

Information Transfer Effects of Bond Rating Downgrades

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ABSTRACT

This paper investigates information transfer effects of bond rating downgrades measured by equity abnormal returns for industry portfolios. Industry rivals can be subject to two opposing effects, the contagion effect and the competition effect. We find that the net effect is strongly dependent on the original bond rating of the downgraded firm. For investment-grade (speculative-grade) firms, industry abnormal equity returns are negative (positive), which implies a predominant *contagion* (*competition*) effect. The analysis reveals a rich pattern of positive and negative correlations across negative credit events, which can be used to improve our understanding of portfolio credit risk models.

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1. Introduction

Recent years have witnessed technical advances in portfolio credit risk models, in theory allowing financial institutions to measure and manage the risk of loans and bonds on an overall, portfolio basis. In parallel, there has been a surge of academic research on credit risk models. While the models can be fairly complex, they all rely on the basic insight from Markowitz, which is that portfolio risk heavily depends on correlations. The measurement of correlations, however, is a particular challenge for credit risk models due to the sparse nature of credit events.

This paper attempts to improve our understanding of the correlations with an empirical analysis of the information transfer effects of bond rating downgrades. We analyze the effect of 679 downgrades during the period 1996 to 2002 on the stock prices of industry competitors. This gives a much larger sample of credit events than previously studied in the literature. Moreover, it allows more precise and detailed analysis of contagion versus competition effects across the whole spectrum of bond ratings.

“Contagion” implies that a negative credit event, such as a downgrade, will negatively affect other firms in the same industry. Contagion effects can arise for several reasons. First, the event can reveal new information about negative shocks to cash flows that are common across the industry. Alternatively, there can be counterparty risk within the industry, which occurs when the default of one firm causes financial distress on other firms with which the first firm has close business ties. Jorion and Zhang (2009) and Hertz, Li, Officer, and Rodgers (2008) study the effect of financial distress on creditors and along the supply chain, respectively. Thirdly, investors can require a greater risk premium for the industry, reflecting the updating of beliefs. A recent example is the downgrade of General

Motors and Ford to ‘junk’ status that led to industry-wide shocks, where all three factors were at play.

“Competition,” in contrast, implies that a negative credit event will positively affect other firms in the industry. With a fixed demand for the product, remaining firms can capture new clients from the displaced firm, generally benefit from reduced capacity, or have more market power, which is the case in more concentrated industries. For example, when the bond rating of United Airlines was lowered to deep ‘junk’ status in July 2002, fears of financial distress steered passengers away to other competitors.

Lang and Stulz (1992) investigate the industry contagion and competition effects for a sample of 59 U.S. corporate bankruptcies and find a net contagion effect. They find strong competition effects for firms in more concentrated industries. Jorion and Zhang (2007a) extend the study with a larger sample of Chapter 11 and Chapter 7 bankruptcies using Credit Default Swap (CDS) and stock price data. They confirm that contagion effects dominate for Chapter 11 bankruptcies, which involve reorganization. However, competition effects dominate for Chapter 7 bankruptcies, which involve liquidation.

Our focus on bond rating downgrades is closely related to this line of literature but differs in important ways. The analysis of industry effects around bankruptcy is limited in terms of sample size and scope. Credit rating changes are a more general class of credit events that can also have large effects on portfolio values.

This paper extends the large and growing literature that examines the price impact of bond rating change on the stock price of the affected firm. This body of research indicates that stock prices react very strongly to downgrades, but less so to upgrades. We show that rating downgrades convey information not only about the downgraded firm, but have information implications for its peer firms as well, as measured by abnormal equity returns

for an *industry portfolio*. The industry reaction is not uniform, however. Specifically, we present the first evidence that the direction of industry reaction to downgrades is conditioned by the bond rating of the downgraded firm. Significant negative industry returns arise for downgrades of investment-grade firms, which is consistent with predominant contagion effects. In contrast, industry returns are positive for downgrades of speculative-grade firms, which is consistent with greater competition effects.

This study provides the first detailed analysis of the extent and drivers of contagion and competition effects for rating downgrades. We also extend the literature by examining industry effects upon announcements of negative credit watch placement and around the pre-bankruptcy filing period.

Finally, we investigate the economic implications of the results by showing how portfolios can be constructed to have lower risk, using groups of firms where the competition effects are the largest. We report substantial reductions in portfolio risk across the credit event, which otherwise could not be attained by the traditional time-series analysis based on stock prices.

2. Information content of news

2.1 Literature review

A credit rating is an evaluation of creditworthiness, which can be interpreted as a subjective probability of default. A rich compilation of literature investigates the information content of changes in bond ratings measured in terms of abnormal stock or bond returns around the announcement,¹ which has led to two key conventional findings. First, most papers report significant negative abnormal returns in equity and bond markets in the case of

¹ See Zaima and McCarthy (2005); Dichev and Piotrovski (2001); Hand, Holthausen, and Leftwich (1992); Holthausen and Leftwich (1986); Pinches and Singleton (1978); and Weinstein (1977), among others.

downgrades. Second, bond rating upgrades are associated with a much smaller effect, typically not significant. This suggests that markets view upgrades as less informative than downgrades.

Another stream of research investigates information transfers across firms for corporate events such as bankruptcies, mergers and acquisitions, seasoned equity issues, earnings announcement, stock repurchases, and so on.² A positive (negative) information transfer occurs when a surprise of the announcing firm is associated with abnormal returns to other firms in the same (opposite) direction as the announcer. Positive information transfers are found around management's forecasts of earnings, earnings announcements, dividend announcements, and more recently, earnings restatements (Xu, Najand, and Ziegenfuss, 2006). Other studies find both positive and negative information transfers following certain types of corporate events. Lang and Stulz (1992) find overall negative industry share responses around announcements of Chapter 11 bankruptcies, but they also find favorable share responses of rivals in highly concentrated industries. Jorion and Zhang (2007a) show that contagion effects dominate for Chapter 11 bankruptcies and when firms experience an unanticipated adverse credit event, but competition effects dominate for Chapter 7 bankruptcies, when firms liquidate. However, bankruptcies are extreme credit events.

Credit rating downgrades are much more common, which can cause contagion or competition effects. Our paper is most closely related to Caton and Goh (2003) and Akhigbe, Madura, and Whyte (1997). Akhigbe, Madura, and Whyte (1997) conduct a study of information transfer effects for bond rating changes. Negative abnormal returns are found for

² For management's forecasts of earnings, see Foster (1981); for announcements of earnings, see Firth (1976); for dividend announcements, see Laux, Starks, and Yoon (1998) and Firth (1996); for seasoned equity issues, see Slovin, Marie, and Polonchek (1992). Other papers examine information transfer effect across sovereign countries. For example, Ferreira and Gama (2007) find that sovereign debt rating downgrade news of one country has a significant negative effect on the stock market returns of other countries.

firms that experienced bond rating downgrades and for their industry rivals, but their results are not conditioned on the rating before firms are downgraded. Caton and Goh (2003) investigate the implications of rating downgrades for earnings forecasts but do not find statistically significant differences across groups for the industry portfolios. The present study differs from theirs in that it is the first to present a detailed analysis of contagion and competition effects of bond rating downgrades.

2.2 Hypothesis development

Our main hypothesis is that the contagion and competition effects on industry rivals will depend on the original credit quality of the downgraded firm.

The downgrades of investment-grade firms are likely to produce negative industry abnormal returns (contagion effects) while the downgrades of speculative-grade firms should lead to positive industry abnormal returns (competition effects).

This hypothesis is justified by a number of theories. First, prior studies on industry competition imply that downgrades of lower-rated firms are more likely to benefit their industry rivals. For example, Brander and Lewis (1988) argue that the external benefits to rivals increase with the extent of financial distress as the damage to a firm's reputation or the probability of output disruption could be increasing in the size of the shortfall. Therefore, we expect greater competition effects for downgrades of speculative-grade firms.

Second, credit contagion theories suggest that downgrades of higher-rated firms are more likely to have contagion effects for industry rivals. Credit risk contagion can arise from counterparty risk when the default of one firm causes financial distress on entities with which it has close business ties or which have financial claims, such as trade credits between customers and suppliers, or bank loans. (See Davis and Lo, 2001, and Jarrow and Yu, 2001,

for theoretic models and Jorion and Zhang, 2009, and Hertz, Li, Officer, and Rodgers, 2008, for empirical tests.) The effect should be stronger if investment-grade companies are downgraded, first because of their larger size (which implies relationships with more counterparties) and also because counterparties typically require less credit protection from investment-grade firms.

In parallel, Collin-Dufresne, Goldstein, and Helwege (2003) present an information-based contagion model in which contagion arises due to a Bayesian updating of beliefs by investors. For example, Enron led investors to reassess their perception of the quality of accounting information of other firms even though there may not have been business ties between the firms. The fall in the stock price is driven by an increase in the risk premium. Collin-Dufresne, Goldstein, and Helwege argue that “one would expect that jumps in the yield spreads of larger, ‘safer’ firms would produce a greater impact on the market portfolio than ‘riskier’ firms.” Again, the argument is that contagion effects should be stronger for investment-grade firms.

2.3 Cross-sectional predictions

The above explanations of competition effects and credit contagion lead to other useful cross-sectional predictions. For example, the study of Brander and Lewis (1988) implies that, all else equal, industries with less competition should benefit more from the collapse of one of the firms because the remaining firms will have more market power. Therefore, competition effects should be stronger when the industry is more concentrated, as measured by the Herfindahl index.

Both counterparty risk and information-based contagion theories imply that the contagion effects should be stronger when the failing firm is large, controlling for concentration. Contagion theories also suggest that contagion effects should be stronger for

industry rivals with greater equity returns correlation to the downgraded firm due to greater cash flow similarities. On the other hand, industry rivals with greater correlation to the distressed firm are closer substitutes and are therefore more likely to capture the market share left by the distressed firm. Therefore, the net effect could be positive or negative. Next, we consider the effect of the average bond rating or leverage for industry peers. Few studies on industry information transfer differentiate rival firms by credit quality.³ Contagion implies that industries with lower bond ratings, or greater leverage, will be more negatively affected. The competition effect, however, suggests that an ailing industry should benefit more from a company exit than in the case of a profitable industry. So, the net effect is not clear-cut.

We also explore the effect of Regulation Fair Disclosure (FD), which was put in place on October 23, 2000. FD conferred a strategic advantage to the ratings agencies because it allows U.S. public companies to disclose non-public information to credit rating agencies but not to equity analysts. This can increase the value of credit ratings to equity investors. Jorion, Liu, and Shi (2005) find that the informational effect on firms experiencing rating changes is much bigger in the post-FD period. DeFusco, Mishra, and Raghunandan (2009) confirm that the improvement in the informational efficiency of stock prices persists in later periods. Finally, we account for the number of notches of the downgrade, as in Jorion, Liu, and Shi (2005) and Akhigbe, Madura, and Whyte (1997).

In summary, we explore how industry concentration, firm size, equity returns correlation, average bond rating, leverage of the industry peer group, and the implementation of Regulation FD can help explain the cross-section of industry price effects.

3. Research design

³ Exceptions include Aharony and Swary (1996), who show that the contagion effect is worse for banks with less capital or more leverage. Lang and Stulz (1992) also find a negative relation, albeit not significant.

We analyze share price reactions for downgraded firms and their horizontal rivals in response to rating downgrades.

3.1 Sample

The sample used in this study consists of rating downgrade announcements over the period 1996 to 2002. We identify our initial sample of downgrades from the Fixed Investment Securities Database (FISD), which provides information on ratings from Standard & Poor's, Moody's, Fitch, and Duff and Phelps. Each issuer's rating change constitutes one sample observation. If multiple issues of the same company are downgraded on the same date, we use the largest magnitude of rating change in the subsequent analysis. We use the first downgrade if Standard & Poor's and Moody's assign downgrade ratings consecutively for the same company. We also require the issuer to have daily stock returns 250 days before and 5 days after the downgrade announcement date in the CRSP file. This results in a sample with 775 rating downgrades. We also require the bond rating downgrades to be free of any confounding events that could distort the measurement of the downgraded firm's valuation effects and the intra-industry effects. To this end, we exclude rating changes that coincide with other major corporate news such as announcements concerning earnings, mergers, and divestments recorded by Factiva News database within a three-day event window surrounding the downgrade announcement. We eliminate a total of 96 downgrades due to potentially confounding news announcements. This yields an uncontaminated sample of 679 rating downgrades, covering 132 industries in terms of four-digit SIC codes, as shown in Panel A of Table 1. The underlying securities consist of 605 issues of senior unsecured debt (89.1% of the sample), 56 issues of subordinated debt (8.2%), nine issues each of senior secured debt and senior subordinated debt (1.3%). The mean and median of events per industry are five and three, respectively.

Panel B describes the industry distribution of our sample based on the one-digit SIC code. Manufacturing, transportation, and wholesale and retail trade industries account for most of our sample. In terms of four-digit SIC code, the telecommunication industry has 40 rating downgrade events, followed by the airlines industry with 28 events (not reported).

Panel C of Table 1 categorizes the sample by the magnitude of rating downgrades. The magnitude of a rating change is the absolute value of the difference between the cardinal value of the new rating and that of the old rating of the same bond issue. For the vast majority of observations, the downgrade is either one or two categories.

[Insert Table 1]

For a firm to qualify for the industry peer group, we impose the following selection criteria: (1) it has the same four-digit SIC code as the downgraded firm, (2) it has equity returns 250 days before and 5 days after the downgrade announcement date from the CRSP daily file, and (3) it does not experience a downgrade within a five-day event window, as indicated before. The mean and median numbers of rival firms per announcement are 35 and 29; the minimum and maximum numbers of rivals are one and 281, respectively.

3.2 Abnormal equity returns method

We conduct a standard event study of the market reaction to an announcement of a rating downgrade. Our announcement dates (day 0) are those listed in FISD. The abnormal return for a downgraded firm is the deviation of the stock return from a contemporaneous expected return generated by a market model. The abnormal return (AR_{jt}) for the common stock of firm j on day t is defined as follows:

$$AR_{jt} = R_{jt} - (\alpha_j + \beta_j R_{mt}), \tag{1}$$

where R_{jt} is the rate of return for the common stock of firm j on day t . The market model's

parameters (α_j, β_j) are estimated against the benchmark market return (R_{mt}), which is proxied by the CRSP value-weighted equity returns over a 200-trading-day estimation period ending 50 days prior to the announcement.

We define the event window as $[T_1, T_2]$, where T_1 and T_2 are number of days relative to the announcement day. We then compute cumulative abnormal returns for the two-day announcement window. To test the null hypothesis that the (cumulative) abnormal return is equal to zero, we report the corrected z-statistic from the standardized cross-sectional test of Boehmer, Musumeci, and Poulsen (BMP, 1991). The BMP test is an extension of the Patell (1976) test to the case where the event can effect the return variance. The BMP test makes a final empirical cross-sectional variance adjustment in place of the analytical variance of the total standardized abnormal returns to account for possible violation of the assumption of independence across securities. Cowan (2007, page 80-85) fully describes the standardized cross-sectional test statistic.

In addition to the statistical tests for average abnormal returns, we also report the proportion of negative abnormal returns and conduct a generalized sign test as a non-parametric check on the abnormal returns, where the fractions of positive and negative returns under the null hypothesis are determined by the fractions observed in the estimation period, rather than fixed at 0.5 as in the simple sign test (see Cowan, 1992; Cowan, Nandkumar, and Singh, 1990; and Singh, Cowan, and Nayar, 1991).

The procedure is extended to industry effects as follows. For each announcement, we construct a value-weighted portfolio consisting of the downgraded firm's industry counterparts and perform event tests on the industry returns.⁴

⁴ Alternatively, we construct equally-weighted industry portfolios. Results are very similar and are not reported to save space.

4. Results

4.1 Abnormal stock returns for the downgraded firm and industry portfolios

The market response to bond rating changes is presented in Table 2. Consistent with prior studies, such as Holthausen and Leftwich (1986) and Hand, Holthausen, and Leftwich (1992), we observe a significant negative average cumulative abnormal stock return (CAR) for the two-day event window of -1.7% ($z = -3.49$) for the entire sample of 679 downgraded firms. The fraction of negative CAR is 56.3%, which is also significant. Next, Jorion and Zhang (2007b) indicate that we should expect greater price impact for lower initial ratings. This is confirmed in the data, with a CAR of -1.56% for firms initially rated as investment grade and -1.79% for speculative-grade firms.

[Insert Table 2]

Next, we consider the response of industry portfolios to downgrades, which is reported in the right panel of Table 2. No significant and economically meaningful abnormal return is recorded for the entire sample of downgrades. The average two-day CAR is -0.08%, which is small and insignificant. Rating downgrades appear to convey, on average, no information concerning common stock values for the rest of the industry. There may be differences across categories, however.

To differentiate information transfer effects induced by downgrades due to firm-specific reasons as compared to industry common factors, we examine two sub-samples: one with 582 single-firm downgrade events and another with 97 multiple-firm downgrade events. We define multiple downgrades as consecutive downgrades of multiple firms in the same industry (having the same four-digit SIC code) within a five-day period. Multiple downgrades in an industry can occur in a short period in the case of generalized deterioration

of industry prospects (e.g., reduced demand), as in the case of the recent automotive downgrades. In this case, industry peer firms should post negative returns due to the common industry factors; competition effects should be weaker. In contrast, a single downgrade is more likely due to a firm-specific reason, which can lead to both contagion and competition effects.

For multiple downgrades (see Table 2), we find that the industry portfolio CAR is -1.06%, which is negative and significant. In contrast, for single downgrades, the net effect is +0.1%, which is not significant. We need to take a closer look at the effect conditioned on the initial credit quality of downgraded firms.

The full sample is partitioned into two groups according to whether the downgraded firm originally carries an investment-grade or speculative-grade rating. For the investment-grade sample, the industry portfolio CAR is -0.45%, with a z-statistic of -2.07, suggesting a strong contagion effect. This is in the same direction as the downgraded firms but is smaller, in line with other information transfer studies. For the speculative-grade sample, the industry portfolio CAR is 0.17%, with a z-statistic of 1.71, indicating a weak competition effect. The preliminary evidence is in support of our first hypothesis.

To compare with prior studies, we also conduct an empirical analysis of bond rating upgrades for the period 1996 to 2002, similar to how we handled bond rating downgrades. Results are reported in Panel B of Table 2. Firms that experienced bond rating upgrades on average show positive but insignificant abnormal returns, consistent with the absence of a significant reaction for upgrades in most rating change studies. However, the average [0, 1] event window CAR for speculative-grade firms is positive and significant, consistent with the finding by Jorion and Zhang (2007b) that stock price effects for bond rating upgrades are much stronger for low-rated firms relative to high-rated firms. In line with Akhigbe, Madura,

and Whyte (1997), we find negative but insignificant abnormal returns for industry rivals. Thus, it appears that the upgrades do not reveal new information for industry rivals.

Because the use of the multiple-downgrade sample can bias the results towards contagion effects, we restrict our attention to cases where a single firm is downgraded in the subsequent analysis. Table 3 provides a cleaner test of our main hypothesis. We divide the *single-downgrade* sample into two groups according to whether the downgraded firm originally carries an investment-grade or speculative-grade rating. Here, the differences are more apparent. As shown in Panel A of Table 3, for the investment-grade sample, the industry portfolio CAR is -0.34% for the [0, 1] event window, which is significant at the 5% level. This result suggests that investors perceive that downgrades of high-rated firms reflect new information regarding general conditions within the industry group. The negative sign points to a contagion effect.

[Insert Table 3]

The industry response to downgrades of speculative-grade firms, however, is sharply different. Here, the industry portfolio CAR is +0.36% for the [0, 1] event window, which is significant at the 1% level. This result reflects a net competition effect. Panel B shows that the mean differences of -0.70%, -1.24%, and -1.74% for the [0, 1], [-2, 2], and [-5, 5] event windows for the two rating categories are all significant at the 1% level, as indicated by the t-statistics. The median differences for the three event windows are also statistically significant at the conventional level, as shown by the Wilcoxon statistics. The result lends consistent support for our main hypothesis.

We also repeat the analysis by examining whether our results hold for the full contaminated sample that includes downgrades that are accompanied by confounding events. The industry CARs for the investment-grade (speculative) sub-sample are negative (positive)

and significant. Both the contagion effects and competition are stronger than the uncontaminated sample. This suggests that downgrades accompanied by other corporate shocks, carry stronger industry implications. The results are skipped due to space constraint but available upon request.

4.2 Cross-sectional analysis

Next, we examine the factors associated with cross-sectional differences in the industry reaction. Our cross-sectional regression extends the usual analysis to the industry portfolio in the literature, which focuses on the direct price impact for the firm downgraded. We conduct the Ordinary Least Square (OLS) regression of the downgrade effect for the industry portfolios, with t -statistics based on heteroskedasticity-corrected standard errors. Because the BMP standardized cross-sectional test is based on the abnormal return variance being non-constant across security-events, we also use Weighted Least Square (WLS) regressions where each security-event is weighted by the inverse of the standard deviation of the prediction errors. The left (right) panel presents results for the OLS (WLS) regression, respectively.

[Insert Table 4]

As a starting point, we examine univariate effects, by sorting abnormal equity returns on the variables one at a time, taken separately for the investment-grade and speculative-grade sample. We split the sample according to RCHANGE, SIZE, CORR, HERF, RTIND, LEVIND, and REGFD. Results are consistent with the multiple regressions. They are skipped to save space but are available upon request.

Next, we focus on the results based on the OLS regression. For the investment-grade sample, we find a negative coefficient on the firm size (SIZE), indicating a greater contagion effect when the downgraded firm is large. The coefficient on the regulation FD dummy

(REGFD) is negative, consistent with the univariate analysis that information transfer effects are stronger after the implementation of Regulation FD. For the speculative-grade sub-sample, we find positive coefficients on equity return correlation (CORR), industry concentration index (HERF), the average bond rating of the industry (RTIND), and median industry leverage (LEVIND), indicating greater competition effects for the industries with greater cash flow similarities, higher concentration, lower bond ratings, and higher leverage.

Finally, for the full sample, the coefficient on the level of the initial rating of the downgraded firm (RTO) is positive, suggesting competition effects are stronger for lower-rated firms (higher RTO values), which lends further support to our main hypothesis. The coefficients on HERF and LEVIND are positive and significant, as expected. The coefficient on REGFD is negative, suggesting overall stronger contagion effects to industry portfolios during the post-Reg FD period. Coefficients on CORR, SIZE, and RTIND are not significant, perhaps due to offsetting effects from the two sub-samples. Overall, the coefficients are consistent with the univariate analysis and generally are in accordance with our predictions. For investment-grade rivals, contagion effects are prevalent, which implies positive correlations. For speculative-grade rivals, competition effects are more important, which suggests negative correlations across credit events.

To test the sensitivity of our results in the presence of outliers and influential observations, we eliminate observations that the R-Student statistics indicate as influential. The results are similar to those reported in the tables and do not change substantively when truncated for outliers at the largest one, three, or five percent levels for each tail of the distribution for the model variables.

Results based on the WLS regressions are similar, with two exceptions. SIZE is statistically significant for the full sample, suggesting a predominant contagion effect for

larger firms when the security-event with lower prediction error is given greater weight.

REGFD is not significant, suggesting that the result for REGFD in the OLS regression may be driven by some observations with greater prediction errors.

4.3 Abnormal equity returns for the firm placed on S&P negative CreditWatch list and industry portfolios

Wansley and Clauretie (1985), Holthausen and Leftwich (1986), and Hand, Holthausen, and Leftwich (1992) examine abnormal equity and bond returns associated with the announcements of additions to Standard and Poor's CreditWatch list. Companies are added to the list when the rating agency believes a rating change is likely. They find significant abnormal equity returns at the time of additions to the negative watch list but not at the time of additions to the positive watch list, suggesting the negative watch list placement carries information value for the firm. However, no prior studies have examined the information transfer effects around the credit watch placement date.

We examine information transfer effects for an uncontaminated sample of 275 additions to the Standard and Poor's negative CreditWatch list for the period of 1996 to 2002, which is collected from the FISD database. We expect that such events are also informational for industry rivals.

Panel A of Table 5 reports the market response to negative credit watch placement. The left panel shows the mean CARs for firms that are placed on the negative watch list. For the full sample, the average CARs are negative and significant at the 1% level. This negative effect is consistent with the findings by Hand, Holthausen, and Leftwich (1992) and Holthausen and Leftwich (1986), that the CreditWatch list is informative. We also find that the average CARs for the investment-grade sub-sample are smaller than those for the speculative-grade sub-sample for all three event windows in our study.

[Insert Table 5]

The right panel reports the mean CARs for industry portfolios. For the entire sample, we find that the average CAR is negative but barely significant. However, for the investment-grade sub-sample, the average CARs for industry portfolios are -0.52% and -0.78% around the [-2, 2] and [-5, 5] event windows, with z-statistics of -2.51 and -2.43, respectively. In contrast, there is no significant average industry response when a speculative-grade firm is placed on a negative credit watch. Collectively, the findings in Table 9 provide some evidence that industry peer firms are adversely affected if an investment-grade firm is added to the negative credit watch list.

4.4 Industry information transfer effects around pre-bankruptcy filing period

As bankruptcy is frequently anticipated, contagion effects would probably be more pronounced during a pre-filing date indicating a possible bankruptcy (e.g., when a firm defaults on payment of interest or principal). To test this hypothesis, we collect from Moody's default reports a sample of 91 distressed firms that missed these payments and subsequently filed for Chapter 11 bankruptcy, similar to Theocharides (2007). We examine abnormal equity returns for both the distressed firm and its industry portfolios around the default date. Results are reported in Table 6.

[Insert Table 6]

Because some distressed firms are not traded around the event window and therefore have no equity returns from CRSP, the sample is reduced to 44 observations in the left panel. The firms suffer both economically and statistically significant negative returns. The average CARs for distressed firms are -10.92%, -15.17%, and -14.67% for the 2-day, 5-day, and 11-day event windows, respectively. This provides strong evidence that default events are informative. The average CARs for industry portfolios are not significantly different from

zero, however. The results for industry portfolio based on the 44 events yield similar results as those based on the 91 events.

This result seems puzzling because all the distressed firms are speculative-grade firms, which should normally lead to competition effects on the industry portfolio. The default events in our sample, however, are different from other rating downgrades because such events are followed by Chapter 11 bankruptcy filings. Jorion and Zhang (2007a) present evidence of net contagion effects around Chapter 11 bankruptcy, which arise from competitive disadvantages to industry rivals caused by the protective nature of the Chapter 11 bankruptcy law. Instead of liquidating, the filing firm can reemerge as a stronger low-cost competitor due to the substantial rights and subsidies bestowed by Chapter 11 to the distressed firm including DIP financing, lower debt costs, tax loss carry-forwards, and concessions from unions and other stakeholders. Therefore, one explanation for an insignificant industry effect around the pre-bankruptcy filing date is that industry competition effects are offset by contagion effects arising from the pro-debtor nature of Chapter 11 bankruptcy. On the other hand, the result should be interpreted with caution because the sample is too small to draw strong conclusions.

5. Implications for diversification

To illustrate the practical importance of our findings, we now explore how these results could be used to construct better portfolios. The standard deviation of equity returns during a credit event can be derived from the cross-section of 582 events. Define σ_F as the cross-sectional standard deviation across firms F , σ_I as the cross-sectional standard deviation of the industry portfolio I and $\sigma_{F,I}$ as the covariance between F and I across events. We seek to construct portfolios with lower credit risk. To keep the experiment simple, we construct a

portfolio P equally invested in the firm and the industry portfolio, with volatility of σ_P .

The diversification benefit across the downgraded firm and its industry peers can be measured by the following correlation coefficient:

$$\rho = \frac{\sigma_{F,I}}{\sigma_F \times \sigma_I}. \quad (2)$$

Panel A of Table 7 presents the average cross-sectional volatility of downgraded firms, peer industry indices, and combined portfolios based on the single-downgrade sample with 582 events. We observe a daily volatility across credit events around 7.7%, reflecting the variation in the stock price reaction to the downgrade announcement. The dispersion for industry rivals is lower, at 1.3% only, which reflects the greater diversification of the industry portfolio. The correlation is 0.04, slightly positive. As a result, the equally-weighted portfolio has a variance of $\sigma_P^2 = (0.5)^2 7.7^2 + (0.5)^2 1.3^2 + 2(0.5)^2 0.04 \times 7.7 \times 1.3$, which gives a cross-sectional volatility of 3.9%. Panel A also shows statistics for the investment-grade and speculative-grade samples. The volatility across downgraded firms is 6.0% and 8.8%, respectively. For investment-grade firms, however, the correlation is significantly higher, at 0.22 versus -0.04 for speculative-grade firms.

[Insert Table 7]

We then separate the investment-grade and speculative-grade sample on the basis of our observed contagion and competition effects. Investment-grade firms are split into two groups above and below the median for size. Speculative-grade firms are split into two groups above and below the median for industry concentration. From the cross-sectional analysis, we expect lower correlations among the small-size investment grade group, as well as among the high-concentration speculative-grade group. This is indeed what we find.

We then use this information to construct less risky portfolios. The sample is

separated into a “contagion” portfolio, which consists of investment-grade firms in the large size group and speculative-grade firms in the low concentration group, and a “competition” portfolio, which consists of investment-grade firms in the small size group and speculative-grade firms in the high concentration group. The “contagion” portfolio is expected to have high correlations between the downgraded firm and its industry group, and the “competition” portfolio is expected to have low correlations between the downgraded firm and its industry group. The table shows that the risk of the “competition” portfolio is substantially lower than that of the contagion portfolio. Its daily volatility is 3.5%, which is 18.6% lower than that of the contagion portfolio (4.3%). Note that this choice is purely predictive and does not involve using actual correlations. Hence, the analysis in this paper can be used to construct better credit-sensitive portfolios with lower risk.

A remaining issue is whether these results could have been obtained more simply from historical correlations of equity prices that are commonly used to infer credit event correlations. Panel B of Table 7 presents cross-sectional averages of the time-series volatility based on the year prior to the rating downgrade. This is split into a sample of investment-grade and speculative-grade firms, as in Panel A. Next, we separate each group into sub-samples with correlations higher and lower than the median. We construct a “low correlation” portfolio, composed of investment-grade and speculative-grade firms with low historical correlations, and a “high correlation” portfolio with the rest. The “in-sample” panel describes the characteristics of these two portfolios. Because this covers the same period over which correlation is measured, the correlation for the first group is higher than that for the second group, at 0.49 versus 0.13.

Next, we compute the characteristics for the “out-of-sample” period, which means across the downgrade windows, in the bottom panel. The out-of-sample correlations, 0.18

and 0.07, are now much closer to each other than those constructed in-sample. The spread is lower than that obtained in Panel A. Similarly, a portfolio sorted by historical volatility has fairly similar risk out of sample, at 4.0% and 3.5%. In contrast, sorting by structural characteristics gives a wider spread in risk measures, at 4.3% and 3.5%. This demonstrates that our cross-sectional structural approach improves on the traditional method of constructing portfolios based on time-series volatility of stock prices.

6. Conclusion

This paper considers information-transfer effects of bond rating downgrades. Prior studies show that downgrades elicit significant negative share responses of the downgraded firm and industry counterparts. We show that these industry effects are not uniform and reveal a rich pattern of competition and contagion influences.

When the downgraded firm starts from an investment-grade rating, the industry effect is negative. This is evidence of a predominant contagion effect, which is consistent with theories of counterparty risk and updating of beliefs. When the downgraded firm starts from a speculative-grade rating, however, the industry effect is positive. This result is evidence of a predominant competition effect, which implies that competing firms benefit from the downgrade of the affected firm. These results are generally confirmed using other announcements, including additions to a Negative Credit Watch List and payment defaults.

The analysis can be used to improve our understanding of portfolio credit risk models. Correlations across credit events can be positive or negative, reflecting contagion or competition effects. We show that the structural information uncovered in this paper can be used to build a less risky portfolio than the traditional approach that is based on historical time-series of equity returns.

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Table 1**Sample characteristics**

Panel A describes the summary statistics of downgrade events by industry. Panel B describes the industry affiliation of the downgrade events. Panel C breaks down the sample of rating downgrades by the magnitude of rating changes, which is defined as the cardinal value of new rating minus the cardinal value of old rating.

Panel A: Distribution of downgrade events by industry (full sample, N=679)

N. of events	N. of industries	Mean	Median	Max	Min	Std. dev.
679	132	5	3	39	1	6

Panel B: Industry distribution

First digit of SIC code	Firm-year	Obs.	Fraction (%)
1	Mining and construction	63	9.28%
2	Manufacturing (food-petroleum)	81	11.93%
3	Manufacturing (plastics-electronics)	179	26.36%
4	Transportation	145	21.35%
5	Wholesale trade and retail trade	105	15.46%
6	Finance, insurance, and real estate	32	4.71%
7	Services (hotel-recreation)	51	7.51%
8	Services (health-private household)	23	3.39%
Total		679	100%

Panel C: Distribution of rating downgrades by absolute magnitude of rating changes

Absolute magnitude of rating change	Number	%
1	463	68.19
2	142	20.91
3	40	5.89
4	22	3.24
5	7	1.03

Table 2**Abnormal equity returns for firms with bond rating changes and industry portfolios**

This table reports the mean and median cumulative abnormal returns (CAR) for the [0, 1] event window for firms with bond rating changes and industry portfolios, where 0 is the effective date of a rating change. An industry portfolio is a value-weighted portfolio of firms with the same four-digit SIC code as the firm with bond rating change and for which stock returns are available in CRSP. Abnormal returns are calculated using a market model against the benchmark market return proxied by the CRSP value-weighted equity returns estimated over the period (-250, -50). To test the null hypothesis that the CAR is equal to zero, we use the standardized cross-sectional test of Boehmer, Musumeci, and Poulsen (1991). z-statistics are given in parentheses directly below the mean % CAR. The percentage of negative CAR over all the observations are reported. The statistical significance for the percentage of negative CARs is based on a generalized sign test (Cowan, 1992).

Panel A and B report results for the full downgrade and upgrade samples, respectively. The multiple-downgrade subsample contains consecutive downgrades of multiple firms in the same industry (having the same four-digit SIC code) that occur within a five-day period. The full sample is also partitioned into investment-grade and speculative subsamples according to whether the firm with a bond rating change originally carries an investment-grade or speculative-grade rating.

Panel A: Downgrade (full sample, N=679)

	Downgraded firms				Industry portfolios			
	Mean CAR (%)	Median CAR (%)	% of CAR<0	# of Obs.	Mean CAR (%)	Median CAR (%)	% of CAR<0	# of Obs.
All	-1.7 (-3.49)***	-0.83	56.3**	679	-0.08 (-0.67)	-0.08	51.9	679
Single-downgrade	-2.19 (-4.33)***	-0.97	59.0***	582	0.1 (0.87)	-0.01	50.1	582
Multiple-downgrade	1.24 (0.78)	0.63	54.5	97	-1.06 (-2.39)**	-0.61	62.3**	97
Investment-grade	-1.56 (-2.39)**	-0.63	54.6	269	-0.45 (-2.07)**	-0.38	59.1***	269
Speculative-grade	-1.79 (-2.54)***	-0.96	57.5**	410	0.17 (1.71)*	0.15	47.5	410

Panel B: Upgrade (full sample, N=473)

	Upgraded firms				Industry portfolios			
	Mean CAR (%)	Median CAR (%)	% of CAR<0	# of Obs.	Mean CAR (%)	Median CAR (%)	% of CAR<0	# of Obs.
All	0.12 (0.94)	0.09	48.2*	473	-0.03 (-0.49)	-0.08	52.9	273
Investment-grade	-0.33 (-1.36)	-0.26	53.5	245	-0.1 (-1.04)	-0.15	53.4	245
Speculative-grade	0.6 (2.04)**	0.21	44.1**	228	0.04 (0.32)	0.04	47.8	228

***, **, and * indicate statistical significance at the 0.001, 0.01, and 0.05 levels, respectively.

Table 3
Comparison of abnormal equity returns for industry portfolios
for investment-grade and speculative-grade subsamples

Panel A presents the mean and median abnormal equity returns (AR) and cumulative abnormal returns (CAR) for industry portfolios for the single downgrade sample (N=582). An industry portfolio is a value-weighted portfolio of firms with the same four-digit SIC code as the downgraded firm and for which stock returns are available in CRSP. The sample is partitioned according to whether the downgraded firm originally carries an investment-grade or speculative-grade rating. To test the null hypothesis that the AR (CAR) is equal to zero, we use the standardized cross-sectional test of Boehmer, Musumeci, and Poulsen (1991). z-statistics are given beside the mean % AR (CAR). The percentage of negative CAR over all the observations are reported. The statistical significance for the percentage of negative CARs is based on a generalized sign test (Cowan, 1992). Panel B reports mean and median differences in CAR for industry portfolios between investment-grade and speculative-grade sub-samples, using *t*-tests and Wilcoxon two-sample tests, respectively.

Panel A: Abnormal equity returns for industry portfolios by the initial bond rating

Day	Investment-grade (N=226)			Speculative-grade (N=356)		
	Mean (%)	corrected z-statistics	% (<0)	Mean (%)	corrected z-statistics	% (<0)
-5	-0.07	-0.54	53.50	0.06	0.39	51.7
-4	-0.30	-1.50	57.5*	0.07	0.59	51.6
-3	-0.12	-0.68	52.50	0.01	0.13	51.1
-2	-0.23	-1.87*	53.00	0.10	0.84	51.3
-1	-0.12	-1.08	50.00	0.13	1.23	48.9
0	-0.04	-0.29	50.70	0.08	0.83	50.6
1	-0.31	-2.34**	58.4**	0.29	2.43**	44.4*
2	0.01	0.02	47.20	-0.02	0.24	49.7
3	-0.02	-0.07	53.30	-0.01	-0.01	48.2
4	0.34	2.22**	45.2*	0.04	0.39	48.3
5	0.02	0.20	50.20	0.20	1.75*	49.2
[0,1]	-0.34	-1.98**	57.8**	0.36	2.66***	48.9
[-2,2]	-0.68	-2.40**	52.50	0.56	2.60***	46.2*
[-5,5]	-0.80	-1.72*	53.40	0.94	2.37**	44.8**

Panel B: Comparisons of abnormal equity returns for the industry portfolios

	CAR (2 days)		CAR (5 days)		CAR (11 days)	
	Mean	Median	Mean	Median	Mean	Median
Investment-grade	-0.34	-0.09	-0.68	-0.12	-0.80	-0.25
Speculative-grade	0.36	0.09	0.56	0.34	0.94	0.43
Difference	-0.70	-0.18	-1.24	-0.46	-1.74	-0.68
<i>t</i> -statistic	(-3.07)***		(-3.48)***		(-2.74)***	
Wilcoxon statistic	(-1.71)*		(-2.39)**		(-1.67)*	

***, **, and * indicate statistical significance at the 0.001, 0.01, and 0.05 levels, respectively.

Table 4
The effect of bond rating downgrades on the abnormal equity returns
for the industry portfolio

The dependent variable is CAR_IND, the cumulative abnormal returns for the [0,+1] announcement window for industry portfolios, where zero is the effective date of a downgrade. An industry portfolio is a value-weighted portfolio of firms with the same four-digit SIC code as the downgraded firm and for which stock returns are available in CRSP. Abnormal returns are calculated using a market model against the benchmark market return proxied by the CRSP value-weighted equity returns estimated over the period (-250, -50).

RTO is the level of original rating of the downgraded firm, with higher values indicating lower credit rating. RCHANGE is a dummy variable that is equal to one if the absolute magnitude of the downgrade is greater than one notch, and zero if the downgrade is one notch. CORR is the correlation of equity returns between the downgraded firm and the industry portfolio during the 12 months preceding the bond rating downgrades. HERF is the industry Herfindahl index computed as the sum of the squared fractions of sales of each individual firm over total sales of the industry. RTIND is the average credit rating of the industry portfolio. LEVIND is the median leverage ratio of the industry peer group during the last 12 months. REGFD is a dummy variable that is equal to one if the downgrade occurred during the post-Regulation-FD period (since October 23, 2000) and zero otherwise. The results from the OLS regressions report *t*-statistics based on heteroskedasticity-corrected standard errors. The results from the Weighted-Least-Square (WLS) regressions weight each security-event by the inverse of the square root of the abnormal return variance.

Model	OLS regression			WLS regression		
	Investment-grade sub-sample	Speculative-grade sub-sample	Full sample	Investment-grade sub-sample	Speculative-grade sub-sample	Full sample
Independent variables	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
	(<i>t</i>)	(<i>t</i>)	(<i>t</i>)	(<i>t</i>)	(<i>t</i>)	(<i>t</i>)
Intercept	3.18 (1.67)	-5.12 (-2.57)***	-2.06 (-1.59)	2.36 (1.58)	-3.80 (-2.73)***	-0.84 (-0.91)
RTO	0.01 (0.12)	0.14 (1.44)	0.10 (2.04)**	-0.03 (-0.36)	0.11 (1.58)	0.07 (1.89)*
RCHANGE	0.23 (0.56)	0.29 (1.01)	0.27 (1.19)	0.15 (0.48)	0.21 (0.84)	0.24 (1.20)
SIZE	-0.34 (-1.96)**	-0.01 (-0.13)	-0.13 (-1.32)	-0.24 (-2.07)**	-0.07 (-0.71)	-0.15 (-2.11)**
CORR	-1.36 (-1.52)	2.00 (2.57)***	0.37 (0.60)	-0.78 (-1.16)	1.92 (3.04)***	0.53 (1.19)
HERF	1.09 (1.04)	1.71 (2.01)**	1.25 (1.86)*	0.32 (0.32)	1.72 (2.41)**	0.87 (1.49)
RTIND	-0.09 (-1.24)	0.11 (1.96)**	0.05 (0.99)	-0.07 (-1.18)	0.09 (1.74)*	0.01 (0.30)
LEVIND	1.67 (1.13)	2.18 (2.14)**	1.70 (2.02)**	1.20 (0.88)	1.98 (2.23)**	1.33 (1.80)*
REGFD	-0.72 (-1.70)*	-0.26 (-0.91)	-0.49 (-1.97)**	-0.48 (-1.50)	-0.11 (-0.45)	-0.27 (-1.42)
R-squared (%)	9.09	8.11	6.03	6.32	6.56	3.79
Adj.R-squared (%)	6.17	6.04	4.74	2.87	4.45	2.46
<i>p</i> -value for F-stat.	0.0038	0.0031	<.0001	0.0427	0.0021	0.0040
# of obs.	226	356	582	226	356	582

***, **, and * indicate statistical significance at the 0.001, 0.01, and 0.05 levels, respectively.

Table 5**Abnormal equity returns for firms placed on the negative credit watch list and the industry portfolios**

This table examines information transfer effects associated with additions to the Standard and Poor's negative Credit Watch List for the period of 1996 to 2002 collected from the FISD database. Panel A reports the mean and median cumulative abnormal returns (CAR) for the [0,+1], [-2, 2] and [-5, 5] announcement windows for affected firms and industry portfolios, where 0 is the placement announcement date. An industry portfolio is a value-weighted portfolio of firms with the same 4-digit SIC code as the affected firm and for which stock returns are available in CRSP. Abnormal returns are calculated using a market model against the benchmark market return proxied by the CRSP value-weighted equity returns estimated over the period (-250,-50). To test the null hypothesis that the CAR is equal to zero, we use the standardized cross-sectional test of Boehmer, Musumeci and Poulsen (1991). z-statistics are given in parentheses directly below the mean % CAR. The percentage of negative CAR over all the observations are reported. The statistical significance for the percentage of negative CARs is based on a generalized sign test (Cowan, 1992). Panel B reports mean and median differences in CAR for industry portfolios between investment-grade and speculative-grade sub-samples, using t-tests and Wilcoxon two-sample tests, respectively.

Panel A: Abnormal equity returns

	Firms on negative watch list				Industry portfolios			
	Mean CAR (%)	Corrected z-statistic	Median CAR (%)	% of CAR<0	Mean CAR (%)	Corrected z-statistic	Median CAR (%)	% of CAR<0
Full Sample (N=275)								
[0, 1]	-1.93	-2.43**	-0.92	60.1***	-0.05	-0.45	-0.09	51.6
[-2, 2]	-4.09	-3.67***	-2.05	61.1***	-0.24	-1.26	-0.20	55.1
[-5, 5]	-5.31	-3.96***	-2.64	60.4***	-0.57	-1.85*	-0.38	54.0
Investment grade (N=177)								
[0, 1]	-1.12	-1.60	-0.79	60.45**	-0.10	-0.75	-0.11	53.1
[-2, 2]	-2.23	-2.46***	-2.07	61.02**	-0.52	-2.51**	-0.33	59.3**
[-5, 5]	-2.35	-2.09**	-1.76	58.20*	-0.78	-2.43**	-0.36	54.2
Speculative grade (N=98)								
[0, 1]	-3.22	-1.86*	-1.23	59.5*	0.04	0.45	0.02	48.9
[-2, 2]	-7.05	-2.84***	-1.98	61.3**	0.26	1.35	0.17	47.5
[-5, 5]	-10.02	-3.41***	-4.24	63.9***	-0.19	-0.01	-0.51	53.5

Panel B: Comparisons of abnormal equity returns for industry portfolio

	CAR (2 days)		CAR (5 days)		CAR (11 days)	
	Mean	Median	Mean	Median	Mean	Median
Investment-grade	-0.10	-0.11	-0.52	-0.33	-0.78	-0.36
Speculative-grade	0.04	0.02	0.26	0.17	-0.19	-0.51
Difference	-0.14	-0.13	-0.78	-0.50	-0.59	0.15
t-statistic	(-0.53)		(-1.98)**		(-0.91)	
Wilcoxon Statistic	(-0.16)		(-1.81)*		(0.88)	

***, **, and * indicate statistical significance at the 0.001, 0.01, and 0.05 levels, respectively.

Table 6**Industry information transfer effects around the pre-bankruptcy filing period**

This table examines information transfer effects around the pre-bankruptcy filing period. Panel A reports the mean and median cumulative abnormal returns (CAR) for the [0,+1], [-2, 2], and [-5, 5] announcement windows for distressed firms and industry portfolios, where zero is the date when a firm missed interest payments or principal. An industry portfolio is a value-weighted portfolio of firms with the same four-digit SIC code as the distressed firm and for which stock returns are available in CRSP. Abnormal returns are calculated using a market model against the benchmark market return proxied by the CRSP value-weighted equity returns estimated over the period (-250, -50). To test the null hypothesis that the CAR is equal to zero, we use the standardized cross-sectional test of Boehmer, Musumeci, and Poulsen (1991). z-statistics are given in parentheses directly below the mean % CAR. The percentage of negative CAR over all the observations are reported. The statistical significance for the percentage of negative CARs is based on a generalized sign test (Cowan, 1992).

Because a fraction of distressed firms are not traded around the event window and therefore have no equity returns from CRSP, the sample is reduced to 44 observations in the left panel.

	Distressed firms					Industry portfolios				
	Mean	Corrected	Median	% of	# of	Mean	Corrected	Median	% of	# of
	CAR (%)	z-statistic	CAR (%)	CAR<0	Obs.	CAR (%)	z-statistic	CAR (%)	CAR<0	Obs.
[0, 1]	-10.92	-2.90***	-7.62	65**	44	-0.20	-0.79	0.09	49.5	91
[-2, 2]	-15.17	-3.19***	-10.71	68.2**	44	-0.52	-1.10	-0.89	54.9	91
[-5, 5]	-14.67	-2.40**	-12.1	65.9**	44	-0.18	-0.24	-0.36	53.8	91

***, **, and * indicate statistical significance at the 0.001, 0.01, and 0.05 levels, respectively.

Table 7**Implications for diversification**

This table illustrates the implications of our results for constructing better portfolios. Panel A reports the cross-sectional average of the volatility of downgraded firms, peer industry indices, and equally-weighted portfolios invested in both, as well as the average correlation coefficient between the firm and industry index. Returns are measured as raw returns over a two-day period around the rating downgrade. Volatility is adjusted to a daily measure. The "contagion+" portfolio consists of investment-grade firms in the large size group and speculative-grade firms in the low concentration group. The "competition*" portfolio consists of investment-grade firms in the small size group and speculative-grade firms in the high concentration group. Panel B reports the cross-sectional average of the time-series volatility over an annual period prior to the rating downgrade. Volatility is measured over one day. A "high correlation" portfolio consisting of investment-grade and speculative-grade firms with high correlations and a "low correlation" portfolio consisting of investment-grade and speculative-grade firms with low correlations. The daily volatility of these portfolios is measured over the year before the rating change (in-sample) and over the rating downgrade window (out-of-sample).

Panel A: Comparisons of portfolio risk across rating downgrades event windows

	Volatility (%)		Correlation	Volatility (%)	# of
	Firm	Industry		Portfolio	
All	7.7	1.3	0.04	3.9	582
Investment-grade	6.0	1.4	0.22	3.2	226
Speculative-grade	8.8	1.2	-0.04	4.4	356
Investment-grade					226
Large firms+	6.8	1.7	0.30	3.7	113
Small firms*	5.1	0.9	0.05	2.6	113
Speculative-grade					356
Low concentration+	9.5	0.8	-0.01	4.7	178
High concentration*	8.1	1.6	-0.11	4.0	178
"Contagion" portfolio+	8.4	1.3	0.13	4.3	291
"Competition" portfolio*	6.9	1.3	-0.07	3.5	291

Panel B: Comparisons of risk of portfolios based on time-series volatility

	Volatility (%)		Correlation	Volatility (%)	# of
	Firm	Industry		Portfolio	
Portfolio risk across year before rating changes					
All	4.7	2.4	0.31	2.8	582
Investment-grade	2.8	2.2	0.39	2.0	226
Speculative-grade	5.7	2.5	0.26	3.3	356
Investment-grade					226
High correlations+	2.7	2.1	0.57	2.1	113
Low correlations*	3.0	2.2	0.21	2.0	113
Speculative-grade					356
High correlations+	5.3	2.6	0.44	3.3	178
Low correlations*	6.0	2.5	0.08	3.3	178
Portfolio risk across year before rating changes (in-sample)					
High correlation portfolio+	4.4	2.4	0.49	2.8	291
Low correlation portfolio*	5.0	2.4	0.13	2.8	291
Portfolio risk across rating change windows (out-of-sample)					
High correlation portfolio+	7.5	1.9	0.18	4.0	291
Low correlation portfolio*	6.5	1.9	0.07	3.5	291