Effects of credit rating change on risk-taking

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Abstract

This thesis investigates whether there are changes in risk-taking behavior following an upgrade or downgrade in credit ratings. Research on effects of rating changes on capital markets is well-documented but the literature on how rating changes may affect firm behavior is sparse. Following, a downgrade in credit rating, managers may increase risk-taking to improve their overall performance or reduce risk-taking following upgrades to ensure that their performance is assessed more on the basis of what they may deem success in the form of an upgrade. Using a sample of firms trading in the U.S from 1994-2013, we find evidence of change in risk-taking behavior. We use cross-sectional regressions and matching using propensity scores and Barber and Lyon (1997) methodology to measure changes in risk-taking and we do find evidence of changes in managerial risk-taking behavior. Furthermore, we find that the direction of change (increase or decrease) in some cases is dependent on the type of measure rather than the type of rating change.

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1 Introduction

Credit Rating Agencies (CRA) occupy an important role in the securities markets and that role is part of a paradigm of informational efficiency. They provide information on the ability of debt issuers to meet their obligations. There are three major credit rating agencies in the U.S- Fitch, Moody's and Standard & Poor's (S&P). CRA's provide issuer ratings as well as ratings for instruments. CRA's summarize their opinion about the credit worthiness of an issuer using ordinal scales. The long-term rating from these CRA's can vary from AAA to D (Fitch), Aaa to C (Moody's) and AAA to D (S&P), with AAA, Aaa and AAA being the highest (best creditworthiness) and D, C and D being the lowest (worst creditworthiness) rating. Credit Ratings are not static and can change over time to reflect the change in the opinion of CRA's about the creditworthiness of issuers. Long-term ratings are assigned to issuers or instruments with an original maturity of one year or more. Short-term ratings are assigned to instruments with maturity of less than one year. In this thesis we use the long-term issuer rating change. The reason for this is that issuer rating would better reflect the overall creditworthiness of firms as compared to instrument specific ratings.

Credit events such as credit rating changes can effect firms by several means, but the area on effects of credit events on decision making within the firm is somewhat of a novelty. Kisgen (2006, 2009) investigate the relationship between rating changes and capital structure. Ashbaugh-Skaif, Collins and LaFond (2006) test whether firms with better governance also have higher credit ratings. There is extensive on the effects of credit events on stock and bond prices[1].A more recent paper, Karampatsas, Petmezas and Travlod (2014) considers the association between credit rating and choice of payment in Mergers and Acquisitions (M&A). Although, Kisgen (2006, 2009) link credit events with capital structure which is itself a measure of risk. Our research contributes to the effects of credit events on risk-taking using a range of measures for robustness.

Literature suggests that the agency cost of debt is a severe problem for corporate governance and capital structure decisions. The agency costs of debt that concerns us can be described as asset substitution. This agency cost arises because of the conflict of interest between debt and equity holders. Equity holders may undermine the interest of debtholders by investing in riskier projects. Shareholders will capture the upside and downside risks while debtholders will only be exposed to the downside risk (Jensen and Meckling, 1976; Fama and Miller, 1972). Following Merton (1974)[2] increasing the volatility of the assets would increase the value of the stock but decrease the value of debt. We hypothesize that managers whose interest maybe more aligned with that of shareholders may increase or decrease the volatility following rating changes. Goetzmann et al. (2007) argues that mutual fund managers may increase or decrease volatility to maximize their compensation. We postulate that in a similar fashion mangers may increase (decrease) volatility following a downgrade (upgrade). The effect of credit rating on bonds and stocks has already been documented, in this paper we try to investigate

[1]Hand, Holthausen and Leftwich (1992), Goh and Enerington (1993), Katz (1974), Grier and Katz (1976), Weinstein (1977), Holthausen and Leftwich (1986) and Wansley, Glascock and Clauretie (1992) are some of the notable research works linking credit events with bond and stock Prices.

[2]Equity can be considered as a call option on assets of a firm and debtholders sell a put to equityholders on firm's assets. The strike price is the face value of debt in both options. Equityholders are better off if volatility increases because of their long position on the call. Debtholders will suffer if volatility increases because of their short position on the put.

whether this relationship between debt and credit rating also creates opportunities for expropriation of wealth from bondholders by stockholders.

Although the research on effects rating changes on one-step ahead investment policy or risk-taking is novel, Kuang and Qin (2013) do look at the effects of ratings on managerial incentives on ratings. They also look at how the level of rating may influence incentives and investment policy. They find that managerial incentives do play a role in investment policy and rating. We also include managerial incentives as conditioning variables in our analysis.

Nini, Smith and Sufi (2009) investigate the effect of deterioration in credit quality on private creditor agreements. They find that increase in bankruptcy risk results in restrictive covenants. In, contrast we look at issuer rating changes on risk-taking, where the risk-taking is a broader term than investment policy.

There are several factors that may influence risk-taking. Our methodology lets us rule out these alternative factors through conditioning on certain firm and industry characteristics. We use the literature on compensation management effects on risk-taking to develop our measures of risk-taking.

We use cross-sectional regression and matching using propensity scores to measure changes in risk-taking. Using data spanning 1994-2013, covering 13882 firm-year observations, we find evidence of change in risk-taking following rating changes but the results for change in risk-taking following upgrades and downgrades, separately are mixed. With some measures showing different risk-taking behavior (increase or decrease) following downgrades and upgrades and other measures showing similar change following downgrades and upgrades. Changes in credit-rating are not linear but in our methodology they are treated similarly[3].

The remainder of this thesis is organized as follows. Chapter II reviews the literature about the agency cost of debt and effects of rating changes on stocks, bonds and other aspects of the firm. Chapter III develops the different hypotheses tested. Chapter IV describes the sample data, measures of risk-taking and control variables. Chapter V discusses the methodologies used, Chapter VI explains the results and Chapter 7 concludes the analysis.

[3] A change from AAA to AA+ is not similar to a change BBB to BBB- in terms of change in default risk. Our method does not account for this non-linearity in rating changes. We do however, control on effects of rating changes that have been identified in the literature to have effects that are different from other rating changes. These include rating changes from investment grade to speculative grade and vice versa.

2 Literature Review

2.1 Agency Cost of debt

A principal-agent problem exists between shareholders and managers due to the separation between management and ownership. The management (agent) who is making decisions on behalf of shareholders (principal) may expropriate shareholder wealth. Corporate governance deals with ways in which this conflict of interest can be mitigated. Stockholders risk their investments but cannot directly observe or control the actions of managers. Like shareholders, the firm is also a source of capital for them but only one of these may be equity related. Managers, may therefore make certain decisions that maximizes their non-equity based compensation which may harm shareholder interest. Jensen and Meckling (1976) demonstrate that maximizing perquisites is not the only way managers may harm the shareholders. They may also make less of an effort to seek out profitable ventures as it would require more of an effort. As the claim to ownership falls, managerial motivation to increase profitability may also fall. Byrd, Parrino, and Pritsch (1998) explain that managers can suffer losses when the firm is in a loss but their payoffs are limited if the firm performs very well. This convexity can lead to conservative decision making. They also find that the reluctance to take project increases with project's risk. The managers would rather undertake safe but less profitable projects.

Maximizing non-monetary benefits and being more risk averse than shareholders both harm shareholders. Taking on debt is one way to reduce the chance of managers absconding with shareholder wealth. Debt can bind managers in their commitment to pay out cash flows, which would otherwise be under their control (Jensen, 1986). Gale and Hellwig (1985) discuss that an ideal contract that can minimize the cost of investigating the books, if the investors suspect the manager of wrongdoing is the debt contract. Myers and Majluf (1984) illustrate that because equity is more difficult to value as compared to debt, shareholders find it hard to directly link manager's actions with stock value.

Introduction of debt can further add another source of conflict of interest because there are now three parties; shareholders, managers and bondholders. This conflict of interest arises because managers may make decisions that benefit shareholders and undermine the interest of bondholders. Smith and Warner (1979) discuss dividend payment, claim dilution, asset substitution and underinvestment as potential sources of conflict of interest between bondholders and stockholders. Dividend rate can be increased after issuing bonds which assumed a certain dividend policy. This may reduce debtholder claims by reducing investment. The firm can issue additional debt of the same or higher priority which would reduce the claims of the debtholders. The firm can increase its risk which would increase the value of equity but decrease the bondholder claims; this replacement of lower risk projects with higher risk projects is called asset substitution. Underinvestment is the rejection of projects whose benefit would only add to bondholder wealth and not to shareholders (Myers, 1977).

Fama and Miller (1972) and Black (1976) have similarly suggested that what may be in the interest of shareholders may not be in the interest of debtholders. Fama and Miller give examples in which maximizing shareholder wealth may not maximize bondholder wealth. Black (1976) explains that any increase in the dividend rate not financed by external financing will harm the debtholders. Black and Scholes (1973) give another extreme example. The easiest way firms can get rid of debt is to pay out all the liquidated assets of the firm as dividend and leave nothing for the debtholders. The idea of managerial reputation as an incentive to harm bondholders is discussed in Hirschleifer and Chordia (1991). They show that preferences for early resolution by managers would result in higher Research and Development (R&D). High quality managers would like to advance realization of innovations. A greater investment in R&D would increase volatility which would be better for shareholders but not creditors. The problem for debtholders is not simply of increase in risk for projects that are undertaken but even when the firm goes bankrupt. Franks and Torous (1989) and Longstaff and Schwartz (1995) document that in case of a bankruptcy shareholders may be able to extract a greater share in value than they should have gotten according to absolute priority. Similarly, Bergman and Callen (1991) and Anderson and Sundaresan (1996) show that concessions maybe extracted by shareholders from debtholders even before the actual bankruptcy.

Various agency cost of debt have been widely documented but for our study, the focus is on the asset substitution. Because debtholders have fixed claim, they do not benefit if the returns are much higher but are effected if the returns are much lower, as compared to shareholders, debtholders are only exposed to downside risk (Jensen and Meckling, 1976). Managers can thus, acting in the interest of shareholders can promise to take the lower risk project when borrowing debt. Taking on the high risk project later on and transferring wealth from debtholders to shareholders. However their cost of debt would be based on the firm taking the lower risk project. The managers are motivated to favor shareholders because of their equity-based compensation packages. Jensen and Meckling (1976) explain stock options are one solution to managerial risk aversion. Coles, Naveen and Lalitha (2006) find that risk-taking is positively related equity based compensation. These incentives to make managers less risk averse can however, harm debtholders. Black and Scholes (1973) and, Black, Miller and Posner (1978) discuss how various covenants regarding dividends, further debt issues and minimum working capital requirements could be used to restrict managerial behavior and protect bondholders. Mella-Barral and Perraudin (1997) also show how strategic debt service can be used to the same effect but perfect contracts that protects bondholders in every situation is neither practical nor possible. So, there exists possibilities for bondholders to be exploited.

2.2 Rating change effects on Bond Yields

Katz (1974), Grier and Katz (1976), Hite and Warga (1997), Clauretie, Glascock and Wansley (1992), Holthausen and Leftwich (1992), Hand, Holthausen and Leftwich (1992) and, Steiner and Heinke (2001) find abnormal returns for credit rating changes and/or watchlist additions. With Katz (1974) finding that the price adjustment after S&P rating changes takes place six to ten weeks after the change and no adjustment before that. Grier and Katz (1976) find adjustment for 4 months, including the month of the rating change using downgrades only. Hite and Warga (1997) find market reaction for upgrades when rating goes from non-investment to investment and for all downgrades but the downgrade effect is more profound when it's from investment to noninvestment. Clauretie, Glascock and Wansley (1992) only find effects for downgrades, one week after and two weeks before the downgrade. They find no effect of watchlist additions. Holthausen and Leftwich (1992) find effects for two days after downgrades but not for upgrades. They also find effects for all types of additions to watchlists. Hand, Holthausen and Leftwich (1992) find asymmetry in effects as most of other literature but when they use a subsample of rating announcements not contaminated by other news, the effects become symmetric. They also find effects for additions to watchlists. Steiner and Heinke (2001) find effects for downgrades and negative additions to watch list and also find the magnitude of impact to be effected by country and conclude difference in regulation to be a factor.

Although most of the past research has found some form of effects but some have also found evidence in support of market efficiency; Weinstein (1977) for example using holding period returns and monthly data. He shows that the adjustment takes place seven to eighteen months before the rating change.

Most of these studies have found evidence of abnormal returns. They also find an asymmetry in effects. Upgrades have no or lower impact as compared to downgrades. Two reasons have been identified for these asymmetries in the effects. Ederington and Goh (1993) argue that this could be because companies willingly disclose good news but are unwilling to disclose bad news. Another reason is discussed in Jorion and Zhang (2007); because prior ratings are ignored in empirical cross-section design. If the rating changes from a lower rating, the increase in riskiness is higher than the increase if the rating had changed from a higher rating. Jorion and Zhang further explain that the proportion of downgrades from lower ratings is much more than upgrades from lower rating.

2.3 Rating change effects on Stock Return

Similar to research done on effects of rating changes on bonds, most studies find downgrades to have greater effects as compared to lower or no effects by upgrades on stocks. Most of these studies find results that contradict the efficient market hypothesis. One of the articles that does find stock market adjustment to be complete before the actual change is Pinches and singleton (1978). Using a one-factor model they find abnormal positive (negative) returns only before an upgrade (downgrade) and not after the actual change. Majority of the literature finds only downgrades to cause abnormal returns even after the actual change. Hand, Holthausen and Leftwich (1992) and Holthausen and Leftwich (1992) find negative returns for downgrades but no abnormal returns after upgrades. Dichev and Piotroski (2001), use a larger dataset and find abnormal and negative returns for downgrades only. They show that these abnormal returns may exist from a month to in some cases a year. Followill and Martell (1997), study the effects of downgrades with watch lists and conclude that downgrades cause negative returns if they aren't preceded by negative addition to the watchlist. Using daily data as compared to Pinches and Singleton's monthly data. Davidson, Glascock, Henderson (1987) find anticipation by the stock market and abnormal returns for downgrades but only abnormal returns after upgrades.

Goh and Ederington (1993) use a different approach to study the effects of downgrades, they divide downgrades in three groups by the reason for which they were downgrades. They argue that downgrades due to an increase in leverage should be followed an increase in stock price. Since, an increase in leverage can be a sign of transfer of wealth from bondholders to stockholders. Whereas downgrades due to changes in firm prospect should reduce the stock price. But they only find decrease in stock price following downgrades due to change in firm prospects but no change due to downgrades because of change in leverage.

Goh and Ederington (1999) and Jorion and Zhang (2007) consider rating changes and the actual category of rating. They examine whether the rating change occurred for speculative grade or investment grade bonds. Goh and Ederington (1999) find that the stock market reacts more strongly to downgrades for bonds that are in speculative category than the ones in investment category. Reaction is stronger for bonds that had low ratings before and after the change. They find similar reaction for multiple downgrades as single downgrades. Jorion and Zhang (2007) also consider the rating before the change. They argue that if prior rating is used, upgrades from lower rating also carry information but not as much (half) as downgrades. They conclude that the asymmetry in effects is due to not considering prior rating and because companies willingly disclose good news but are unwilling to disclose bad news (Ederington and Goh, 1993). Norden and Weber (2004) find similar results.

2.4 Corporate governance and credit rating

Bhojraj and Partha (2003) use an ordered probit model to study the effect of corporate governance on bond yields and ratings separately. They find that bond ratings (yields) are positively (negatively) associated with percentage of shares held by institutions and fraction of board members that are outsiders. They also found an inverse relationship between bond ratings and yields with concentration of institutional ownership.

Ashbaugh-Skaife, Collins and LaFond (2006) use a relatively greater number of measures of corporate governance and an ordered logit model. They aim to capture corporate governance measures that tend to mitigate the conflict of interest between managers and all stakeholders and, stockholders and bondholders. Overall they find ratings to be positively associated with better governance. They find that firms with poor governance overcompensate CEOs, which might explain the resistance to better governance. This paper touches on the hypothesis we will test in this research. They argue against the explanation that lower rated firms overcompensate CEOs due to the increase in risk. They show that if that were the case the future performance of lower rated firms would be higher. They illustrate this by showing that next year's ROA and ROE is positively related to investment grade ratings. When they control for risk effects using standard deviation of ROA and ROE, overcompensation is not due to bearing excess risk.

Similar to Ashbaugh-Skaife, Collins and LaFond (2006), Klock, Sattar and William (2005) also find that bondholders see anti-takover measures unfavorably but offer a competing conclusion. They explain that governance measures that favor shareholders are seen as undesirable by bondholders. Using a governance index that includes various antitakeover measures, they find that firms that make takeovers easy have higher costs of debt. Concluding that hostile takeovers could be financed by expropriating wealth from bondholders.

2.5 Other related research

Some recent literature also looks at how ratings can effect managerial decision making. For example, Jung, Soderstrom and Yang (2013) and Alissa et al. (2013) look at earnings manipulation by management to influence credit rating. Kisgen (2006 & 2009) look at how credit ratings can affect capital structure decisions. Karampatsas, Petmezas and Travlod (2014) study the effects of credit rating on choice of payment for mergers and acquisitions (M&A).

Jung, Soderstrom and Yang (2013) use standard deviation of earnings scaled by the standard deviation of cash flows from operating activities as a measure of earning volatility. They find that earning smoothing is more common in firms with plus notch ratings and that earnings smoothing increases the likelihood of subsequent rating upgrades. Using further analysis, they show that this asymmetry between plus and minus rating are due to minus rated firms being followed more closely by the market. This results in more scrutiny and consequently, less incentive to manipulate earnings due to fear of being caught. The intuition behind exploiting the plus and minus in the ratings is that most changes are single notch. A plus or minus rated firm (near rating change) has a greater chance of moving to another broad category. Regulators care more about the broad category (Kisgen, 2006), therefore, so do managers.

Alissa et al. (2013) provide similar insight into the relationship between ratings and earnings management activities. They empirically model expected ratings and study whether firms that are below (above) their expected rating engage in earnings increasing (decreasing) management activities. Expected ratings are developed using characteristics from the literature: size, profitability, operating risk, growth opportunities, asset tangibility and market valuation. Using mean reversion, they find that credit rating deviations are economically significant. By utilizing regression analysis, they show statistically significant negative (positive) relationship between expected ratings and income increasing (decreasing) management activities. They also find that management can influence future ratings with these practices.

Credit ratings are an important factor in a firm's capital structure (Graham and Harvey, 2001). Kisgen (2006) shows that firms that are near rating changes (ratings with a plus or minus sign) are more likely to issue equity than debt. He reaffirms that managers are concerned with credit ratings as this effects their access to capital markets. Kisgen uses dummy variables in regression analysis to account for firms that are near a rating change. While Kisgen (2006) looks at how credit rating changes affect capital structure decisions ex ante, Kisgen (2009) extends this analysis to show that firms will issue less debt, following downgrades.

Kuang and Qin (2013) study the relationship between credit ratings and managerial compensation and, whether firms that have experienced a downgrade will adjust their incentives to reduce managerial appetite for risk. They find that CEO risk-taking incentives increase with default risk and that firms that were downgraded in the previous year will decrease risk-taking incentives as measured by vega. They also consider the possibility of simultaneity bias and investigate the relation between credit ratings, compensation and investment policy. While there research focuses on the differences in rating levels in explaining CEO incentives and investment policy, we focus on the impact of rating on risk-taking in the next period. Kuang and Qin (2013) also look at the effect of downgrades on incentive structure but fail to account for changes in CEO. In our sample 16.04 percent observations have different CEO's after downgrades and 11.18 percent for firms without any rating change. The difference is significant at 99 percent, but the difference following upgrades is not significant. So, the difference in incentive structure may just be because of replacing CEO's.

Investment policy can be effected by creditor restrictions. Nini, Smith and Sufi (2009) investigate the effects of private creditor agreements on capital expenditures. They use a sample of 3,720 private credit agreements and find that 32 percent of these agreements have restrictions on capital expenditure. They find that deterioration in credit quality as measured by debt to cash flow ratio and credit rating can increase the likelihood of these covenants. While, the effect of private credit agreements is significant on investment policy, Billett, King and Mauer (2007) find that fewer than five percent of public bond indentures contain explicit restrictions on firm investments. So, the effect of rating change on investment policy through covenants is limited. Our research focuses on multiple measures of risk-taking and investment policy which may change because of risk-shifting motivated by managerial preference for favoring shareholders.

Sufi (2009) studies the effects of start of syndicated bank loan ratings on investment and working capital. They find that after firms are rated they use debt more and see an increase in capital expenditure, asset growth and working capital investment. To remove the effects of start of rating on risk-taking, we use a sample of only those companies that are rated. If a firm becomes unrated during our sample period, we remove those observations. If the firm is rated again, we consider it as a new rating and do not consider it as a change from previous rating (before being unrated) to the new rating (after being rated again). This is done because firms that are not rated by S&P may behave differently because of being unrated or having being rated by another rating agency which is not known to us.

Credit ratings affect firm’s access to public debt markets and also strategic goals in bidding for contracts. Literature suggests that most of the cash transaction in M&A are funded by debt. Consequently, choice of funding for M&A can be influenced by firms' ratings vis-à-vis it's access to debt markets. Karampatsas, Petmezas & Travlod (2014) study the effects of credit on choice of payment for M&A. Using logit and probit regressions they show a positive relation between a bidders' credit rating level and cash payment method. This is probably due to firms with higher ratings having better access to cash to fund M&A transactions.

3 Hypotheses

Literature on the performance of mutual fund manager discusses the moral hazard created by risk shifting through time. Chevalier and Ellison (1997) investigate the flow-performance relationship and the agency problem that arises from differences in motivations of mutual fund companies and consumers. Consumers want their fund managers to maximize the risk-adjusted expected returns, whereas the mutual fund companies want to increase the inflow of funds, as their profits are determined by assets under management. They find that if the fund has been performing poorly, the nonlinear relationship between flow and performance will justify taking more risk at the end of the year. The fund would benefit more if it is successful in achieving higher returns due to higher risk and getting higher investment for the next year but the loss would be lower if the higher risk results in lower returns. Similarly, they find that funds that have been performing well would benefit more if they locked-in that performance by lowering risk.

Compared to Chevalier and Ellison (1997) who look at the moral hazard created by the divergence of aims between investors and funds in the flow-performance relationship, Goetzmann et al. (2007) looks at how using scalar performance measures can create incentives for fund managers to change their risk-taking behavior. They argue that if a manager has been performing better in the past, he would reduce risk going forward. This would allow the better performance to be weighed more heavily in the assessment of manager’s performance. However, if the manager has been performing poorly, he will increase risk. As the manager has already been performing poorly he cannot be worse off but he can improve his overall performance.

Huang, Sialm and Zhang (2011) look at risk-shifting as well but they also consider the possibility that it may not be due to moral hazard if the funds perform better after increasing risk and if risk-shifting behavior is well known, so that investors can adjust their fund allocation. They find that funds that shift risk perform poorly than funds that do not change risk. Concluding, that risk-shifting is likely due to ill-motivated trades motivated by the agency issues.

We believe that rating change can also induce a similar moral hazard in firm managers. We have already elaborated on the effect of rating change on stock prices in Section 2. A firm is owned by shareholders and if a downgrade (upgrade) decreases (increases) stock price, that means the manager has performed poorly (better). Therefore, following downgrades managers would try to make up for the poor performance by taking on more risk. However, after upgrades managers would reduce risk to lock-in the success they have already had.

H1: A recent change in credit rating will be an incentive for managers to change risk-taking.

Regulators are more concerned about the broad category of rating than the position of the firm in that category (Kisgen, 2006). Kisgen (2006) shows that ratings are a bigger factor in a firm's capital structure decision if their credit rating is near a credit change to a different broad category (plus or minus sign ratings). Jung, Soderstrom and Yang (2013) also find that firms with a plus or minus in their rating do more to influence their ratings as compared to if their rating is in the middle of a category. Given this research, we posit that managers of firms whose rating is near a category change will take on less risk than other firms because managers would care more about the broad rating category rather than the position within that category.

H2: Firms who have been downgraded or upgraded to the border of a broad rating (ratings with + or -) category will take on more risk.

Consistent with prior research, we also bifurcate the effects on risk-taking by number of notch changes and if the rating changed from speculative to investment or investment to speculative grade.

Section 2.2 and 2.3 documents the asymmetry in effects of downgrades and upgrades. Most of the research on effects of rating changes on stock and bond prices shows that downgrades have more profound effects as compared to upgrades. We also consider the possibility, that there may be an asymmetry in effects. Managers may increase risk more following downgrades as compared to decreasing risk after upgrades.

H3: Managers will change risk-taking more following downgrades as compared to upgrades.

We hypothesize that rating changes may cause changes in risk-taking but there is also the possibility that changes in risk-taking behavior may have an effect on the credit rating. We therefore also investigate if rating changes and risk-taking are jointly determined.

H4: Rating changes and changes in risk-taking are jointly determined.

4 Sample data and variable measurement

Multiple data sources are used in this study to get the data for rating changes and constructing variables for studying the effects on risk-taking and to be used as control variables. In subsection 4.1, we explain the data collection process. Subsections 4.2 and 4.3we discuss the variables to be used to measure risk-taking and as control variables respectively.

4.1 Data collection

The ratings data covers the period from 1994 to 2013 in our sample. There are 13381 firm-year observations. For HHI and Number of segments COMPUSTAT only has information from 2007 onwards, this leaves us with 5169 observations. The sample selection procedure is as follows. Initially, we compile the list of all the firms' covered by COMPUSTAT. From those we pick companies that have ratings information in COMPUSTAT. We remove companies that didn't have ratings information. The removed firms maybe rated by other CRA's but not S&P. Including these firms will result in assuming that they didn't have a rating change, even though their ratings may have been changed by other CRA's. We only use ratings by S&P because as compared to studies looking at effect of rating change on stock and bond price, we look at the impact on risk-taking using yearly data and within that span using ratings by multiple CRA's would have redundant information. Our objective is to use a measure that summarizes the creditworthiness of a firm as a whole. We therefore use local issuer rating. The accounting data is taken from COMPUSTAT for the variables discussed in subsections 4.2 and 4.3. The data for executive compensation is taken from EXECUCOMP and stock prices from CRSP. We use the merged COMPUSTAT and CRSP data to match observations. Table 1 summarizes the different variables used and the source.

4.2 Measures of risk-taking

To the best of our knowledge, this is the first study to link a rating change with change in risk-taking behavior. Therefore, we draw on the literature that looks at the effects of corporate governance mechanisms and compensation to name a few on risk-taking. Majority of the literature using measures of risk-taking, use volatility of earnings (John et al., 2008; Faccio et al., 2011; Boubakri et al., 2013 and Chan et al., 2013) because earnings volatility is calculated using five years. It would not be feasible for us because in the five years following rating changes numerous other events including multiple rating changes could happen.

4.2.1 Research & Development (R&D) and Capital Expenditures (Capex)

R&D expenses are considered more risky investments than Capex (Bhagat and Welch, 1995; Kothari et al., 2001). R&D investments are considered risky because they have a low probability of success and their benefits are distant and uncertain (Li, Yue and Zhao, 2013). Coles, Naveen and Lalitha (2006) use R&D and capital expenditures to show a causal relationship between managerial compensation and investment policy, with higher R&D and lower Capex meaning higher risk investments. They find that results for R&D and Capex as a measure of risk-taking are consistent with their other measures of risk-taking. King and Min-Ming (2011) also use R&D and Capex in their examination of relationship between corporate governance structure and risk-taking.

Following Coles et al. (2006) we use R&D and Capex scaled by total assets to proxy for risk-taking. We remove companies that don't have R&D data or have zero R&D expenditure.

4.2.2 Cash holding

Bargeron, Lehn and Zutter (2010) and Gormley, Matsa and Milbourn (2013) use cash and other marketable securities to measure risk-taking. Bangeron et al. assess the effect of the Sarbanese-Oxley Act on risk-taking and Gormley et al. (2013) examine the two-way relationship between managerial compensation and risk-taking. We use similar treatment for cash holding as we did for R&D and Capex. We divide value of cash and marketable securities with total assets.

4.2.3 Focus

Firms can reduce firm-specific risk by diversifying into different segments. Recent studies use number of segments and the Herfindahl–Hirschman Index (HHI) as a measure of risk-taking (Coles, Naveen and Lalitha, 2006; Achariya, Yakov and Lubomir, 2011; Serfling, 2014). We use segments data from COMPUSTAT. Segment data is only available for 2007 onwards, so the sample size for these measures is smaller.

Firms can also reduce risk by diversifying into different segments. We get annual data from COMPUSTAT North America segment. We calculate the HHI by summing the squares of the ratios of individual segment sales and dividing by total sales and comparing the HHI before and after a rating change. Number of segments is the log natural of total number of segments. Different segments are identified by the first two digits of NAICS.

4.3 Control Variables

We control or condition on variables that have been identified in the literature as having a bearing on risk-taking. These include size, sales growth, growth opportunities, leverage and profitability. Size is calculated as logarithm of firm's sales (John et al., 2008).Larger firms have better governance mechanism and thus the amount of risk taking maybe different between large and small firms. Small firms are more risk-taking than larger firms (Boubakri, Cosset and Saffar, 2013). Due to limited availability we do not condition on governance quality measures which may have a bearing on risk-shifting. Including size however mitigates some of this problem. Larger firms have stronger governance quality because of higher public scrutiny and visibility (Chung, Elder and Kim, 2010).

Sales growth is calculated as the sales increase/decrease as a percentage of previous year sales (Claessens, Djankov and Nenova, 2001). Sales growth controls for differences in the life cycle and growth opportunities of a firm, riskiness may decrease as the firm has less opportunities or as it matures (Faccio, Marchia and Mura, 2011). Firms with higher sales growth have more resources and may take on more risk. Book-to-market is also used to proxy for growth opportunities (Coles, Daniel and Naveen, 2006) and future profitability, which may affect the amount of risk firms take (Liu, Shi and Wu, n.d.).Book-to-market ratio is calculated as the ratio of market to bookvalues of common equity (Bageron, Lehn and Zutter, 2010).

Book leverage is calculated as a ratio of book values of Long-term debt and total assets (Boubakri, Cosset and Saffar, 2013). Leverage effects financial risk of the firm and can also constrain the firm risk-taking policies. Nini, Smith and Sufi (2009) find that deterioration in credit quality can cause changes in firm's investment policies. Having more debt could therefore increase the likelihood of changes in credit quality and resultantly investment policy. Yearly stock return over the last fiscal year is also used as a control variable.

Following Coles, Daniel and Naveen (2006), we use values of delta and vega, tenure and total salary. Where delta is the sensitivity of CEO wealth to sock price and vega is the sensitivity of CEO wealth to stock returns volatility. Berger, Ofek and Yermack (1997) argue that CEOs with longer tenure and higher total salary are more likely to be entrenched and will take less risk. Perry and Zenner (2000) document the increase in equity-based compensation in the form of stocks and options to align managerial and shareholder incentives. These are meant to align the interests of managers with that of shareholders. Coles et al. (2006) and a number of other studies have found delta and vega to be determinants of risk-taking. We therefore, use delta and vega to capture the effect of equity-based compensation on CEO incentives.

For calculating delta and vega, we follow Coles et al. (2006) and Core and Guay (2002). We use the formulae in Core and Guay (2002) for delta and vega, which is the same as Black-Scholes (1973) option pricing formula, modified by Merton (1973) to account for dividends. Delta and vega are calculated for vested and unvested shares and options only. The unearned awards are not used because the data for these calculations is not available on EXECUCOMP. Calculations for pre-2006 data are different from post-

2006 because of the changes in the way firms report equity-based compensation, in line with the directives of FASB. For the pre-2006 data three option portfolios are considered: 1. Current year's option grants 2. Portfolio of unvested options from previous years and 3. Portfolio of vested options. For the port-2006 EXECUCOMP reports separately the outstanding option tranche.

Following Coles et al. (2006) we also use CEO changed as one of the conditioning variables. CEO changed takes the value of one if the CEO was replaced and zero otherwise. Changes in risk-taking may just be due to a change in CEO as different CEOs may have different appetites for risk. We also run granger causality tests on whether rating changes can cause changes in CEO's and vice versa (results not reported here). The results are significant for downgrades but not upgrades. Whether CEO's are punished by being fired for downgrades or downgrades proxy for other performance measures that caused the CEO turnover is outside the scope of this research. We therefore, include CEO changed as a dummy variable in the cross-sectional regressions and exclude observations where the CEO is different from last year for our conditional logistic regression.

5 Methodology

The objective of this study is to examine changes in risk-taking behavior driven by changes in rating. We use two approaches to look at the change in this behavior. We first estimate cross-sectional regressions for risk-taking on control variables, discussed in section 4.3, industry dummy variables and dummy variables for rating changes. Finally, we calculate the change in risk-taking measures using difference in differences, risk-taking of the firm with rating change is compared to a matched firm that didn't have a rating change. Matching is done using propensity scores and, book-to-market ratio and firm size. When matching using propensity scores we match firms in the same year and same industry (2-digit NAIC codes). For our second matching approach, we follow Barber and Lyon (1997). Firms with rating change in the previous year are matched with firms without the rating change.

5.1 Cross-sectional regression

To compare the differences across firms in risk-taking, we use cross-sectional regression. Our sample consists of two types of observations. Firms that had rating change in the previous year and firms that didn't have any rating changes in the previous year. If managers change risk-taking after credit rating changes, then the effects should be observed in the year after the rating change. We control for firm characteristics that have been established in prior literature to have an impact on risk-taking. For each risk-measure, we regress the risk-taking on the control variables discussed in Chapter 4.3, industry dummy variables and one dummy variable for rating changes in each regression. In every regression we use firms that had a certain type of rating change and the firms that did not have any kind of rating changes. For example, when we look at the effects of Two-notch upgrades on risk-taking, we only include firms with two-notch upgrades and firms without any rating change.

$$Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + Upgrade_{t-1} + \varepsilon_{it} \quad (1)$$

$$Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + Downgrade_{t-1} + \varepsilon_{it} \quad (2)$$

Equation 1 regresses risk-taking on X_{it}, which are the different conditioning variables we discussed in Chapter 4.3, industry dummy variables and a dummy variable Upgrade, which is 1 if the firm had a rating upgrade in the previous year and zero otherwise. Similarly, the dummy variable Downgrade takes on the value 1, if the firm had a rating downgrade in the previous year and zero otherwise. We use two types of observations in each regression, the firms that had a certain type rating change in the previous year and the firms that didn't have any rating changes in the previous year. For example, when investigating the effects of a multi-notch downgrade on capital expenditure (risk), we regress capital expenditure on the conditioning variables and dummy variable Multi-notch downgrade (more than two-notch). We only use firms that did not have any kind of rating change and firms that only had multi-notch downgrades in the previous year.

5.2 Matching

In randomized data samples, the researcher randomly assigns subjects (firms) to treatment groups (firms with rating changes in the previous year) and control groups (firms without rating changes in the previous year). Random assignment balances the two groups, so that the only difference is due to intervention (rating changes) up to the random error. However, when evaluating the effects of any intervention in Financial Economics such as the effects of credit rating change in our case, we cannot assume that the assignment of firms to control group or treatment groups was purely random. When dealing with observation as is the case here, the differences in the control and treated group may be due to a third variable which effects both the treatment and the control group. Regression analysis deals with such variables by using control variables that we have used. Using control variables makes strong functional form assumptions that may be improbable (Winship and Morgan, 1999). Another approach used in observational data is matching. Matching attempts to replicate the design of experimental studies the main issue is to find a comparable control group that is similar. Matching has several advantages over the regression. There is no assumption made for the functional form about the relationship between the treatment effect and the control variables. Only observations that belong only to the control and treatment group are used. Additionally, Rubin (2001) discusses that not knowing the how design choices affect the outcome result in greater research honesty. In regression analysis, research can change the specification based on statistical significance of best fit. The estimated causal effect obtained by comparing control group with treatment group could be biased due to self-selection or any other bias introduced by the researcher. But if matching is done based on similar characteristics, the estimates could be unbiased.

LaLonde (1986) compares the experimental results and results from non-experimental procedures to show that conventional econometric estimates including cross-sectional and longitudinal regression fail to replicate the experimentally determines results. They show that the results can be biased upwards for some groups and downwards for some groups. Dhejia and Wahba (1999) however, find that compared to the estimators investigated by LaLonde (1986), propensity score estimates are much closer to the experimental results. They also find that the estimated propensity scores are not effected by specification of the scores but are sensitive to the conditioning variables used. Propensity score-matching also has the advantage of reducing the dimensionality along which to match (Dhejia and Wahba, 2002). For robustness we also match using Book-to-Market and firm size, suggested by Barber and Lyon (1997). We calculate the difference-in-differences (DiD) between the risk-taking of firms after they have had rating changes and the risk-taking of comparable firms that didn't have rating changes in the previous year. Matching estimators estimate the effects of a treatment by comparing the outcomes for treated entities to those of similar characteristics. The treatment in our research is credit rating changes. Comparable firms are assumed to be comparable if they have similar characteristics. Matching also has the advantage of filtering out effects of factors that may have influenced the firm over time by calculating differences between the two firms in the same year. In this thesis we match using propensity scores and, Book-to-Market and firm size.

5.2.1 Propensity Score matching

One method of finding comparable firms in the literature is the conditional probability of inclusion into a program (treatment), also called propensity scores. Rosenbaum and Rubin (1983, 1985a, b) were the first to suggest the use of propensity scores for matching. Heckman, Ichimura and Todd (1997) also played a role in the development of propensity score matching methods. They focused on selection bias and making casual inferences when there is non-random assignment. In this paper, propensity score is the conditional probability of firms having a rating change in the coming year. One advantage of using propensity scores is the simplicity. When matching is done based on propensity scores, the effects of treatment can assessed in two stages. First by finding comparable firms based on propensity scores and then evaluating the differences. In this way, matching exhibits characteristics of the conventional econometric approach to selection bias (Heckman and Robb, 1986; Heckman et al. 1998). For the conditioning variables we choose variables that are not influenced by the rating change. Choosing conditioning variables that are affected by rating changes will result in the matching estimator not correctly measuring the effect of the rating change because it will not be able to capture changes in the distribution of conditioning variables caused by the rating change (Heckman, Ichimura and Todd, 1997; Heckman, Ichimura and Todd, 1998).Propensity scores are calculated using conditional logistic regression. To illustrate:

$$y *_{it} = \alpha_i d_{it} x'_{it}\beta + \varepsilon_{it}, i = 1 \ldots . n, t = 1 . \ldots T \quad (3)$$

$$Prob(y_{it} = 1|x_{it}) = \frac{e^{\alpha_i + x'_{it}\beta}}{1 + e^{\alpha_i + x'_{it}\beta}} \quad (4)$$

Equations 3-4 show the fixed effects model. Where dummy variable d takes the value 1 for firm 1 or zero otherwise. In similar fashion we also estimate fixed effects model with fixed industry effects. Equation 5 is the probability of a firm having rating change in the coming year. The dependent variable is the dummy variable that takes a value of 1 if there will be a rating change at time t and the independent variables are the control variables discussed earlier for time t-1. We estimate the regression separately for upgrades and downgrades separately. We do this because literature on effects of rating changes shows different effects of upgrades and downgrades and we postulate that the conditioning variables may also effect the probability of downgrades and upgrades differently. The firms with rating changes are matched to those firms without any rating changes with the closest propensity score. The matched observations are in the same year and industry, based on 2-digit NAIC. We match with replacement as it has the advantage of increasing chances of a match with the closest score, industry and year. Matching is nearest neighbor and one-to-one. The difference-in-differences (DiD) are then the differences in risk-taking between matched firms after the rating change. The t-stats for the differences are then calculated and checked for significance.

5.2.3 Size and Book-to-Market matching

We also match based on size and book-to-market ratio. Following, Barber and Lyon (1997) we first find firms whose size is a maximum of 30 percent higher or lower than the firm with the rating change in the previous year and then we find the firm with the closest book-to-market ratio. Our methodology is different from Barber and Lyon (1997) because we also match in the same industry (using 2-digit NAIC) and we measure size as the log natural of total assets rather than market value of equity. We do this because rating changes can effect equity values (see chapter 2.3) and this will result in the matching estimator not correctly measuring the effects of rating change, as discussed in the previous section. The t-stats for the differences are then calculated and checked for significance.

6. Empirical Findings

This section reports the descriptive statistics for our data and the results for the analysis that is conducted using the framework explained in Section 5.

6.1 Descriptive statistics

This subsection reports the descriptive stats for the dataset. Table 2 gives the number of upgrades and downgrades, downgrades (52 percent) outnumber upgrades (48 percent) which is consistent with previous studies; Ederington and Goh (1993) use a dataset with 243 downgrades and 185 upgrades. Bannier and Hirsch (2010) use 2531 downgrades and 1512 upgrades. Table 1 also gives the number of upgrades and downgrades by number of classes changed. Single and double-notch changes dominate the sample with 81.5 percent of sample comprising of single and double-notch upgrades and downgrades. Multi-notch (more than one) are more common in downgrades. 23.5 percent of downgrades are multi-notch whereas only 12.6 percent of upgrades are multi-notch.

[Please insert table 2 about here]

Table 3 divides the sample by rating class. First column reports the percentage of firms in our sample with a certain rating; given in the second column. 81.3 percent of the observations in our sample have rating in the B band. Percentage of firms with C rating is less than 0.01 percent. This is consistent with the COMPUSTAT data used by Kuang and Qin (2013). Their data of 8189 ratings only has two rating of C. 69 percent of the sample contains investment grade (BB and above) issuers as compared to 31 percent for noninvestment grade (BB- and below).

[Please insert table 3 about here]

Table 4 reports the different industries included in the sample using the North American Industry Classification System (NAICS). As is consistent with prior research, we exclude firms from the financial and utility sector. More than 50 percent of our sample is from the manufacturing sector. To check for biases in our sample of rating changes. We calculate the percentage of manufacturing firms in our sample that had rating changes in the previous year. The subsample has 48.5 percent observations from the total firms with rating changes. We find that the difference is not statistically significant.

[Please insert table 4 about here]

Table 5 reports the descriptive statistics for some key variables. R&D calculations only use observations where R&D was greater than zero. We follow a similar approach for other calculations that use R&D as a measure of risk-taking. We do this because we believe that some firms have zero R&D not because of risk preferences but because of the nature of their business. For HHI and Numseg calculations we use data from 2007-2013, because COMPUSTAT does not provide segment data prior to 2007. All other calculations are done using data from 1994-2013. We also calculate these stats separately for firms that had downgrades and upgrades (not reported here) in the previous year. We find greater variability (standard deviation) for risk-taking measures in downgrades as compared to upgrades. The standard deviation of risk-taking measures for upgrades is closer to that for our overall sample. This is consistent with prior research (see chapter 2) that finds downgrades to have more profound effects on firms. However, the standard deviation of other variables is higher after upgrades than for firms that had downgrades or no rating changes.

[Please insert table 5 about here]

Table 6 reports the correlations between different measures of risk we use in this thesis. Overall the correlations between risk-measures is low except for cash. This is expected because any type of investment would affect firm’s cash holding. A low correlation between risk-measures means that a change in one type of risk-taking is not related to a change in another. This supports our choice of risk-measures as we are not measuring redundant information.

[Please insert table 6 about here]

6.2 Results

Tables 7-9 report the results for the regressions with different measures of risk-taking as the dependent variable. Table 7 provides the results for the effects of upgrades on risk-taking. Positive coefficients for R&D and HHI mean more risk-taking whereas positive coefficients for Capex, Cash and Numseg mean less risk-taking. Only Numseg and Cash are significant and are positive. This shows reduction in risk-taking following upgrades. This is consistent with our hypothesis that managers will take on less risk to protect their better performance following upgardes. Vega is insignificant for HHI. For R&D, Numseg and cash it is positive and for Capex it is negative. For R&D and Capex, having higher vega (incentive for risk-taking) will translate into more risk-taking. This is consistent with prior research (Coles, Naveen and Lalitha, 2006). But for Cash and Numseg, higher vega translates into less risk-taking. Other incentives for managerial risk-taking like tenure and salary are also consistent with prior research. Managers with higher tenures and salaries are more entrenched and therefore have less of an incentive for risk-taking. Tenure is positive and significant for Numseg and salary is negative for R&D. This means that higher tenure and salary contribute negatively managerial appetite for risk. Interestingly, the dummy variable CEOchanged is positive and significant for R&D. The reason maybe that firms change CEO's when they want their firms to concentrate on developing different technologies or products, rather than concentrating on the same business.

[Please insert table 7 about here]

Table 8 shows the effect of downgrades on risk-taking. Numseg and cash are significant and positive whereas Capex is significant and negative. Capex shows an increase in risk-taking whereas Cash and Numseg show reduction in risk-taking due to downgrades. Even though some of the results contradict our hypothesis of downgrades resulting in more risk but more measures being significant show that downgrades have more pronounced effects than upgrades which is consistent with literature. As mentioned previously that the dataset used for HHI and Numseg is different from the dataset used for other measures and this may result in a bias because this dataset spans years 2007 to 2013 and this might capture the effects the financial crises. As firm and managerial behavior maybe different during these years, trying to reconcile other measures of risk with these has to be done with this consideration. The signs for other variables are the same as in table 6. This means that the dataset for upgrade and downgrade regressions are consistent and the difference is only due to the type of rating change. Similar to the results in the upgrade regressions (see table 6), CEOchanged is positive and significant for R&D for the downgrade regression as well. In the downgrade regression, the CEO changed is also positive and significant for Cash. This could be because downgrades and changes in CEO maybe interacting in some way. We also run conditional logit with CEOchanged as the dependent variable and downgrades as one of the independent variables (not reported here). We find that downgrades increase the likelihood of the CEO being replaced.

[Please insert table 8 about here]

Tables 9 provides results for the effects of different types of rating changes on risk taking. We do not report the coefficients for other independent variables, as this information would be redundant. Capex results are similar to the results in tables 7 and 8, with downgrades having a negative, significant effect on capex and all capex coefficients are insignificant except for category upgrades. This may be because managers are not concerned with upgrades unless they are upgraded to a category rating. When a firm is upgraded to a category rating Capex is negative, which is not consistent with our hypothesis. In regressions, where cash is the dependent variable, downgrades are significant and positive. Which translates into less risk-taking. Category upgrades also have a positive and significant impact on cash. In all the regressions with Cash as the dependent variables, the coefficients are positive, whenever they are significant. This maybe because rating changes induce a more cautious behavior in managers. HHI is significant only for multi-notch downgrades. The sign is positive which means higher risk-taking following multi-notch downgrades. This is again consistent with our hypothesis. Numseg is significant and positive for double-notch downgrades, category upgrades and when a firm is downgraded from investment grade to speculative grade. This result is consistent with results we had for Cash. Both types of rating changes result in managers reducing risk. Multi-notch downgrades have a positive impact on R&D, which means increase in risk-taking. This is again consistent with our hypothesis.

[Please insert table 9 about here]

Table 10 reports the results for panel logit. The dependent variables are downgrades and upgrades. We are run separate regressions for downgrades and upgrades and also use different combinations of fixed firm and fixed industry effects. Kuang and Qin (2013) find that firms with higher vegas are assigned lower rating. In our logit, we consider the effect of vega and other variables on rating changes in the next period. We find that firms with higher (lower) vegas have a higher chance getting downgraded (upgraded). This is likely due to managers with more incentives to increase volatility of firm stocks cause higher firm risk and hence a downgrade. Delta is positive and significant for upgrades. This maybe because managers with higher incentives to increase stock price reduce default risk.

[Please insert table 10 about here]

Table 11 provides results for matched differences using propensity scores. The results for Cash are consistent with the cross-sectional regression results in tables 7-9, when they are significant. Cash is significant for downgrades, multi-notch downgrades and category downgrades using fixed firm effects. These are all positive, showing a decrease in risk-taking. This is not consistent with our hypothesis. The coefficients for Capex are significant mostly for all types of downgrades with a negative sign, which is consistent with our hypothesis of less risk-taking following downgrades. The coefficient for upgrades using fixed industry are positive and significant, again consistent with our hypothesis. But multi-notch downgrade coefficient is significant and negative for fixed firm upgrades. This inconsistency between multi-notch upgrades and all upgrades for Capex may be because managers taking less risk to lock-in their better performance as measured by a rating upgrade. Multi-notch upgrades however may result in managers thinking that they the reward for one upgrade and multi-notch upgrade is the same but if they take on more risk, they may get higher returns for the higher risk but also upgrade because if there is rating reversal it may not be a multi-notch. Results for R&D are negative and significant for upgrades, downgrades and category downgrades for fixed firm effects. The HHI coeffcients are positive and significant for category upgrades (increase in risk-taking) and, negative and significant for upgrades (decrease in risk-taking) from speculative to investment category. This conflict may be because managers see an advantage in being in the investment grade category and want to retain it. Numseg is positive (less risk-taking) and significant for investment to speculative using fixed firm effects and also for investment to speculative and speculative to investment using fixed industry effects. As for cash, this may be because any kind of rating change between speculative and investment grade may make managers more cautious.

[Please insert table 11 about here]

Tables 12 reports results for difference-in-differences using the Baber and Lyon (1997) methodology for matching, discussed in chapter 5.2.3. Some of the coefficients for Cash are significant and consistent with our hypothesis but not consistent with results for other two methodologies. Coefficients for downgrades, category downgrades and investment to speculative are negative and significant. Coefficient for two-notch upgrades is significant and positive. The results for capex is consistent with our initial hypothesis of upgrades resulting in lower risk-taking and downgrades resulting in higher risk-taking. Results are also similar category upgrades and downgrades. But for multi-notch, two-notch and investment/speculative rating changes, the coefficients are only significant (negative) for downgrades. This is expected because literature (see chapters 2.2 and 2.3) shows effects of downgrades being more common and profound than upgrades. R&D is positive and significant for upgrades, downgrades, category upgrades and downgrades and investment to speculative. This shows that managers increase risk-taking (higher R&D) irrespective of the type of change. Results for HHI are similar with R&D with firms seeing reduced risk irrespective of the type of change. Coefficients for upgrades, downgrades, two-notch downgrades, category upgrades and downgrades, and investment/speculative upgrades and downgrades are all negative and significant.

[Please insert table 12 about here]

We also conduct Granger causality tests for two-causality between rating changes and risk-taking. For Cash the test is significant for two-way causality with downgrades but for upgrades it is only significant for cash causing upgrades and not the opposite way. For Capex similarly, downgrades are significant for both directions but for upgrades only the test for upgrades causing Capex are significant. Downgrade causing R&D is the only one significant for this type of risk-taking. HHI has significant results for two-way causality with upgrades. For downgrades HHI causing downgrades is significant only. For Numseg, downgrades are significant for both test and for upgrades, only upgrades causing Numseg is significant. These tests were done simply to check whether there is some evidence a relationship between rating changes and changes in risk-taking behavior. Overall, the results do confirm this.

[Please insert table 13 about here]

Our last hypothesis (see chapter 3) is to check if there are differences in effects of upgrades and downgrades. We run the regression in equation 6, which includes upgrade and downgrade data. $Dummy_1$ takes a value of 1, when there was an upgrade. Similarly, $Dummy_2$ takes the value of 1 when there is a downgrade. This regression allows us to directly compare the differences in effects of upgrades and downgrades.

$$Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + Dummy_1\, Upgrade_{t-1}(\alpha_1 + \beta_{it} X_{it} \sum_{i=1}^{p} \beta_{it} X_{it}) + Dummy_2(\alpha_2 + \sum_{i=1}^{p} \beta_{it} X_{it} Downgrade_{t-1}) + \varepsilon_{it} \quad (5)$$

We then calculate F-stats using equation 7. The coefficients in the calculation are the ones estimated for upgrades and downgrades, standard errors are their respective standard errors and the covariance is the covariance between upgrades and downgrades.

$$F - stat = \left(\frac{\beta upgrade - \beta downgrade}{\sqrt{(s.e.(upgrade))^2 + (s.e.(downgrade))^2 - 2 * covariance)}}\right)^2 \qquad (6)$$

The results for the F-stats are given in table 14. F-stats are significant for Two-notch rating changes using Cash and capex and all rating changes and category rating changes for Numseg. The results discussed previously showed that effects of downgrades were significant more commonly than upgrades. The results in table 14 however show that the differences are mostly not significant. One of the reason for this could be that the standard errors for upgrades (see tables 7-9) are higher than downgrades. Which results in lower test-statistics in table 14. As mentioned in section 6.1, that we also look at the descriptive stats for firms upgrades and downgrades separately (not reported here), the standard deviation of these stats were higher for upgrades and the difference for the average of these stats was also highest between upgrades and the entire sample. This may be contributing to higher standard errors. The variation in how upgrades effect firms may be higher because of these differences in the sample of firms being upgraded.

[Please insert table 14 about here]

We also run regressions similar to the ones in tables 7-9 but include a dummy variable for rating changes that happened during the recession from December, 2007-June, 2009.

$$Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + D + IND + RAT_{t-1} + \varepsilon_{it}, \quad (7)$$

[Please insert table 15 about here]

Adding the dummy variables changes the results of tables 7-9. The Numseg variable becomes insignificant for two-notch downgrades and category upgrades and Cash becomes insignificant for upgrades. These changes make the results for the cross-sectional regressions more consistent with the results for the propensity score matching results in table 11. This supports the literature discussed in section 5.2 about propensity score matching methodology being more robust. We match the control and treated firms based on closeness of propensity scores prior to the rating change and in the same year and industry when taking the difference after rating changes. This ensures that any effect of the recession on the treatment group is cancelled out by a similar effect on the control observation. We also find that the dummy variable for recession is significant and positive for Numseg in some regressions. A possible justification for this effect is offered by Petersen and Rajan (1997), who argue that firms who have poor access to capital markets use trade credit more often. During the recession, firms may not be able to find enough capital and may simply be increasing the number of segments to increase the number of suppliers they deal with and hence, have better access to trade credit.

7. Conclusion

Numerous studies argue that the interest of stockholders and bondholders may not be aligned. Managers may as a result acting in the interest of stockholders harm bondholders by taking on more risk. The negative impact of downgrades on stock and bonds is also well-documented. We hypothesize that downgrades have a negative impact on managerial performance assessment, managers may hence take on more risk to improve their overall performance. Similarly, managers may decrease risk, following upgrades because they would want to preserve their better performance. We run cross-sectional regressions, with different measures of risk-taking as the dependent variable and dummy variables for rating changes as the independent variable. We control for industry effects and different variables in the literature that have been identified to impact risk-taking. There is also the possibility that managerial risk-taking may change as the result of rating change effect on capital markets rather than the rating change itself. We control for this possibility by including the yearly stock return for the previous year as one of our conditioning variable. For robustness, we also calculate difference-in-differences (DiD) for matched samples. We match based on propensity scores and the Barber and Lyon (1997) framework. The results in sections 6.2 provide evidence of change in risk-taking behavior. For cross-sectional regressions, Numseg and Cash show decrease in risk-taking following downgrades and upgrades, this is in contrast to Capex showing increase in risk-taking following downgrades. We believe that even though the literature suggests reduction in Capex means increasing risk-taking. The manager may in fact be decreasing risk-taking by not investing in the same business (Capex) that resulted in a downgrade. This can also be confirmed by positive Numseg coefficient which is suggesting an increase in segments. A manager may be decreasing risk by not investing in Capex and instead investing in other segments. This result also has important bearing on the way Capex is used as a measure of risk-taking in the literature. Whether an increase/decrease in Capex means decrease/increase depends on the context. There is also clear evidence of downgrades having more pronounced effects than upgrades.

The results for DiD, where we use matching to calculate change in risk-taking behavior, the results provide mixed results. For propensity scores, Cash and R&D showing decrease in risk-taking and Capex showing increase in risk-taking following most types of downgrades. R&D also shows decrease in risk-taking following upgrades using fixed firm effects and capex shows decrease in risk-taking following upgrades using fixed industry effects. HHI and Numseg are only significant for Investment/Speculative type rating changes. With both showing decrease in risk-taking following upgrades or downgrades. Following the same intuition decrease in Capex here, could mean a decrease in risk-taking. The relationship between Cash and risk-taking could be more complicated as it could be affected by other risk measures. For matching using size and BM, HHI is negative for upgrades and downgrades, meaning decreased risk-taking. Capex is decreasing for downgrades and positive for upgrades. R&D and

Cash show increase in risk-taking for some type of downgrades and upgrades. HHI is positive, meaning higher risk-taking for category upgrades and downgrades.

These results provides evidence of change in risk-taking following rating changes. Granger causality tests done in table 13 also confirm this. Downgrades and Upgrades are both significant but as in the results from the regression the results are significant more often for downgrades. The analyses from cross-sectional regression and matched DiD show that there are some changes in risk-taking following rating changes and the results are more pronounced for downgrades. But the results do not provide a robust conclusion as to whether downgrades and upgrades result in changes in risk-taking similarly or in the opposite direction. This is also confirmed in table 14 where most differences between effects of risk-taking after downgrades and upgrades are not significant. Although this may also be due higher standard errors for upgrades that may affect firms in different means. A more robust conclusion that could be drawn from this research is that credit rating changes influence the type of investments managers make. Conclusion from Nini, Smith and Sufi (2009) about downgrades resulting in more restriction on Capex seems plausible for downgrades but it would not explain the changes after upgrades and changes in other measures of risk-taking. Consistent with prior research we find downgrades have more pronounced effects. We also find that rating changes between Speculative and investment grades affect more measures of risk-taking than other type of rating changes.

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Table 1. Definition of variables

This table explains the construction and the source of data used in our analysis. We use COMPUSTAT, CRSP and EXECUCOMP for our analysis. COMPUSTAT only reports segment data starting from 2007. The analysis for HHI and Number of segments used data from 2007-2013. The analysis on other risk-taking measures is done using data from 1994-2013.

Variable	**Description**	**Data source**
Capital expenditure (CAPEX)	(Capital Expenditure – Sale of Property, Plant and Equipment)/ Total Assets	COMPUSTAT
Book leverage (Leverage)	(Long-term debt + Debt in current liabilities)/Total Assets	COMPUSTAT
Cash to Assets (Cash)	Cash and Short-Term Investments / Total Assets	COMPUSTAT
Delta	Dollar change in CEO wealth for a 1 % change in stock price	COMPUSTAT EXECUCOMP AND CRSP
Vega	Dollar change in CEO wealth for a 0.01 % change in standard deviation of returns	COMPUSTAT EXECUCOMP AND CRSP
Herfindhal Index (HHI)	Herfindhal Index= (Sum of squared segment sales) / (squared firm sales)	COMPUSTAT segment database (only available 2007 onwards)
Market-to-book (MB)	(Assets - Total – Common/Ordinary Equity - Total + Price Close - Annual * Common Shares Outstanding)/Assets-Total	COMPUSTAT
Sales	Log natural of sales	COMPUSTAT
Sales growth (salesg)	Log ($Sales_t$/$Sales_{t-1}$)	COMPUSTAT

Table 1 (Continued)

Variable	Description	Data source
Number of segments (Numseg)	Log natural of Number of operating segments(using 2-digit NAIC)	COMPUSTAT segment database (only available 2007 onwards)
Size	Log natural of total assets	COMPUSTAT
Tenure	log natural of number years CEO has been in this position	COMPUSTAT EXECUCOMP
Total Salary (Tsalary)	total salary per year of CEO	COMPUSTAT EXECUCOMP
Yearly return (yrret)	stock return over the fiscal year	COMPUSTAT

Table 2. Number of upgrades and downgrades

This table provides information on the distribution of upgrades and downgrades by Standard and Poor's. All rating changes occur between 1994 and 2013. An upgrade is defined as any positive change in credit rating and a downgrade as any negative change in credit rating. The first column lists the number of rating categories changed in the rating change. Second column provides the total number of rating changes (upgrades and downgrades) that had a certain number of class changes. Columns 3 and 4 bifurcate number of class changes by upgrades and downgrades. The distribution is similar to previous research (see chapter 2) that finds downgrades outnumbering upgrades.

Number of class changes	Total	Upgrade	Downgrade
1	2246	1125	1121
2	402	134	268
3	61	13	48
4	20	7	13
5	9	2	7
6	5	0	5
>6	10	7	3
Total	**2753**	**1288**	**1465**

Table 3. Percentage of observations by rating class

This table provides the breakup of our sample by rating class. Ratings are by S&P. The rating changes happened between 1994 and 2013. First column reports the percentage of firms in our sample with the rating; given in the second column. 81.3 percent of the observations in our sample have rating in the B band. Percentage of firms with C rating is less than 0.01 percent. This is consistent with the COMPUSTAT data used by Kuang and Qin (2013)

Percentage of observations	**Rating**
0.04%	AAA
0.11%	AA+
0.51%	AA
1.38%	AA-
3.20%	A+
4.87%	A
6.61%	A-
8.54%	BBB+
11.41%	BBB
11.30%	BBB-
10.72%	BB+
11.77%	BB
10.75%	BB-
8.35%	B+
5.81%	B
2.65%	B-
0.98%	CCC+
0.36%	CCC
0.22%	CC
0.00%	C
0.18%	D

Table 4. Sample break-up by industry classification

This reports the different sectors included in our sample. The industry classification is North American Industry Classification Standard (NAICS) The first column lists the different categories, the second column lists the percentage of issuers in the sample belonging to each category. Finance and utility firms have been excluded as is consistent with prior research. 51.79 percent firms in our sample are from manufacturing industry. To avoid our analysis being heavily weighed on this industry. We condition on industry dummy variables in our regression analysis and match using industry for propensity score and, Size and book-to-market matching.

Industry (NAICS codes)	Observations (%)
Raw Materials and Energy Production (11, 21, 22)	7.30%
Construction (23)	2.12%
Manufacturing (31-33)	51.79%
Distribution and Transportation of goods (42, 44, 45, 48, 49)	16.53%
Real Estate, and Rental and Leasing (53)	0.99%
Professional and Business Services (54, 56)	5.42%
Education, Health and Social Services (61, 62)	2.85%
Leisure, Accommodation and Food Services (71, 72)	3.48%
Other Services (except Public Administration) (81)	0.43%
Public Administration (92)	0.00%
Others	9.11%

Table 5. Descriptive stats

This table reports the descriptive stats for key variables. Calculations for R&D have been done using only nonzero observations. Similarly for HHI and Numseg, that data used is from 2007-2013 as COMPUSTAT does not report segment data prior to that.

	Mean	Standard deviation
Vega	176.0587	360.0983
Delta	1384.1046	12240.5821
Tenure	7.05970	6.9486
Total Salary	1444.3396	1794.1711
Sales	7736.4741	16601.8549
Market-to-Book	1.8875	1.9746
Leverage	0.2889	0.1856
Total Assets	9462.4315	31363.0449
Capex	496.8330	1528.3451
Cash	812.8162	3092.3170
HHI	74.6108	2511.2483
Number of segments	13.7537	9.0690
R&D	386.3917	1003.7425

Table 6. Correlation between risk-taking measures

This table reports the correlation coefficients between the different risk-measures used. Where Risk is measured by R&D (research and development expense), HHI (herfindahl-hirschman index), Numseg (number of segments), Capex (capital expenditures) and Cash. The data is from 1994-2013 for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013. Observations that did not have an equivalent observation in the same period were omitted. For example, if for a certain firm the data for Capex exists but not for HHI in a certain year, then that observation if not used.

Risk-taking	Capex	Cash	HHI	Numseg	R&D
Capex	1	-0.1326	-0.0072	-0.0077	0.0487
Cash		1	0.0362	-0.1022	0.5043
HHI			1	0.0029	0.0318
Numseg				1	-0.0132
R&D					1

Table 7. Regression results of risk-taking on upgrades

This table reports the results for the regression, $Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + Upgrade_{t-1} + \varepsilon_{it}$, where Risk is measured by R&D (research and development expense), HHI (herfindahl-hirschman index), Numseg (number of segments), Capex (capital expenditures) and Cash. X contains the conditioning variables Vega, sensitivity of CEO wealth to stock volatility, Delta, sensitivity of CEO wealth to stock price, CEOchanged, which takes the value of 1 if the CEO changed last year and 0 otherwise, tenure, number of years CEO has been working as CEO, Tsalary is total salary of CEO, MB is market-to-book ratio, yrret is the stock return over the financial year and leverage is book leverage. IND is a dummy variable for industries, defined by the 2-digit NAIC code. Upgrade is a dummy variable which takes the value of 1 if the firm had an upgrade in the previous year and 0, otherwise. Firms that had downgrades have been removed. The data is from 1994-2013and uses 12416 firm-year observations for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013 and there are 4606 observations. Firms that had downgrades have been removed. *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level. Upgrade is significant for Cash and Numseg only. Positive coefficients for both show that upgrades decrease risk-taking.

Table 7. Continued

Independent Variables	**R&D upgrade**	**HHI upgrade**	**Numseg upgrade**	**Capex upgrade**	**Cash upgrade**
Intercept	0.0747*** (0.0033)	4.9259*** (0.2193)	1.7535*** (0.0897)	0.0640*** (0.0039)	0.3133*** (0.0088)
Vega	0.0008*** (0.0001)	-0.0157 (0.0096)	0.0224*** (0.0039)	-0.0004*** (0.0002)	0.0018*** (0.0003)
Delta	0.0009*** (0.0002)	-0.02149 (0.0168)	-0.0205*** (0.0066)	0.0013*** (0.0003)	0.0040*** (0.0007)
CEOchanged	0.0037*** (0.0013)	-0.0054 (0.0749)	0.0282 (0.0305)	-0.0003 (0.0015)	0.0054 (0.0035)
Tenure	-0.0001 (0.0001)	-0.0001 (0.0038)	0.0041*** (0.0015)	0.0001 (0.0001)	-0.0002 (0.0002)
TSalary	-0.0018*** (0.0004)	0.0195 (0.0270)	0.0028 (0.0111)	0.0001 (0.0004)	-0.0088*** (0.0010)
Sales	-0.0054*** (0.0002)	-0.2106*** (0.0186)	0.0931*** (0.0075)	-0.0027*** (0.0004)	-0.0168*** (0.0008)
MB	0.0045*** (0.0000)	-0.1363*** (0.0295)	-0.0777*** (0.0118)	0.001*** (0.0002)	0.0146*** (0.0005)
Salesg	-0.0000 (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	-0.0000 (0.0000)
Yrret	-0.0001*** (0.00002)	0.0027 (0.0032)	-0.0018 (0.0013)	-0.0000*** (0.0000)	-0.002*** (0.0000)
Leverage	-0.0383*** (0.0022)	0.2141* (0.1228)	-0.4003*** (0.0500)	0.0006 (0.0026)	-0.1616*** (0.0058)
Upgrade	0.00001 (0.0013)	0.0614 (0.0625)	0.0435* (0.0256)	0.0016 (0.0051)	0.0095*** (0.0034)
Adjusted R-squared	**0.2061**	**0.1097**	**0.2044**	**0.2405**	**0.1979**

Table 8. Regression results of risk-taking on Downgrades

This table reports the results for the regression, $Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + Downgrade_{t-1} + \varepsilon_{it}$, where Risk is measured by R&D (research and development expense), HHI (herfindahl-hirschman index), Numseg (number of segments), Capex (capital expenditures) and Cash. X contains the conditioning variables Vega, sensitivity of CEO wealth to stock volatility, Delta, sensitivity of CEO wealth to stock price, CEOchanged, which takes the value of 1 if the CEO changed last year and 0 otherwise, tenure, number of years CEO has been working as CEO, Tsalary is total salary of CEO, MB is market-to-book ratio, yrret is the stock return over the financial year and leverage is book leverage. IND is a dummy variable for different industries, defined by the 2-digit NAIC code. Downgrade is a dummy variable which takes the value of 1 if the firm had a downgrade in the previous year and 0, otherwise. Firms that had upgrades have been removed. The data is from 1994-2013and uses 12593 firm-year observations for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013 and there are 4554 observations *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level. Downgrade is positive and significant for Cash and Numseg. This shows a decrease in risk-taking. Downgrade for Capex is negative and significant, which shows an increase in risk-taking.

Table 8. Continued

Independent Variables	**R&D downgrade**	**HHI downgrade**	**Numseg downgrade**	**Capex downgrade**	**Cash downgrade**
Intercept	0.077*** (0.0033)	5.0060*** (0.2155)	1.6907*** (0.0871)	0.0646*** (0.0038)	0.3150*** (0.0088)
Vega	0.0018*** (0.0002)	-0.0117 (0.0099)	0.0229*** (0.0040)	-0.0012*** (0.0002)	0.0035*** (0.0005)
Delta	0.0007*** (0.0002)	-0.3150* (0.0171)	-0.0120* (0.0066)	0.00177*** (0.0002)	0.0038*** (0.0007)
CEOchanged	0.0048*** (0.0013)	-0.0660 (0.0742)	0.0283 (0.0300)	-0.0001 (0.0015)	0.0093*** (0.0033)
Tenure	-0.0001* (0.0000)	0.0029 (0.0038)	0.0038** (0.0015)	0.0000 (0.0000)	-0.0003* (0.0002)
TSalary	-0.0023*** (0.0004)	0.0136 (0.0245)	0.0078 (0.0100)	-0.0004 (0.0004)	-0.0093*** (0.0010)
Sales	-0.0058*** (0.0003)	-0.2061*** (0.0184)	0.0858*** (0.0074)	-0.0018*** (0.0004)	-0.0181*** (0.0008)
MB	0.0045*** (0.0002)	-0.1506*** (0.0315)	-0.0780*** (0.0125)	0.0011*** (0.0002)	0.0143*** (0.0005)
Salesg	-0.0000 (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)	0.000 (1.3)	-0.0000 (0.0000)
Yrret	-0.0001*** (0.0000)	0.0021 (0.0017)	-0.0003 (0.0007)	-0.0000* (0.0000)	-0.0002*** (0.0000)
Leverage	-0.0366*** (0.0022)	0.1948 (0.1225)	-0.3869*** (0.0493)	-0.0035 (0.0025)	-0.1508*** (0.0057)
Downgrade	0.0005 (0.0012)	0.1043 (0.0672)	0.0814*** (0.0272)	-0.015*** (0.0014)	0.0149*** (0.0032)
Adjusted R-squared	**0.2027**	**0.1092**	**0.2059**	**0.2375**	**0.1904**

Table 9. Regression estimates for different types of up/downgrades

This table reports the results for the regression, $Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + RAT_{t-1} + \varepsilon_{it}$, where Risk is measured by R&D (research and development expense), HHI (herfindahl-hirschman index), Numseg (number of segments), Capex (capital expenditures) and Cash. X contains the conditioning variables Vega, sensitivity of CEO wealth to stock volatility, Delta, sensitivity of CEO wealth to stock price, CEOchanged, which takes the value of 1 if the CEO changed last year and 0 otherwise, tenure, number of years CEO has been working as CEO, Tsalary is total salary of CEO, MB is market-to-book ratio, yrret is the stock return over the financial year and leverage is book leverage. IND is a dummy variable for different industries, defined by the 2-digit NAIC code. RAT is a dummy variable which takes the value of 1 if the firm had a certain type of downgrade/upgrade in the previous year and 0, otherwise. For example, when we look at the effects of Two-notch upgrades on risk-taking, we only include firms with two-notch upgrades and firms without any rating change. The data is from 1994-2013for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013. *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level. Downgrade is positive and significant for Cash and Numseg. This shows a decrease in risk-taking. Downgrade for Capex is negative and significant, which shows an increase in risk-taking.

Table 9. Continued

Rating change type	**CAPEX**	**CASH**	**HHI**	**NUMSEG**	**R&D**
Two-notch upgrade	0.0038 (0.0044)	0.0165 (0.0100)	0.1608 (0.2131)	0.1180 (0.0870)	0.0063 (0.0039)
Two-notch downgrade	-0.0168*** (0.0031)	0.0171** (0.0071)	0.0222 (0.1593)	0.1564** (0.0650)	0.0009 (0.0027)
Multi-notch upgrade	-0.0128 (0.0094)	-0.0049 (0.0215)	0.7260 (0.4803)	0.0404 (0.1876)	0.0054 (0.0082)
Multi-notch downgrade	-0.0200*** (0.0058)	0.0311** (0.0133)	0.5904** (0.2705)	0.0830 (0.1110)	0.0096* (0.0051)
Category upgrade	-0.0060*** (0.0018)	0.0155*** (0.0040)	0.0632 (0.0767)	0.0631** (0.0314)	0.0014 (0.0015)
Category downgrade	-0.0079*** (0.0017)	0.0134*** (0.0040)	0.1177 (0.0776)	0.0504 (0.0315)	-0.0008 (0.0015)
Spectoinvest	0.0015 (0.0040)	-0.0090 (0.0091)	-0.2027 (0.1812)	0.0194 (0.0735)	-0.0034 (0.0035)
Investtospec	-0.0160*** (0.0037)	0.0112 (0.0084)	0.1862 (0.1820)	0.1491** (0.07365)	-0.0012 (0.0032)

Table 10. Conditional Logit results for propensity score estimation

This table reports the coefficients (standard errors) for the conditional logit. The regression uses dummy variable RAT as the dependent variable, which takes the value of 1 if the firm had an upgrade/downgrade in year t+1. The independent variables are for year t. The objective is to get the probability whether a firm will have an upgrade/downgrade in the coming year. This will help in finding firms that have similar characteristics and any difference in risk-taking at t+2 will be due to the rating change. The predictor variables are Vega, sensitivity of CEO wealth to stock volatility, Delta, sensitivity of CEO wealth to stock price, CEOchanged, which takes the value of 1 if the CEO changed last year and 0 otherwise, tenure, number of years CEO has been working as CEO, Tsalary is total salary of CEO, MB is market-to-book ratio, yrret is the stock return over the financial year and leverage is book leverage .Separate regressions are run for downgrades and upgrades. We also use different combinations of fixed firm and fixed industry effects. .The data is from 1994-2013 for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013. *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level.

Table 10. Continued

Variable	FFE Downgrade	FFE Upgrade	FIE Downgrade	FIE Upgrade
Vega	0.1092*** (0.0261)	-0.0376** (0.0177)	0.0659*** (0.0188)	-0.0111 (0.0075)
Delta	-0.0206 (0.0279)	0.0784*** (0.0290)	-0.0805 (0.0201)	0.0617*** (0.0215)
Tenure	-0.0006 (0.0070)	0.0017 (0.0075)	-0.0076*** (0.0047)	-0.00935* (0.0048)
Tsalary	-0.0407 (0.0393)	0.0424 (0.0396)	-0.0325 (0.0292)	0.0448 (0.0332)
Sales	0.4582*** (0.0755)	0.1355** (0.0594)	0.1587*** (0.0254)	0.0864*** (0.0257)
MB	-0.3944*** (0.0723)	0.00218 (0.0208)	-0.5070*** (0.0503)	-0.0048 (0.0187)
Salesg	0.0003 (0.0007)	-0.00276 (0.0220)	0.0003 (0.0006)	-0.0006 (0.0033)
Yreturn	-0.9926*** (0.0883)	0.1251*** (0.0335)	-1.1221*** (0.0825)	0.0005 (0.00168)
Leverage	1.6058*** (0.2828)	1.0349*** (0.2895)	1.6282*** (0.1623)	1.0168*** (0.1629)

Table 11. Difference-in-differences results using propensity score

This table reports the results for the means difference-in-differences; calculated by subtracting risk-taking (Cash, Capex, R&D, HHI and Numseg) measures of matched (control) firms from the firms that had rating changes. Cash is cash and marketable securities scaled by total assets, CAPEX is capital expenditures scaled by total assets, R&D is research and development expense scaled by total assets, HHI is Herfindhal-Hirschmann Index and NUMSEG is number of segments the firm operates in. Standard error of mean is reported in the bracket. Firms are firms are first matched using 2-digit NAIC code and fiscal year. Both the control and the rating change firm have the same matched using propensity scores. The observations are then matched based on propensity scores. The matched control firm has the closest propensity score and the same fiscal year and 2-digit NAIC code. Matching is done one-to-one and with replacement. Propensity scores are calculated using conditional logistic regression, conditioning on Firm and industry. The data is from 1994-2013 for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013.*** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level.

Table 11 Continued

Fixed effect	DID type	Cash	Capex	R&D
Fixed firm	Upgrades	0.0060 (0.0046)	0.0027 (0.0022	-0.0079** (0.00033)
Effects	Downgrades	0.1152*** (0.0036)	-0.012*** (0.0017)	-0.0060** (0.0026)
Fixed Industry	Upgrades	0.0028 (0.0046)	0.0050** (0.0023)	-0.0031 (0.0037)
Effects	Downgrades	-0.0002 (0.0037)	-0.0148*** (0.0017)	-0.0042 (0.0027)
Fixed firm	Two notch Upgrades	0.0081 (0.0152)	-0.0069 (0.0076)	0.0067 (0.0083)
Effects	Two notch Downgrades	0.0196 (0.0084)	-0.0147** (0.0037)	-0.0002 (0.0064)
Fixed Industry	Two notch Upgrades	0.0171 (0.0133)	0.0025 (0.0063)	-0.0014 (0.0114)
Effects	Two notch Downgrades	0.0004 (0.0096)	-0.0202*** (0.0040)	-0.0008 (0.0069
Fixed firm	Multi-notch Upgrades	-0.0169 (0.0237)	-0.0408** (0.0155)	0.0115 (0.0317)
Effects	Multi-notch Downgrades	0.0220* (0.0130)	-0.0118* (0.0067)	0.0045 (0.0122)
Fixed Industry	Multi-notch Upgrades	-0.0306 (0.0220)	-0.0312 (0.0277)	0.0238 (0.0256)
Effects	Multi-notch Downgrades	-0.0018 (0.0170)	-0.0183** (0.0080)	0.0083 (0.0134)
Fixed firm	Category Upgrades	0.0053 (0.0057)	0.0031 (0.0027)	-0.0080 (0.0040)
Effects	Category Downgrades	0.0090** (0.0046)	-0.0138*** (0.0023)	-0.0068** (0.0032)
Fixed Industry	Category Upgrades	0.0018 (0.0056)	0.0045 (0.0028)	-0.0033 (0.0047)
Effects	Category Downgrades	-0.0017 (0.0046)	-0.0145*** (0.0021)	-0.0036 (0.0033)
Fixed firm	Speculative to investment	-0.0051 (0.0133)	0.0019 (0.0061)	-0.0092 (0.0076)
Effects	Investment to speculative	-0.0026 (0.0108)	-0.0075 (0.0048)	-0.0095 (0.0086)
Fixed Industry	Speculative to investment	-0.0051 (0.0116)	-0.0035 (0.00058)	-0.0023 (0.0547)
Effects	Investment to speculative	-0.0001 (0.0099)	-0.0172*** (0.0052)	-0.0086 (0.0084)

Table 11 Continued

Fixed effect	DID type	HHI	NumSeg
Fixed firm	Upgrades	0.0773 (0.0725)	0.0049 (0.0311)
Effects	Downgrades	0.0397 (0.0840)	0.0255 (0.6797)
Fixed Industry	Upgrades	0.0311 (0.0801)	0.0220 (0.0297)
Effects	Downgrades	0.0012 (0.0791)	-0.02046 (0.0347)
Fixed firm	Two notch Upgrades	-0.02169 (0.2913)	-0.0990 (0.1197)
Effects	Two notch Downgrades	-0.1219 (0.2093)	0.0236 (0.6410)
Fixed Industry	Two notch Upgrades	0.1637 (0.2129)	-0.1184 (0.1169)
Effects	Two notch Downgrades	-0.0476 (0.1782)	0.1098 (0.0884)
Fixed firm	Multi-notch Upgrades	0.5332 (0.6642)	-0.06153 (0.2062)
Effects	Multi-notch Downgrades	0.3888 (0.4881)	0.0062 (0.7949)
Fixed Industry	Multi-notch Upgrades	0.0644 (0.4471)	0.2307 (0.2100)
Effects	Multi-notch Downgrades	0.1060 (0.3145)	-0.0802 (0.1619)
Fixed firm	Category Upgrades	0.1475* (0.0871)	0.0103 (0.0390)
Effects	Category Downgrades	0.1091 (0.1031)	0.0005 (0.7014)
Fixed Industry	Category Upgrades	-0.0440 (0.0994)	0.0242 (0.0375)
Effects	Category Downgrades	0.0256 (0.0985)	-0.0473 (0.0434)
Fixed firm	Speculative to investment	-0.0856 (0.2209)	0.0396 (0.0877)
Effects	Investment to speculative	-0.0319 (0.2364)	0.1856* (0.7080)
Fixed Industry	Speculative to investment	-0.5721** (0.2461)	0.1902** (0.0712)
Effects	Investment to speculative	-0.1258 (0.2258)	0.2233** (0.0900)

Table 12. Difference-in-differences results using book and size matching

This table reports the results of difference-in-differences; calculated by subtracted risk-taking (Cash, Capex, R&D, HHI and Numseg) measures of matched (control) firms from the firms that had rating changes. Cash is cash and marketable securities scaled by total assets, CAPEX is capital expenditures scaled by total assets, R&D is research and development expense scaled by total assets, HHI is Herfindhal-Hirschmann Index and NUMSEG is number of segments the firm operates in. Standard error of mean is reported in the bracket. We first find control firms whose size (log natural of total assets) is a maximum of 30 percent higher or lower than the firm with the rating change in the previous year and then we find the firm with the closest book-to-market ratio. Matched observations have the same 2-digit NAIC code. .The data is from 1994-2013 for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013. *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level.

Table 12 Continued

DID type	CASH	CAPEX	R&D	HHI	NUMSEG
Upgrades	0.0008	0.0085***	0.0131***	-0.2836***	0.0196
	(0.0046)	(0.0023)	(0.0026)	(0.0858)	(0.0373)
Downgrades	-0.0147***	-0.0179***	0.0069***	-0.2959***	0.0556
	(0.042)	(0.0019)	(0.0025)	(0.0935)	(0.0398)
Two notch	0.0257*	0.0051	0.0159*	-0.2742	-0.0810
Upgrades	(0.0154)	(0.0069)	(0.0090)	(0.2370)	(0.1297)
Two notch	-0.0122	-0.0262***	0.0076	-0.4199*	0.0652
Downgrades	(0.0099)	(0.0046)	(0.0050)	(0.2124)	(0.0960)
Multi-notch	-0.0154	-0.0135	0.0342	-0.2644	-0.0054
Upgrades	(0.0389)	(-0.0158)	(0.00214)	(0.7706)	(0.2407)
Multi-notch	-0.0185	-0.0083	0.0173	-0.2196	0.2120
Downgrades	(0.0174)	(0.0073)	(0.0108)	(0.5693)	(0.1870)
Category	0.0009	0.0098***	0.0146***	-0.2401**	0.0503
Upgrades	(0.0057)	(0.0003)	(0.0033)	(0.1079)	(0.0482)
Category	-0.0214***	-0.0125***	0.076**	-0.3425***	0.0353
Downgrades	(0.0052)	(0.0023)	(0.0030)	(0.1069)	(0.0479)
Speculative to	-0.0155	-0.0005	0.0111	-0.7154***	0.0763
investment	(0.0116)	(0.0058)	(0.0068)	(0.2277)	(0.1021)
Investment to	-0.0171*	-0.0170***	0.0137*	-0.6280**	0.0000
speculative	(0.0099)	(0.0055)	(0.0069)	(0.2412)	(0.1101)

Table 13. Granger Causality tests

Table 12 reports the results for granger causality tests conducted using three lags .The data is from 1994-2013 for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013. The objective is to test if there is causality between rating changes and risk-taking and vice versa. *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level.

Table 13 Continued

Granger Causality test	F-stat
UPGRADE does not Granger Cause CASH	0.6849
CASH does not Granger Cause UPGRADE	4.8627***
DOWNGRADE does not Granger Cause CASH	19.3753***
CASH does not Granger Cause DOWNGRADE	5.90209***
UPGRADE does not Granger Cause CAPEX	6.0949***
CAPEX does not Granger Cause UPGRADE	1.09389
DOWNGRADE does not Granger Cause CAPEX	20.1530***
CAPEX does not Granger Cause DOWNGRADE	4.70686***
UPGRADE does not Granger Cause R&D	1.4396
R&D does not Granger Cause UPGRADE	0.7740
DOWNGRADE does not Granger Cause R&D	8.8139***
R&D does not Granger Cause DOWNGRADE	0.7455
UPGRADE does not Granger Cause HHI	3.5494**
HHI does not Granger Cause UPGRADE	2.1206*
DOWNGRADE does not Granger Cause HHI	1.7424
HHI does not Granger Cause DOWNGRADE	4.3751***
UPGRADE does not Granger Cause NUMSEG	2.1422*
NUMSEG does not Granger Cause UPGRADE	4.9224
DOWNGRADE does not Granger Cause NUMSEG	6.2492***
NUMSEG does not Granger Cause DOWNGRADE	2.6414**

Table 14. F-test to test for differences in effects of upgrades/downgrades

This table reports the results for the significance of differences in effects of upgrades and downgrades. A regression using the following equation is first run:

$$Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + IND + Dummy_1\, Upgrade_{t-1}(\alpha_1 + \beta_{it} X_{it} \sum_{i=1}^{p} \beta_{it} X_{it}) + Dummy_2(\alpha_2 + \sum_{i=1}^{p} \beta_{it} X_{it} Downgrade_{t-1}) + \varepsilon_{it}$$

Where Risk is a measure of risk-taking, measured by Cash, Capex, R&D, HHI and Numseg. Where Cash is cash and marketable securities scaled by total assets, CAPEX is capital expenditures scaled by total assets, R&D is research and development expense scaled by total assets, HHI is Herfindhal-Hirschmann Index and NUMSEG is number of segments the firm operates in. IND is the industry dummy variable using 2-digit NAIC code. .The data is from 1994-2013 for R&D, Capex and Cash. For HHI and Numseg, data is from 2007-2013. The number in the table are F-stats calculated using the equation:

$$F - stat = \left(\frac{\beta upgrade - \beta downgrade}{\sqrt{(s.e.(upgrade))^2 + \left(s.e.(downgrade)\right)^2 - 2 * covariance)}}\right)^2$$

* Denotes statistical significance.

Rating change type	Capex	Cash	HHI	Numseg	R&D
Upgrade/Downgrade	0.2085	0.3981	0.3361	3.2121*	0.2895
Two notch	5.4644*	2.3419*	0.5153	0.0038	0.1964
Multi-notch	0.6306	0.0024	0.0054	0.0185	0.0301
Category	0.1452	1.4959*	0.2898	4.2832*	0.0898
Speculative/ investment	0.2510	0.0615	0.1969	0.3783	0.8309

Table 15. Regression estimates using dummy variable for the recession

This table reports the results for the regression, $Risk_{it} = \alpha_0 + \sum_{i=1}^{p} \beta_{it} X_{it} + D + IND + RAT_{t-1} + \varepsilon_{it}$, where Risk is measured by R&D (research and development expense), HHI (herfindahl-hirschman index), Numseg (number of segments), Capex (capital expenditures) and Cash. X contains the conditioning variables Vega, sensitivity of CEO wealth to stock volatility, Delta, sensitivity of CEO wealth to stock price, CEOchanged, which takes the value of 1 if the CEO changed last year and 0 otherwise, tenure, number of years CEO has been working as CEO, Tsalary is total salary of CEO, MB is market-to-book ratio, yrret is the stock return over the financial year and leverage is book leverage. IND is a dummy variable for different industries, defined by the 2-digit NAIC code. RAT is a dummy variable which takes the value of 1 if the firm had a certain type of downgrade/upgrade in the previous year and 0, otherwise. For example, when we look at the effects of Two-notch upgrades on risk-taking, we only include firms with two-notch upgrades and firms without any rating change. Variable D is a dummy variable that takes the value of 1, if observation belongs to the recession period from December, 2007-June, 2009 and 0 otherwise. The data is from 1994-2013for R&D, Capex and Cash. For HHI and Numseg data is from 2007-2013. *** denotes significance at 99 percent, ** denotes significance at 95 percent level and * denotes significance at the 90 percent confidence level. Downgrade is positive and significant for Cash and Numseg. This shows a decrease in risk-taking. Downgrade for Capex is negative and significant, which shows an increase in risk-taking.

Rating change	CASH	CAPEX	R&D	HHI	NUMSEG
Upgrades	0.0055 (0.0037)	0.0022 (0.0016)	-0.0006 (0.0014)	-0.0386 (0.0761)	-0.0354 (0.0.0318)
Recession	0.0237*** (0.0085)	-0.0036 (0.0038)	0.0035 (0.0032)	0.2789* (0.1214)	0.2345*** (0.0507)
Downgrades	0.0131 (0.0035)	-0.0152*** (0.0015)	0.0007 (0.0013)	-0.1432 (0.0.0848)	0.0599 (0.0352)
Recession	0.0108 (0.0081)	-0.0007 (0.0035)	-0.0011 (0.0031)	0.5904*** (0.1240)	0.0551 (0.0514)
Two notch Upgrades	0.0151 (0.0104)	0.0034 (0.0046)	0.0054 (0.0040)	0.1370 (0.2408)	0.1311 (0.1003)
Recession	0.0183 (0.0380)	0.0056 (0.1671)	0.0117 (0.0146)	0.1089 (0.5138)	-0.0487 (0.2140)
Two notch Downgrades	0.0139* (0.0076)	-0.0162*** (0.0033)	0.0013 (0.0029)	-0.0470 (0.1942)	0.0979 (0.0805)
Recession	0.0286 (0.0223)	-0.0054 (0.0098)	-0.0043 (0.0086)	0.2070 (0.3326)	0.1482 (0.1379)
Multi-notch Upgrades	-0.0086 (0.0236)	-0.0142 (0.0104)	0.0078 (0.0091)	1.5413** (0.7198)	0.0682 (0.2991)
Recession	0.0212 (0.0567)	0.0081 (0.0250)	-0.0138 (0.0218)	-1.4668 (0.9648)	0.0584 (0.4009)
Multi-notch Downgrades	0.0365** (0.0145)	-0.0223*** (0.0064)	0.0099* (0.0056)	0.3181 (0.3529)	0.1455 (0.1463)
Recession	-0.0343 (0.0363)	0.0151 (0.0160)	-0.0020 (0.0140)	0.6545 (0.5452)	-0.1500 (0.2260)
Category Upgrades	0.0112** (0.0044)	-0.0063*** (0.0019)	0.0013 (0.0017)	-0.1356 (0.0960)	0.0089 (0.0401)
Recession	0.0247** (0.0102)	0.0017 (0..45)	0.0006 (0.0039)	0.5136*** (0.1496)	0.01426** (0.0625)
Category Downgrades	0.0114*** (0.0043)	-0.0071*** (0.0019)	-0.0007 (0.0039)	-0.0762 (0.0969)	-0.0024 (0.0403)
Recession	0.0128 (0.010)	-0.0051 (0.0045)	-0.0006 (0.0039)	0.5054*** (0.1519)	0.1515 (0.0632)
Speculative to investment	-0.0115 (0.0097)	0.0037 (0.0043)	-0.0039 (0.0037)	-0.2526 (0.2133)	-0.1035 (0.0886)
Recession	0.0219 (0.0288)	-0.0199 (0.0043)	0.0045 (0.0111)	0.1771 (0.3994)	0.4758*** (0.1658)
Investment to speculative	0.0078 (0.0092)	-0.0182*** (0.0041)	-0.0011 (0.0035)	-0.1418 (0.2556)	0.2103** (0.1061)
Recession	0.0202 (0.0223)	0.0132 (0.0098)	-0.0008 (0.0086)	0.6570 (0.3595)	-0.1152 (0.1492)