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Why Do Bond and Stock Prices and Trading Volume Change around Credit Rating Announcements?

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It has been well documented that stock prices, bond prices, and trading volume significantly fluctuate around credit rating announcements. Existing literature suggests three alternative theories to rationalize these phenomena. Yet each competing premise can explain only a piece of the puzzle. This study contests these theories and presents a substitute behavioral approach. Our setting leads to a complete and better explanation of the increased trading volume prerating announcement, the significant price movements post-credit announcements, the larger loss post downgrade for low credit categories versus high credit grades, and the stronger loss post downgrade versus gain post upgrade.

Keywords: Credit ratings, Stock price, Trading volume, Risk aversion, Utility theory

INTRODUCTION

Financial academics and practitioners have long recognized that stock prices, bond prices, and trading volume significantly fluctuate around credit rating announcements. Kats [1974] empirically tests the bond market efficiency with respect to credit rating announcements. His study reveals no anticipation at all prior to public announcement of credit reclassification, but an evidence of a minor lag in the price adjustment process post-rating announcements. The author concludes that bond investors rely primarily on the credit rating agencies as determinants of debt value.

Griffin and Sanvicente [1982] investigate common stock price movements during the 11 months before and throughout the month of the credit rating migration announcement. The authors observe statistically significant abnormal stock price movements post-bond downgrading, and although statistically insignificant, positive abnormal returns in the preceding months of credit rating upgrading announcements.

Holthausen and Leftwich [1986] use daily stock price data from 1977–1982 and discover that downgrades by both Moody's and Standard and Poor's are associated with negative abnormal stock returns in the two days following the rating agency reclassification. However, the authors find little evidence for positive abnormal returns post-upgrade announcement. Furthermore, the authors realize that significant abnormal returns are associated with announcements of additions to the Standard and Poor's credit watch list if either a potential downgrade or a potential upgrade is indicated.

Hand, Holthausen and Leftwich [1992] use ordinary event study methodology to examine daily excess bond returns associated with announcements of additions to Standard and Poor's credit watch list from 1981–1983, and credit rating changes by Moody's and Standard and Poor's from 1977–1982. The authors investigate the stock price effects of rating agency announcements as well and comprehend consistent results with previous findings, showing statistically significant average excess bond and stock returns to downgrade announcements, with less pronounced effects within upgrades. In addition, for downgrade credit ratings, the average excess bond returns are stronger for below investment grade bonds than for investment rating categories.

Hsueh and Liu [1992] empirically explore the effect of credit rating announcements on publicly held industrial common stock prices from May 1982 to July 1987 while considering the market anticipation for these bond-rating changes. Their findings reveal various effects across firms and over time. These effects are associated with the information quantity available at the time of the announcement. In particular, the authors observe significant abnormal stock price reactions post credit-rating change for firms with less available information, and when market conditions are obscure.

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Hite and Warga [1997] use a Lehman Brothers bonds proprietary database from 1985–1995 and report a significant price reaction in both the post-announcement month as well as the preannouncement period for downgraded firms. In addition, the authors discover that the magnitude of downgrading effects is significantly larger within the low grading categories relative to the high credit rating tags. These findings do not seize for the upgrading ratings.

Chae [2005] studies trading volume changes before scheduled and unscheduled firm specific announcements including a set of Moody's credit rating changes as externally generated pricing information. The author discovers positive abnormal trading volume prior to unscheduled announcements, such as credit rating announcements, regardless of the level of information asymmetry in the market.

To date, three competing theories try to explain these empirical findings. These theories are discussed hereafter. Yet each alternative explanation can rationalize only a piece of the puzzle. In this study we propose a substitute behavioral approach theory that may solve all the riddles; why do bond and stock prices as well as trading volume change before and after credit rating announcements, why there are different reactions to upgrades versus downgrades, and why these reactions are more pronounced among below investment grade bonds?

The first offered theory is the *efficient market hypothesis*. It argues that rating agencies do not add any valuable input to the market since they review firms' creditworthiness with only publicly available information. This explanation suggests that no change in bond and stock prices are expected post-credit rating announcement. However, most empirical findings contest this premise.

The *private information hypothesis* advises that rating agencies hold additional valuable information from private sources. Therefore, credit rating recommendations reveal new information to previously unaware investors, and hence bond and stock prices adjust accordingly. This second explanation although corresponding to empirical findings, contradicts the rating agencies official policy stating that credit rating action is taken only when it is unlikely to be reversed shortly after, thus rating change always lags behind public information as discussed, among others, by Weinstein [1977]. Löffler [2005] explores this common assertion and concludes that it is the major rationale for why rating agencies are slow to react to new information.

The third and yet most appealing explanation is the *market anticipation theory*. Smith [1986] suggests that when an announcement is fairly predictable, the following stock price reaction should be minor. In contrast, the more surprising the information is, the larger the impact of the revelation on market participants. Since heterogeneous investors may possess dissimilar data across securities, depending on the intensity of media cover, the frequency of analysts' reports, the content often specified in press releases, and the level of firm's transparency, some credit rating announcement may cause a significant equity and debt price reaction while others leave no mark. However, this theory can explain only the various reactions post rating announcements but not changes in trading volume prior to new information release. Furthermore, the market anticipation hypothesis cannot fully capture the differences in excess bond returns between low and high rating categories, or the different reactions for rating upgrades versus downgrades.

Several questions are left unresolved. Why do bond and stock prices as well as trading volume vary before and after credit rating announcements, why are there various reactions to upgrade versus downgrade rating announcements, and why are these effects stronger within the low-grade bonds?

This study aims to answer these enigmas by taking a behavioral approach. We propose a forth alternative explanation suggesting that diverse perception of information as well as different levels of risk aversion among investors are the key determinants for equity and debt price movements and trading volume pre- and post-credit rating announcements. These common behavior patterns are also claimed to prompt the differences found in market reaction between investment grade and non-investment grade bonds, and the differences observed between upgrade and downgrade credit ratings.

The remainder of this study is organized as follows. The second section discusses the explanatory behavioral model and presents complementary sections to confront the precedent empirical findings. The third section summarizes and concludes.

EXPLANATORY BEHAVIORAL MODEL

Basic Framework

Our theoretical setting relies upon several realistic assumptions that are further discussed within the relevant context. First, rational utility-maximization investors may exhibit various levels of risk-tolerance. Second, market participants have divergence expectations, or alternatively, under a given set of knowledge, investors can be classified as more optimistic or more pessimistic. Third, a credit rating announcement event does not provide any new undisclosed information to the market rather it homogenizes investors' beliefs. Forth, when investing in bonds, all investors share the same level of risk aversion due to well defined fixed return and default likelihoods, but this is not true for shareholders. Fifth, without loss of generality, investors expect the same gains and losses.

Our venue considers two alternatives for market participants. Alternative B denotes buying of a stock or a bond. This action may lead to one of the following outcomes: with probability α the asset price drops to level L, hence the investment fails and the investor loses; with the complement probability $(1 - \alpha)$ the asset price rises to level H, thus the investment succeeds, and the investor gains. In contrast, alternative S denotes selling of an asset. In this case the investor faces a deterministic result M. For simplicity this selling price is assumed to be any midpoint between L and H. Market participants exhibit rationality, thus try to maximize their wealth. Investors assign utility levels, denoting as $u(.)$, to each alternative, so that $u(L) < u(M) < u(H)$, or that $L \prec M \prec H$. The model further assumes that all investors must buy or sell. They are banned from doing nothing hence the market remains liquid.

In addition, all investors are assumed to be risk averse. When investing in a specific bond, the model considers the same level of risk aversion for all investors, as a result of identified fixed return and well-recognized default odds. However, this is not necessarily the case for equity holders. Expected return of stocks is unspecified, and thus shareholders with various levels of risk aversion may end up holding the same stock. Furthermore, two investors in two different bonds do not share the same level of risk aversion. Investors with low level of risk aversion, hence risk lovers prefer to invest in low credit grades, since these carry higher potential bankruptcy risk and presumably higher expected return. Investors with high level of risk aversion rather invest in high credit categories, since those posses low default threat.[1]

To describe a genuine scenario, we assume infinite number of market participants with unlimited corresponding wealth, so that each investor can only marginally affect the likelihood of an asset to obtain level L, level M, or level H. Buying an asset by an individual investor does not change the probability to reach level H, and on the other hand selling the asset by one market participant does not necessarily drive the price to level L.

Finally, for simplicity, the model assumes that each investor chooses to buy or sell those assets with all available capital. For example, if an investor chooses to buy, he uses all his vacant funds to purchase the asset. If later he decides to sell, he will then close his position entirely. Partially buying or selling is forbidden according to decision criteria that are defined hereafter.

An investor makes a decision whether to buy or sell a specific asset with respect to two parameters: his idiosyncratic risk aversion level and his belief about the probabilities of gaining and losing. We define p as the probability that the underlying asset price will increase to level H, and the complement probability $(1 - p)$ as the probability for this asset price to drop to level L. Therefore, we can set the probability p as the likelihood for B to be favorable and $(1 - p)$ as the likelihood that S is favorable.

A rational utility-maximization investor buys an asset if and only if $\tilde{u}[pB + (1 - p)S]$ is an increasing monotonic function of p. This investor chooses to sell the asset if and only if $\tilde{u}[pB + (1 - p)S]$ is a decreasing monotonic function of p. We disregard the case where this utility function attains a local optimum. Alternatively, we can further assume that when a regional optimality is achieved, the investor randomly chooses between B and S.

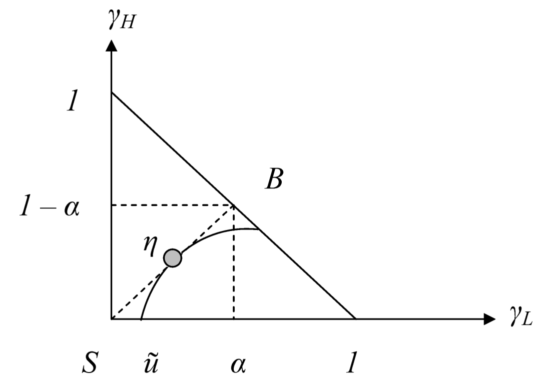

FIGURE 1 Lottery Probability Triangle.

Our setting describes a risk-averse investor who faces a venture with random prospects $(\gamma_L R_L + \gamma_M R_M + \gamma_H R_H)$. This lottery is defined over the three feasible levels, L, M, and H. It contains three possible fixed outcomes denoted as R_L, R_M, and R_H, with corresponding probabilities γ_L, γ_M, and γ_H. This scheme can be reduced into a two-dimensional problem since $\gamma_M = 1 - \gamma_L - \gamma_H$. Thus, the lottery can be characterized as a point (γ_L, γ_H), where $\gamma_L + \gamma_H \leq 1$. The problem an individual investor faces is depicted in Figure 1.

Different lotteries corresponding to various probabilities p are aligned along the interval SB. An investor considers his options, whether to buy or sell, as alternatives on the line SB. If, for example, $\gamma_L = 0$, and $\gamma_H = 0$ then the lottery $(\gamma_L R_L + \gamma_M R_M + \gamma_H R_H)$ is reduced to $\gamma_M R_M$, and therefore the investor sells the underlying asset, and gets R_M with certainty. If however $\gamma_L = \alpha$, and $\gamma_H = 1 - \alpha$, then $\gamma_M = 1 - \gamma_L - \gamma_H = 1 - \alpha - (1 - \alpha) = 0$, hence the lottery is reduced to $(\gamma_L R_L + \gamma_H R_H)$, and so the investor chooses to buy the asset.

A risk-averse investor has quasi-convex preferences leading to concave indifference curves. This risk-averse investor may possess strict-quasi-convex preferences leading to strict-concave indifference curves.[2] Karni [1979] discusses necessary and sufficient conditions for global risk-aversion along with quasi-convex preferences. Machina [1985] presents numerous quasi-convex and quasi-concave preference functions displaying aversion and preference for randomization, respectively. Green [1987] explores the relationship between the independence axiom and the quasi-convexity of preferences and the implications on risk-aversion.

We choose to demonstrate that quasi-convex preferences in our setting entail risk-aversion through the rank-dependent expected utility theory. Quiggin [1982], in his pioneering research, develops a set of axioms for the rank-dependent model. Yaari [1987] further explains that the curvature of the transformation function in the rank-dependent utility theory reflects the level of optimism or pessimism with respect to unobserved probabilities. Segal [1990] analyzes preference relations over two-stage lotteries while developing new set of axioms for the rank-dependent theory.

The rank-dependent expected utility theory takes a perceptional approach, where an investor modifies probabilities prior to the decision process. The model defines the probability distribution lottery $\sum_{i=1}^{n} \gamma_i R_i$, with $i \in \{L, M, H\}$, $L \prec M \prec H$, and $\sum_{i=1}^{n} \gamma_i = 1$ as:

$$\tilde{u}\left(\sum_{i=1}^{n} \gamma_i R_i\right) = \sum_{i=1}^{n}\left(f\left(\sum_{j=1}^{i} \gamma_j\right) - f\left(\sum_{j=1}^{i-1} \gamma_j\right)\right) u(i) \tag{1}$$

where f is a real continuous increasing transformation function of the rank-dependent expected utility theory defined over the domain and picture [0, 1], with u being a von Neumann-Morgenstern [1944, 1947, 1953] utility function. The probability triangle in Figure 1 admits the following indifference curve:

$$\begin{aligned}\tilde{u}(\gamma_L, \gamma_H) &= f(\gamma_L)\, u(L) + (f(\gamma_L + \gamma_M) - f(\gamma_L))\, u(M) \\ &\quad + (1 - f(\gamma_L + \gamma_M))\, u(H) \\ &= f(\gamma_L)\, u(L) + (f(1 - \gamma_H) - f(\gamma_L))\, u(M) \\ &\quad + (1 - f(1 - \gamma_H))\, u(H) \end{aligned} \tag{2}$$

We can define three temporary variables: $\delta_1 \equiv u(M) - u(L)$, $\delta_2 \equiv u(H) - u(M)$, and $\delta_3 \equiv u(H) - \tilde{u}$, to obtain a reduced form indifference curve as:

$$\delta_1 f(\gamma_L) + \delta_2 f(1 - \gamma_H) = \delta_3 \tag{3}$$

This way of presentation reveals that our model assigns concave indifference curves when the transformation function f is concave. Several scholars examine the relationship between concave indifference curves and risk-aversion. Chew, Karni, and Safra [1987] illustrate that a necessary and sufficient condition for an agent to be risk-averse is to compel both the utility function u and the transformation function f to be concave.[3]

These concave indifference curves, illustrated as $\tilde{u}$ within the probability triangle in Figure 1, have at most one tangency point with the feasible lotteries along the line *SB*, as denoted by the point η. This tangency point can be described as: $\eta = \lambda B + (1 - \lambda)S$, where $\lambda \in (0, 1)$ is an idiosyncratic risk-aversion cutoff point for the individual investor.[4] In contrast, the probability p denoting the likelihood for B to be favorable is unobservable prior to credit rating announcement but can be approximated post-credit rating reclassification.

A rational risk-averse utility-maximization investor buys an asset if and only if $p > \lambda$, but rather sells the underlying asset if and only if $p < \lambda$. This key conclusion is derived by estimating the risk-aversion cutoff point λ from the tangency point $\lambda B + (1 - \lambda)S$, and by setting the probability p for B to be favorable from the utility-maximization function $\tilde{u}[pB + (1 - p)S]$. An investor buys an asset when he approximates the probability p to be on the right side of λ, and sells when p is estimated to the left of λ.

In the following discussions, we shell use the formation of λ as an idiosyncratic risk-aversion cutoff point, and p as the likelihood an individual investor assigns for B to be favorable, to explain several observed phenomena. For simplicity, we identify these points on the charts rather than their full expressions. Explicitly we aim to clarify the increased trading volume pre-rating announcement for bonds, the significant price movements post credit announcements, the larger loss post downgrade for low credit categories versus high credit grades, and the stronger loss post downgrade versus gain post upgrade.

Increased Trading Volume Prerating Announcement for Bonds

We find indication for interpretation-disparity among investors in the wavering trading volume prior to credit rating announcements. Karpoff [1986], Bamber, Barron, and Stober [1999], and Chen, Hong, and Stein [2001], among others, use changes in trading volume as a proxy for heterogeneity in investors' opinions. We judge changes in trading volume pre-bond classifications to designate heterogeneity in investors' perceptions.

Among others, Cohen [1995] characterizes the notions of risk-aversion in the framework of rank-dependent expected utility model. The author defines a decision maker as weakly pessimistic under risk if and only if $f(p) \leq p\ \forall p \in (0, 1)$, and weakly optimistic under risk if and only if $f(p) \geq p\ \forall p \in (0, 1)$. Since the probability p is unobserved prior to credit rating announcement, we can distinguish between two types of investors; the more optimistic, denoted as p_2, and the more pessimistic, denoted as p_1, where $p_2 > p_1$.

When investing in a specific bond, the model considers the same level of risk aversion for all investors. As a result of recognized fixed return all market participants share the same risk-aversion cutoff point λ. This scenario is illustrated in Figure 2.

Right before a credit rating agency announces its bond reclassification, the more optimistic investor with $p_2 > \lambda$ buys the bond, and the more pessimistic investor with $p_2 < \lambda$

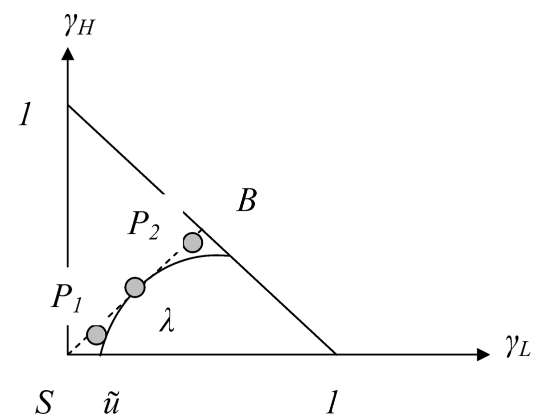

FIGURE 2 Lottery Probability Triangle prerating announcement for bonds.

sells the bond. A market participant trades based on his level of risk aversion and based on his beliefs regarding unobserved likelihoods. The closer period prior to credit rating announcement is characterized by high level of uncertainty about the likelihood p for market participants, while the instant phase post-rating announcement possess more information regarding the probability p. Since credit rating classification homogenizes investors' beliefs, it creates an immediate consensus regarding probability p, but over time, this market agreement fades, until a new rating category is published.

The observed intense trading volume prior to credit rating announcement is directly associated with the divergence expectations regarding the probability p for B to be favorable, despite the market homogeneous risk aversion. Furthermore, this conclusion holds regardless of the fact that rating announcement is an unscheduled event. The time interval between any two credit rating announcements regarding a specific bond starts with high level of certainty about p. This confidence gradually deteriorates hereafter until the next credit rating announcement is published. Trading volume is intensified prior to rating reclassifications due to the high level of uncertainty regarding probability p for B to be favorable.

Significant Price Movements Post-Credit Announcement

While the probability p for B to be favorable is unobserved prior to credit rating announcement, it can be estimated or at least approximated by market participants in the immediate time post-rating reclassification. The credit rating announcement itself does not add any new firm-specific information to the market, but it homogenizes the beliefs regarding the likelihood p.[5] If before the rating announcement there are two types of investors; the more optimistic investors with $p_2 > \lambda$, and the more pessimistic investors with $p_2 < \lambda$, immediately after the rating announcement investors are unified with a single likelihood p'. This probability can fall on both sides of the risk-aversion cutoff point λ as illustrated in Figure 3.

The transition from heterogeneous expectations pre-rating announcement into a homogeneous likelihood p post-announcement triggers price movements, although investors gain no new firm-specific information. If for example $p' > \lambda$ then the prior optimistic investors (with $p_2 > \lambda$) who initially bought the asset would remain in their long position, while the prior pessimistic investors (with $p_1 < \lambda$) who initially sold the asset would switch to a new long position, and vice versa. Within both of these scenarios a significant price movement post-rating announcement is plausible, not because of supplementary valuable firm-related information, but due to a shift from unobserved likelihoods into an approximated one.

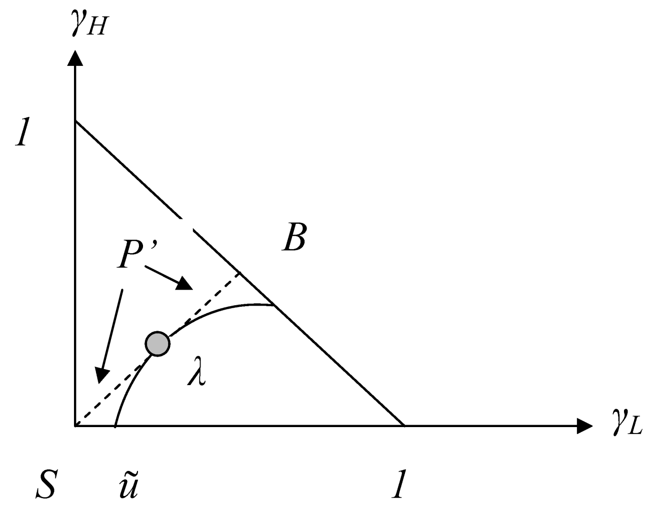

FIGURE 3 Lottery Probability Triangle post-rating announcement.

Stronger Loss Post Downgrade for Low Credit versus High Credit Grades

We distinguish between investors in low credit categories as those with low level of risk aversion, and investors in high credit grades as those with high level of risk aversion. The low risk-averse investors tend to invest in risky debt issuances. These risk lovers have their risk-aversion cutoff point λ_1 located at a lower section on the *SB* line. The high risk-averse investors tend to invest in less risky bonds, and thus their risk-aversion cutoff point λ_2 lies at a higher segment on the *SB* line.

The probability p for B to be favorable is assumed to be known, or at least it can be approximated by market participants, post-rating announcement. If for example, the likelihood p is positioned between λ_1 and λ_2, then $p > \lambda_1$ causes the risk lovers to buy, while $p < \lambda_2$ drives the risk-averse investors to sell. Clearly, if $p > \lambda_2 > \lambda_1$ both types of investors would buy the bond, and if $p < \lambda_1 < \lambda_2$ both types of investors would sell the bond. The behavioral difference is directly associated to the investors risk-tolerance as described in Figure 4.

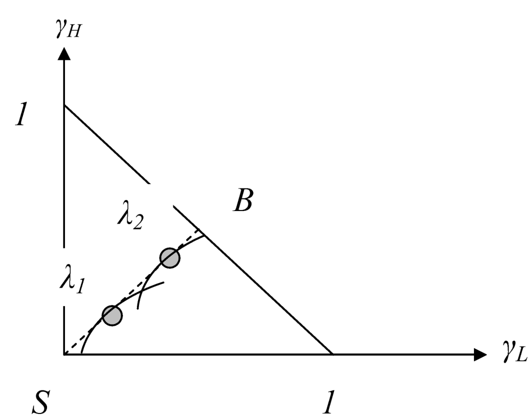

FIGURE 4 Lottery Probability Triangle for low and high-credit grades.

We can express the expected return on a low credit category bond as:

$$\begin{aligned} E\,[R_{LOW}] &= \Pr ob(\mathit{profit}) \times \mathit{profit} + \Pr ob(\mathit{loss}) \times \mathit{loss} \\ &= (1-\alpha) \times \mathit{profit} + \alpha \times \mathit{loss} \\ &= \Pr ob(B) \times \Pr ob(\mathit{price\ increase}) \times \mathit{profit} \\ &\quad + \Pr ob(B) \times \Pr ob(\mathit{price\ decrease}) \times \mathit{loss} \\ &= \Pr ob(p > \lambda_1) \times p \times \mathit{profit} \\ &\quad + \Pr ob(p > \lambda_1) \times (1-p) \times \mathit{loss} \\ &= \Pr ob(p > \lambda_1) \times [p \times \mathit{profit} \\ &\quad + (1-p) \times \mathit{loss}] \end{aligned} \tag{4}$$

In the same fashion, we can convey the expected return on a high credit category bond as:

$$\begin{aligned} E[R_{HIGH}] = \Pr ob(p > \lambda_2) \times [p \times \mathit{profit} \\ +(1-p) \times \mathit{loss}] \end{aligned} \tag{5}$$

Without loss of generality we can assume that p is uniformly distributed over the interval *SB*, and the same amount invested by all investors, thus market participants observe the same profits and losses. We then conclude that $E\,[R_{LOW}] > E\,[R_{HIGH}]$ solely because $\Pr ob(p > \lambda_1) > \Pr ob(p > \lambda_2)$. This observation corresponds to the general hypothesis that riskier investments often yield higher expected return, while less risky alternatives tend to have lower compensation for market participants. We can further simplify equations (4) and (5) for a credit rating downgrade event as:

$$\begin{aligned} & E[\mathit{loss}_{LOW}|\mathit{downgrade}] \\ &\quad = \Pr ob(\mathit{loss}_{LOW}|\mathit{downgrade}) \times \mathit{loss} \\ &\quad = \Pr ob(p > \lambda_1) \times (1-p) \times \mathit{loss} \end{aligned} \tag{6}$$

$$\begin{aligned} & E[\mathit{loss}_{HIGH}|\mathit{downgrade}] \\ &\quad = \Pr ob(p > \lambda_2) \times (1-p) \times \mathit{loss} \end{aligned} \tag{7}$$

Therefore, when the likelihood p is uniformly distributed over the interval *SB*, and when all investors endanger the same amount, we can further conclude that $|E[\mathit{loss}_{LOW}|\mathit{downgrade}]| > |E[\mathit{loss}_{HIGH}|\mathit{downgrade}]|$, where expected losses are expressed with absolute values, exclusively because $\Pr ob(p > \lambda_1) > \Pr ob(p > \lambda_2)$.

Stronger Loss Post-Downgrade versus Gain Post-Upgrade

As before, we assume that credit rating announcement homogenizes investor's expectations regarding the likelihood p, without adding any new firm-specific information to the market. Hence, we denote the probability p for B to be favorable upon remaining at the same credit category, $p' > p$ as the likelihood for B to be favorable upon an upgrade reclassification, and $p'' < p$ as the odds for B to be favorable

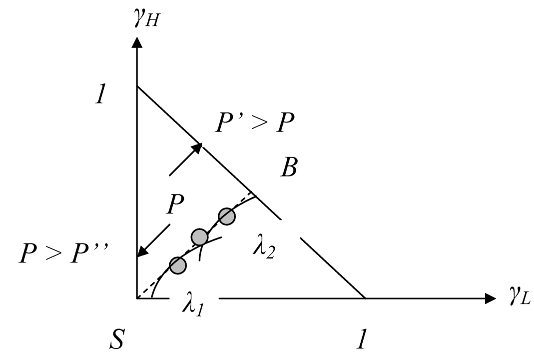

FIGURE 5 Lottery Probability Triangle post downgrade versus upgrade.

upon a downgrade. We further consider the more general circumstances where market participants do not share the same level of risk-aversion, thus the risk lovers have their risk-aversion cutoff point λ_1 located at a lower point on the *SB* interval, while the high risk-averse investors position their risk-aversion cutoff point λ_2 at a higher point on the *SB* line, as depicted in Figure 5.

Analogous to the prospect theory, investors drop the likelihood p for B to be favorable with a larger magnitude post downgrade, than would otherwise lift it after an upgrade. Kahneman and Tversky [1979, 1986, 1992] present an alternative behavioral theory of choice, called the prospect theory, where probabilities are replaced by decision weights, the value function is typically concave for gains, often convex for losses, and is steeper for losses than for gains.

In our venue, the indifference curve $\tilde{u}$ stays concave ($\tilde{u}' > 0$, $\tilde{u}' < 0$) for positive returns, but it becomes convex ($\tilde{u}' > 0$, $\tilde{u}' > 0$) for negative returns. Furthermore, the slope of the utility function is larger for losses than for gains. Therefore, while λ remains the risk-aversion threshold value, a rational investor can no longer decide whether to buy or sell with respect to the inequality $p > \lambda$, or $p < \lambda$, respectively. Instead, the likelihood p for B to be favorable is mapped into a decision weight, which eventually generates p', and p''.

To demonstrate this concept we may assign the concave value function $p' = \sqrt{p}$ for positive returns, and the convex function p^4 for negative returns. Thus, for every $0 \le p \le 1$ we obtain a concave $p' > p$, a convex $p' < p$, and p' drops stronger post downgrade than p' rises post upgrade within the same domain of [0, 1].[6]

Without loss of generality we assume that p lies in the halfway between λ_1 and λ_2, thus we define $\lambda_1 = p - \varepsilon$, and $\lambda_2 = p + \varepsilon$, where $\varepsilon > 0$. We further assume that $p' \sim U(p, B]$ post upgrade, and therefore it may fall to the left or to the right of λ_2. Since p'' drops stronger post downgrade than p' rises post upgrade, we scale the segment *SB* so that p is set to be zero, and place $|p'| = p' + \omega$, where $\omega > 0$. No further assumptions are required regarding the specific locations of λ_1

and λ_2 on the *SB* interval. This setting leads to the following results:

$$\Pr ob(p' > \lambda_2|upgrade) = \Pr ob(p' > p + \varepsilon|p' \sim U(p, B])$$
$$= \frac{(p, B] - \varepsilon}{(p, B]} \quad (8)$$
$$\Pr ob(p'' < \lambda_1|downgrade)$$
$$= \Pr ob(p'' < p - \varepsilon|p' \sim U(p, B], |p''| = p' + \omega, \omega > 0)$$
$$= \Pr ob(p' > p + \varepsilon - \omega|p' \sim U(p, B])$$
$$= \frac{(p, B] - \varepsilon + \omega}{(p, B]} \quad (9)$$

therefore: $\Pr ob(p'' < \lambda_1|downgrade) > \Pr ob(p' > \lambda_2|upgrade)$. We can now postulate the expected loss post downgrade and the expected gain post upgrade as:[7]

$$E\,[loss|downgrade]$$
$$= \Pr ob(loss|downgarde) \times loss$$
$$= \Pr ob(p'' < \lambda_1|downgrade \times loss \quad (10)$$
$$E[gain|upgrade]$$
$$= \Pr ob(gain|upgarde) \times gain$$
$$= \Pr ob(p' > \lambda_2|upgrade) \times gain \quad (11)$$

and since $\Pr ob(p'' < \lambda_1|downgrade) > \Pr ob(p' > \lambda_2|upgrade)$, we can further conclude that $|E[loss|downgrade]| > |E[gain|upgrade]|$, both expressed with absolute values.

REMARKS

Financial academics and practitioners have long recognized that stock prices, bond prices as well as trading volume significantly fluctuate around credit rating announcements. The existing finance literature suggests three alternative theories to rationalize these phenomena. However, each competing premise can explain only a piece of the puzzle. In this study we contest these theories and present a substitute behavioral approach that may resolve all the riddles.

In our notional model a rational utility-maximization investor chooses whether to buy or sell with respect to two parameters: the idiosyncratic level of risk-aversion and the belief regarding unobserved probabilities for the underlying asset price to rise or fall. The risk-aversion cutoff point λ is derived from the tangency point between the investor's indifference curve and the feasible lottery, while the probability p denoting the likelihood for buying the asset to be favorable is assumed to be unobservable prior to rating announcement, yet it can be approximated post credit rating reclassification. An investor decides to buy or sell according to the inequality $p > \lambda$, or $p < \lambda$, respectively.

Our theory considers that an upgrade in the creditworthiness of a debt issuance may trigger the probability p to rise while a credit downgrading causes deterioration in p. Our model suggests that credit rating announcement does not add any firm-specific information to the market but rather homogenizes investor's expectations. Furthermore, we differentiate between low risk-averse investors having their risk-aversion cutoff point λ_1 located at a lower fragment on the feasible lottery, and the high risk-averse investors having their risk-aversion cutoff point λ_2 lies at a higher section. This distinction allows us to identify the low credit categories and the high credit grades investors.

The foremost contribution of our model is that it can lead to a complete and better explanation of a large array of phenomena observed in practice. In particular, the model clarify the increased trading volume prerating announcement for bonds, the significant price movements post-credit announcements, the stronger loss post downgrade for low credit categories versus high credit grades, and the stronger loss post downgrade versus gain post upgrade.

NOTES

1. This assumption does not rule out the option for a single investor to diversify his investments over a large portfolio of bonds, as Michael Milken did with junk bonds during the 1970s and 1980s.
2. If $S \sim B$, a preference ordering $\succ$ is *quasi-convex* if $S \succ pB + (1-p)S$, $\forall p \in (0, 1)$. A preference ordering $\succ$ is *strictly quasi-convex* if $S \succ pB + (1-p)S$, $\forall p \in (0, 1)$. Both terms classify risk aversion to randomization.
3. Chateauneuf and Cohen [1994] reveal that when the transformation function in the rank-dependent expected utility theory exhibits certain levels of pessimism, it is possible that an agent is risk-averse, although having convex utility function. However, the universal Rothschild-Stiglitz [1970] meaning for risk-aversion induces concave utility function.
4. λ is constrained to be strictly larger than zero to authenticate the assumption that all investors can participate in the market. It is strictly smaller than one to assure that investors are rational.
5. The process of homogeneity in investor's expectations is pertinent for credit rating announcements, however it may not hold for analyst's reports, merely because there are two leading credit rating agencies, Moody's KMV and S&P, having similar classifications in a large amount of cases, yet there are numerous analysts covering each stock having a broad range of recommendations.
6. This mapping procedure drops p'' stronger than it rises p' for most of the [0, 1] interval except for very low

values of p, since the likelihood p is bounded from below by zero.

7. From Figure 5 it can be seen that loss can occur only when $p'' < \lambda_1$, and gain may arise only when $p\prime > \lambda_2$. When p lies between $\lambda 1$ and $\lambda 2$, the risk lovers take a long position, while the risk-averse investors go short. Only when $p'' < \lambda_1$ post announcement, the risk-lovers face a change in their beliefs, hence they close their initial long position, and sell with a loss. Only when $p' > \lambda_2$ post announcement, the risk-averse investors shift their expectations, thus they buy with a gain.

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