity/book value of total debt), profitability (= net income/total assets), and free cash flow (= (operating cash flow – depreciation)/ total assets) as the matching variables. The Korea Investor

Table 10
Regression results for precautionary motives.

	Financial crisis		Cashholdings	
	Yes (1)	No (2)	Cashholding1 (3)	Cashholding2 (4)
Constant	0.5254*	0.3080***	0.0932**	0.1247**
	(0.2777)	(0.0919)	(0.0424)	(0.0552)
Rating	0.0245**	0.0047**	−0.0010	−0.0020
	(0.0099)	(0.0020)	0.0009)	(0.0016)
Interval Dummy	0.0150	0.2673***	0.0020	−0.0040
	(0.3504)	(0.0849)	0.0291)	(0.0372)
Rating*Interval Dummy	0.0020	−0.0216***	−0.0010	0.0000
	(0.0281)	(0.0070)	0.0024)	(0.0031)
KZ index	−0.006	−0.0022***	−0.0009***	−0.0012***
	(0.004)	(0.0007)	(0.0003)	(0.0003)
Size	−0.0287*	−0.005	0.0000	0.0000
	(0.0173)	(0.0042)	(0.0019)	(0.0027)
Leverage	0.0680	−0.0310	−0.0180	−0.0360
	(0.1071)	(0.0353)	(0.0141)	(0.0279)
M/B ratio	0.0620	0.0438***	0.0139**	0.0173*
	(0.0628)	(0.0150)	(0.0066)	(0.0089)
Cash_incre	0.0890	0.0850	0.3382***	0.4461***
	(0.4736)	(0.1138)	(0.0446)	(0.0892)
ROA	0.0270	0.5872***	0.0370	0.0160
	(0.3351)	(0.0861)	(0.0331)	(0.0662)
Salesgrow_ratio	−0.0260	0.0792***	0.0010	0.0050
	(0.0756)	(0.0225)	(0.0056)	(0.0091)
R&D_ratio	0.0430	1.2230*	0.3040	0.4040
	(2.0804)	(0.6724)	(0.2892)	(0.3599)
Dividend_ratio	−0.0770	−0.0500	−0.0030	−0.0130
	(0.1461)	(0.0378)	(0.0154)	(0.0201)
Year controls	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes
N	282	2351	2633	2351
Adjusted *R*-sqr	0.0879	0.1822	0.2093	0.1822

The table examines precautionary motive as a basis for the reduced investment in near-BBB firms. For columns (1) and (2), the sample is classified based on financial crisis period and we run a pooled OLS regression of the dependent variable, *invest*, on credit rating, the *interval dummy* representing firms in the near-BBB interval (BBB+ to BB+), the interaction term, *rating * interval dummy*, and a set of control variables. For columns (3) and (4), we replace the dependent variable with two proxies for corporate cash holding (*Cashholding1, Cashholding2*). All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.

***denote statistical significance at the 1% level.

**denote statistical significance at the 5% level.

*denote statistical significance at the 10% level.

Service, which is a major credit rating agency in Korea, considers profitability, cash flow, and financial structure as key evaluation factors when assessing a company's financial position. Jeon and Lee (2015) find that the ratio of net income to total assets and the ratio of operating cash flow to total assets have statistically significant effects on corporate bond ratings. In addition, a high fraction of tangible assets is related to the ability to borrow (Faccio and Masulis, 2005).

Because industrial risks are important for credit ratings, we match only among companies in the same industry. However, following the Korea Investor Service, the importance of assessment items varies by company and business area. As a result, detailed evaluation methods vary. Therefore, even if we use the four variables related to bond ratings, there is a limitation. To mitigate these limitations, we use all the variables used in this study as matching variables and construct a second matched sample.

When matching them, we narrowed the closeness of the matched samples using the pooled estimate of common standard deviations to show the consistency of the results. We used the SAS software's *caliper* = *r* option, which refers to *r* times the pooled estimate of the common standard deviation. Following Austin (2011), approximately 99% of the bias associated with the measured confounders could be reduced by using 0.2. Therefore, we use 0.2 as the caliper width option.

Model (1) to (6) of Table 11 report the results of analyzing our main hypothesis for samples whose credit ratings belong to BBB+ to BBB− and BBB+ to BB+. In models (1) and (2) of Table 11, this study used a raw sample, and the coefficients of the interaction variable are negative and statistically significant. These results are similar to the results in Table 4 using the full sample. In model (3) to (6) of Table 11, we use the two matched samples discussed earlier: *Matched 1* in Table 11 is the sample that uses the four variables related to bond ratings for the matching while *Matched 2* in Table 11 uses all the variables in this study. We find that the coefficients of the interaction variables are negative and statistically significant. Thus, we conclude that the main result of this study is robust in the matched samples.

Table 11
Results for the matched sample.

Sample	Raw sample		Matched 1		Matched 2		Matched 3	Matched 4
Interval:	BBB+BBB−(1)	BBB+BB+(2)	BBB+BBB−(3)	BBB+BB+(4)	BBB+BBB−(5)	BBB+BB+(6)	BBB+BB+(7)	BBB+BB+(8)
Constant	0.5392***	0.5024***	0.3376**	0.2966**	0.3792*	0.3349*	−0.1410	0.1790
	(0.1257)	(0.1223)	(0.1566)	(0.1500)	(0.1979)	(0.1904)	(0.6371)	(0.2741)
Rating	0.002	0.0040	0.0020	0.0050	0.0030	0.0060	0.0508*	0.0311**
	(0.0033)	(0.0034)	(0.0043)	(0.0043)	(0.0048)	0.0051)	(0.0259)	(0.0129)
Interval Dummy	0.1699*	0.2202***	0.3239***	0.2811**	0.1960	0.2770**	0.8252**	0.6157**
	(0.1008)	(0.0849)	(0.1185)	(0.1161)	(0.1231)	(0.1224)	(0.3574)	(0.281)
Rating * Interval Dummy	−0.0139*	−0.0175**	−0.0254***	−0.0214**	−0.0167*	−0.0225**	−0.0805**	−0.0452**
	(0.0082)	(0.0068)	(0.0096)	(0.0094)	(0.0100)	(0.0097)	(0.0339)	(0.0209)
KZ index	−0.0023***	−0.0024***	−0.0025**	−0.0026**	−0.0010	−0.0020	−0.0061***	−0.0020
	(0.0007)	(0.0007)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0021)	(0.0017)
Size	−0.0139**	−0.0135**	−0.0100	−0.0100	−0.0140	−0.0140	−0.0090	−0.0198**
	(0.0061)	(0.006)	(0.0076)	(0.0075)	(0.0095)	(0.0094)	0.0292)	(0.0093)
Leverage	−0.0150	−0.0140	−0.0410	−0.0360	−0.0850	−0.0850	0.1160	−0.091
	(0.0392)	(0.0387)	(0.0497)	(0.0488)	(0.063)	(0.0636)	0.1074)	(0.0879)
M/B ratio	0.0620***	0.0605***	0.015	0.0130	0.0776*	0.0729*	−0.0580	0.0696*
	(0.0202)	(0.0201)	(0.0294)	(0.0293)	(0.0396)	(0.039)	0.087)	(0.0405)
Cash_incre	0.0790	0.0830	0.0500	0.0670	−0.0050	0.0030	0.2970	0.0010
	(0.1218)	(0.1212)	(0.1805)	(0.1785)	(0.2121)	(0.2107)	0.4609)	(0.2994)
ROA	0.6358***	0.6391***	0.6389***	0.6550***	0.6524***	0.6507***	0.1670	0.6176***
	(0.1015)	(0.1007)	(0.1299)	(0.1264)	(0.1579)	(0.1559)	0.293)	(0.2211)
Salesgrow_ratio	0.0590**	0.0583**	0.073**	0.0715**	0.0210	0.0200	0.0060	0.0912**
	(0.0265)	(0.0263)	(0.0327)	(0.0331)	(0.0377)	(0.0374)	0.0719)	(0.046)
R&D_ratio	1.9272**	1.8654**	2.3887***	2.3702**	1.5240	1.4610	−1.1400	3.3666**
	(0.7859)	(0.7783)	(0.9162)	(0.9171)	(1.1288)	(1.1269)	.8399)	(1.4146)
Dividend_ratio	−0.0460	−0.0460	−0.0890	−0.0860	−0.1100	−0.1090	0.5793***	−0.1438*
	(0.0436)	(0.0438)	(0.0608)	(0.0607)	(0.0688)	(0.0698)	(0.2162)	(0.0822)
Year controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1821	1821	1018	1018	854	854	210	512
Adjusted *R*-sqr	0.1600	0.1631	0.1536	0.1554	0.1593	0.1643	0.2186	0.2078

The table is a matched sample analyses of samples created used various control groups when applying the propensity score matching described in the text. We regress the dependent variable, *invest*, on credit rating, the *interval dummy* representing firms in the near-BBB interval (BBB+ to BBB− and BBB+ to BB+), the interaction term, *rating * interval dummy*, and a set of control variables. All models include year and industry effects. Clustered standard errors at firm level are reported in parentheses. All variables are defined in Appendix A.

***denote statistical significance at the 1% level.

**denote statistical significance at the 5% level.

*denote statistical significance at the 10% level.

This study also used the A-interval and BB-interval samples simultaneously as a control group in the matching process. Model (7) of Table 11 presents the analysis results for the matched sample (*Matched 3*) using only the BB-interval sample as the control group. Model (8) of Table 11 reports the results for the matched sample (*Matched 4*) using only the A-interval sample as the control group. This study confirms that the effect of the threat of a downgrade to speculative grade on corporate investment is statistically significant, even if only the BB-interval or the A-interval sample is used as a control group in the matching process.

6. Discussion: Non-linear relationship

Numerically interpreting the main regression analyses results so far, following a credit rating improvement, BB+ firms invest more than the average investment trend, and BBB+ firms make lower investment (Refer to Appendix B). However, one ambiguous result is noteworthy. The companies most likely to move from investment grade to speculative grade due to a credit rating downgrade are companies rated BBB−. However, in the main table of this paper, we find that the investment of BBB− firms is smaller than BB+ firms, but greater than that of near-A rated firms. This phenomenon seems to contrast the idea of the threat of a downgrade to speculative grade, which is the main idea of this paper.

A number of reasons may account for this phenomenon. First, even if interaction variables are used, the linear regression model has a limitation in that it assumes a linear relationship in the specific interval. When the interval dummies and interaction variables are used, the interaction terms and interval dummies reflect a linear relationship within the specific interval that it relates to: in this case, a linear decrease from the aggressive investment behavior of BB+ firms. Another possible reason is that BBB− firms would naturally likely become speculative grade if they make little attempts to improve their firm fundamentals while making conservative investments so it is possible to observe both conservative and aggressive decision making by BBB− companies in the near-BBB interval. Finally, in this paper, the proxy that measures a company's capital investment decision-making is the growth rate of fixed assets, not the absolute amount of capital investment. In other words, it indicates the percentage increase

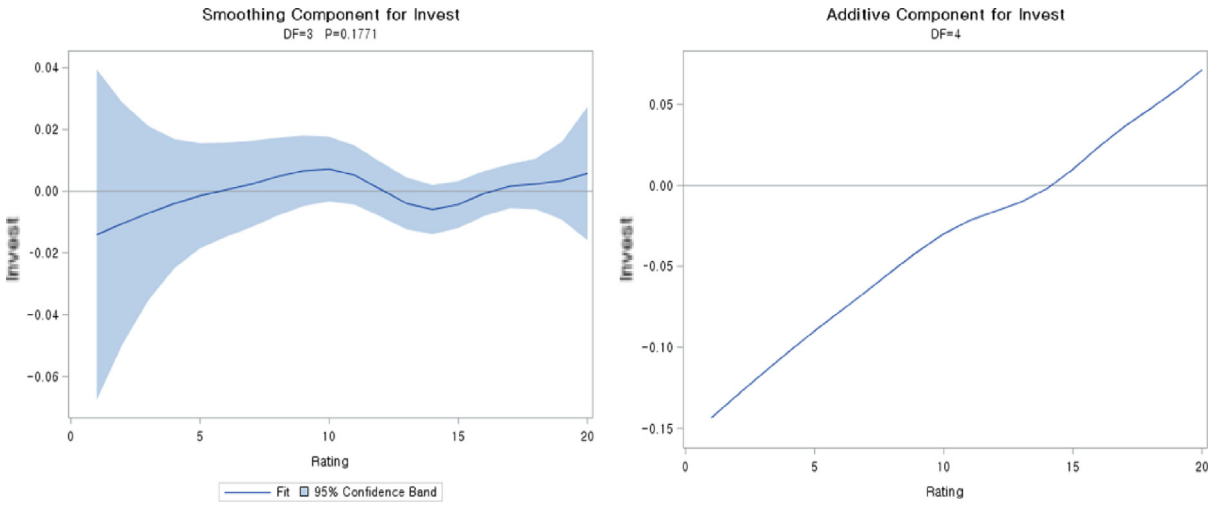

Fig. 1. Smoothing component plots using a cubic spline.

in fixed asset investment in the current year compared to the previous year. Thus, our results suggest that BB+ firms show a higher growth rate and the near-BBB interval firms show a relatively lower growth rate, but it does not mean the absolute size of investment by near-BBB interval firms decrease. For robustness, we test the non-linear relationship between credit ratings and corporate capital investment in several ways.

Fig. 1 shows two plots produced by the generalized additive model using a cubic smoothing spline. The left plot in Fig. 1 shows that the smoothing component decreases from Rating 10 (BB+) and then increases after Rating 14 (A−). The right plot in Fig. 1 shows that the additive components increase linearly with the credit rating, whereas they decrease from Rating 10 (BB+) to Rating 14 (A−) and then begin to show a linear trend again. These results support the discussion so far that the positive relation between investment and credit rating reduces or disappears in the near-BBB interval. We confirm similar results using both non-parametric and semi-parametric tests, but due to space constraints, these additional figures will be available upon request from the authors.

7. Conclusion

This study notes that credit ratings are divided into investment and speculative grades and argues that this characteristic of credit ratings has a special consequence. When rated firms experience a downgrade, the downgrade to the speculative grade causes firms to receive more penalties than other downgrades. Conversely, firms that are currently graded as speculative will remain speculative grade even if their investment fail, but have the possibility of being upgraded to investment grade if their investment is successful. Thus, the gains from a successful investment outweigh the losses from a failed investment for such firms. This study predicts that managers of firms with credit ratings belonging to the near-BBB interval fear a downgrade to speculative grade. Thus, managers try to reduce over-investment to prevent downgrades.

We have shown that as credit rating increases, the growth rate of fixed assets excluding depreciation increases on average, but this increasing behavior is altered around the near-BBB interval. In particular, BB+ firms showed a larger than average increase, which then gradually decreases until BBB+. This is because BB+ firms desire to get upgraded to investment grade, and near-BBB interval firms are reluctant to get downgraded to the speculative grade. In other words, BB+ make active investment decisions to become investment grade, but near-BBB interval firms tend to make conservative investment decisions.[2] A caution to note in the interpretation of our results is that BBB− firms would naturally likely become speculative grade if they make little attempts to improve their firm fundamentals while making conservative investments so it is possible to observe both conservative and aggressive decision making by BBB− companies in the near-BBB interval. However, taking the results of the regression analyses and the checks of the non-linear relationship together, it can be seen that BB+ firms make relatively aggressive investments while near-BBB interval firms make relatively conservative investment decisions. This is a new and exciting finding that the upper cut-off of speculative grade firms and the lower cut-off of investment grade firms exhibit different behavior than the average investment trend.

In particular, the conservative investment tendency of near-BBB interval firms is due to the investment grade cut-offs that provide managers with conservative investment decision incentives, which reduce managers' overinvestment preference or overconfidence. Rated firms have the ability to access the public debt market, and firms with investment grades have low financial constraints. Managers have high discretion in investment decisions (Jensen, 1986; Harford and Uysal, 2014) and less precautionary motives (Opler et al., 1999; Han and Qiu, 2007; Sun and Wang, 2015). Therefore, managers of investment-grade firms may have over-investment preferences or exhibit overconfidence. We present evidence that the phenomenon in which near-BBB firms fear a downgrade to speculative grade and thus tend to reduce their capital investment is evident in firms with over-investment preference or overconfidence.

Our study differs from recent work on the impact of rating agencies on corporate decisions. Kisgen (2019) shows that rated firms change their investment decisions based on the adjustment methodology of credit rating agencies. However, here we examine the impact of credit ratings on corporate governance and managerial behavior. Our evidence suggests that the threat

[2] This paper is motivated by the reality that credit ratings are clearly divided into investment and speculative grades in the bond market at the BBB-/BB+ threshold. Some other works explore an A-/BBB+ threshold suggesting that a downgrade from A- to BBB+ has significant implications for bond trading but this paper does not explore the A-/BBB+ threshold.

Table A.1
Definition of variables.

Invest	(Ending tangible asset − Beginning tangible asset + Depreciation of tangible asset)/Lagged tangible asset
Cashholding1	Cash and cash equivalents/Net asset (Net asset = Total asset − Cash and cash equivalents)
Cashholding2	Cash and cash equivalents/Total asset
Rating	Takes the value 20 for AAA, 19 for AA+, …and 1 for D sequentially
Interval dummy	Take the value 1 if a firm's rating belongs to a specific interval; otherwise, it is zero
KZ index	−1.002 (Cashflow/K) + 0.283(Q) + 3.139 (Debt/Capital) − 39.368 (Div/K) − 1.315 (Cash/K). K is property, plant, and equipment (PPE). However, in Korea, there is no data that directly represents PPE. This study use tangible asset as a proxy for PPE following Korean literature (Kim and Shin, 2017)
Size	Natural log of market capitalization
Leverage	Total debt/Total asset
Market to book ratio	(Book value of debt + Market value of equity)/Total asset
Cash_incre	(Ending cash holding − Beginning cash holding)/Total asset
ROA	Net profit/Total asset
Salesgrow_ratio	(Sales − Lagged sales)/Lagged sales
R&D_ratio	R&D expenditure/Total asset
Dividend_ratio	(Cash dividend + Stock dividend)/Operating profit

of a downgrade to speculative-grade has a disciplinary effect on managers. Therefore, this study has implications for research on the role of rating agencies as external control mechanisms in emerging markets. Since firms are likely to have weak governance in emerging markets (Claessens et al., 2000), this study makes a critical contribution.

This paper however was unable to consider all the other factors that can influence capital investment decisions aside the threat of downgrade. Some other influences which have been explored in the literature include the information channel (Wansley et al., 1992), the regulatory channel (Da and Gao, 2009), the covenant channel (Kisgen, 2007), and other non-regulatory channels (Chen et al., 2014; Abad et al., 2021). In unreported results, our main results remain qualitatively same when a fixed effects regression framework is employed. However, our results are limited to the extent that the unexplored and omitted possible influences and channels are not time-invariant.

This paper concludes by suggesting attractive topics for research on credit rating and financial policy. Other works could focus on whether the impact of investment grade cut-offs may be more significant in large-scale investments such as M&As. Investment grade cut-offs can also significantly impact policies that affect a firm's internal capital, such as dividend policies: this can be another interesting research agenda. Finally, other corporate actions taken by firms in the investment grade–speculative grade (IG–SG) threshold such as cutting expenditure, increasing profitability, increasing liquidity and reducing short-term debt ratio can be explored.

CRediT authorship contribution statement

Seonhyeon Kim: Conceptualization, Methodology, Software, Formal analysis, Writing – original draft. **Ephraim Kwashie Thompson:** Conceptualization, Validation, Writing – review & editing. **Changki Kim:** Conceptualization, Validation, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

See Table A.1.

Appendix B

See Table B.1.

Table B.1
Total effect of rating level, interval dummy and the interaction term on capital investment.

	Table 4 (Base) model 4		Table 8 (High default risk) model 2		Table 9 (Overinvest) model 2	
	Total effect	Difference	Total effect	Difference	Total effect	Difference
D	0.0058		0.0057		0.0098	
C	0.0116	0.0058	0.0114	0.0057	0.0196	0.0098
CC	0.0174	0.0058	0.0171	0.0057	0.0294	0.0098
CCC	0.0232	0.0058	0.0228	0.0057	0.0392	0.0098
B−	0.0290	0.0058	0.0285	0.0057	0.049	0.0098
B	0.0348	0.0058	0.0342	0.0057	0.0588	0.0098
B+	0.0406	0.0058	0.0399	0.0057	0.0686	0.0098
BB−	0.0464	0.0058	0.0456	0.0057	0.0784	0.0098
BB	0.0522	0.0058	0.0513	0.0057	0.0882	0.0098
BB+	0.1063	0.0541	0.1220	0.0707	0.1868	0.0986
BBB−	0.0938	−0.0125	0.1002	−0.0218	0.1623	−0.0245
BBB	0.0813	−0.0125	0.0784	−0.0218	0.1378	−0.0245
BBB+	0.0688	−0.0125	0.0566	−0.0218	0.1133	−0.0245
A−	0.0812	0.0124	0.0798	0.0232	0.1372	0.0239
A	0.087	0.0058	0.0855	0.0057	0.147	0.0098
A+	0.0928	0.0058	0.0912	0.0057	0.1568	0.0098
AA−	0.0986	0.0058	0.0969	0.0057	0.1666	0.0098
AA	0.1044	0.0058	0.1026	0.0057	0.1764	0.0098
AA+	0.1102	0.0058	0.1083	0.0057	0.1862	0.0098
AAA	0.116	0.0058	0.114	0.0057	0.196	0.0098

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