Disclosure of debt covenant violations: the probability of informed trading

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Abstract

This paper examines the impact of firms' disclosure of debt covenant violations on the probability of informed trading. Using stock market intraday trading data of US companies that disclosed debt covenant violations between 2001 and 2008, we compare the probability of informed trading in the disclosure period of [-5, +5] days, to the non-disclosure period of one month prior to disclosure. We show that disclosure of these informationally complicated events may increase information asymmetry in firms already characterized by relatively high information asymmetry (proxied by low analyst coverage and low trading volume). For these firms, the probability of informed trading significantly increases in the disclosure period, compared to the non disclosure period, and the increase in informed trading clusters in the post-announcement period. In contrast, for firms with low embedded information asymmetry, we show no change to the probability of informed trading in the disclosure period, when compared to the non-disclosure period.

Key words Information asymmetry, probability of informed trading, corporate announcements

JEL codes: G10, G14, G18, G30

1. Introduction

We offer market microstructure evidence that links the probability of informed trading to crucial and complex corporate events, in this case, debt covenant violations. While there is a dearth of literature examining information asymmetry around anticipated and relatively frequent events, such as earnings and dividend announcements, the evidence regarding their impact on information asymmetry is conflicting and fundamental questions remain. There is no agreement for example, on whether firms should be required to disclose and if so what types of disclosures should be regulated and which should not (Admati & Pfleiderer, 2000). Disclosures differ in character. They may be anticipated or unanticipated. They may have relatively certain or uncertain outcomes for investors depending on the complexity of the information. How do investors respond to different types of corporate disclosures? A further question, and the focus of this paper, is whether a firm's pre-existing levels of information asymmetry impact on the outcome of regulated disclosures?

We argue that debt covenant violation disclosures are useful events for studying the informational effects of corporate disclosure because they differ from more regular, anticipated announcements in three important ways. First covenant violations are informationally complex in nature making their consequences uncertain, particularly for less sophisticated traders (Griffin, Lont, & McClune, 2012). Second, covenant violations, are less frequent, unanticipated events and thus potentially more difficult for uninformed (unsophisticated) investors to interpret. Third, there is substantial delay between the event and public disclosure (debt covenants violations are usually reported in quarterly or annual SEC filings). This means insiders i.e., management of the violation company or the debtors in the violated credit agreement, are informed of the violation well before public investors, providing a window of opportunity for trading on private information.

Corporate disclosure is an important means for management to communicate firm performance to outside investors. By reducing information asymmetry between informed and uninformed investors, disclosure of information is thought to improve efficiency in capital markets (see Healey & Palepu, 2001). Such beliefs have given rise to a complex framework regulating the disclosure of information including *Regulation Fair Disclosure* (FD)[1]. Such regulation seeks to provide equal access and thus level the playing field for uninformed or unsophisticated investors. In this manner, the adverse selection component of the bid-ask

[1] In October 2000, the Securities and Exchange Commission (SEC) passed Regulation fair Disclosure (FD) to reduce selective disclosure of material information by firms to analysts and other investment professionals

spread, associated with informed trading, is thought to be reduced. However, the evidence is unclear. Eleswarapu, Thompson & Venkataraman (2004) provide empirical evidence that FD has indeed reduced the adverse selection component of trading costs as evidenced by a reduction in informed trading post FD. On the contrary, Sidhu, Smith, Whaley & Willis (2008) find the adverse selection component of the bid-ask spread increases after FD. Using a bid-ask spread regression model, they find, *Regulation Fair Disclosure* actually increases the probability of informed trading and adverse selection costs. They argue that in curtailing the flow of private information, such information becomes more valuable and longer-lived. Earlier research also finds an increase in the adverse selection component of the bid-ask spread around earnings announcements (Kim & Verrecchia, 1994; Krinsky & Lee, 1996). This is a result of the superior ability of informed traders to assess firm performance on the basis of announcements. Hence, the relationship between information disclosure and effects on the market are unclear.

This study addresses two questions: do public disclosures of debt covenant violations result in a reduction in information asymmetry? And, how do informed traders reactions to such violations differ between firms with different levels of information asymmetry pre disclosure? To examine these questions, this paper provides evidence of informed trading around the violation announcement period. Trading volume and analyst coverage are used to proxy for different levels of embedded information asymmetry. The idea of using analyst coverage as a proxy for information asymmetry is that analysts are considered to be sophisticated informational intermediaries with superior resources and processing ability over other unsophisticated traders (Healey & Palepu, 2001). Accordingly, analyst coverage may serve to dampen the effect of information asymmetry by interpreting the violation news for less sophisticated investors.

Debt covenant violations are informationally complex. Unconditionally, they are bad news as they signal deterioration in credit quality and give creditors the legal right to demand immediate repayment, which could force bankruptcy. However, creditors rarely demand repayment or loan acceleration. Instead, depending on the severity of the violation, creditors renegotiate the contract imposing greater restrictions on the firm's capital expenditure, which serves to constrain future investment (Nini, Smith, & Sufi, 2009, 2012). Nini, Smith & Sufi (2009, 2012) show that for violating firms increased creditor control is associated with a reduction in leverage, a decline in acquisitions, a sharp fall in shareholder payouts and increased CEO turnover (Nini, et al., 2012). Conditionally though, debt covenant violations are not necessarily bad news as increased creditor control may be positive for the violating firm in the long run. Chava & Roberts (2008) find less financial distress following large capital investment cuts after violation reports. Similarly, Nini et al. (2012) find positive abnormal stock returns up to 24 months after the violations. Their evidence suggests increased creditor control reduces managerial value-reducing overinvestment.

Our evidence supports the conjecture that disclosure of informationally complex events, such as debt covenant violations, may actually increase information asymmetry for some firms. We find this is the case for firms that already have embedded a high level of information asymmetry i.e., low trading volume firms and firms that do not have outside sources of information, such as analyst coverage. We argue that sophistocated or informed traders with superior processing ability would be aware of the value enhancing outcomes of contract renegotiations following a covenant violation. On the other hand, ordinary investors, without access to other information, may be unaware of the true value implication of the information and over react to what is perceived as bad news.

Using intraday trading data, we infer the probability of informed trading (PI) using a modified market maker bid-ask spread model devolped by Bollen, Smith, & Whaley (2004) (hereafter, BSW). The PI is the probability that trade originates from informed investors, which can be estimated on a daily basis using a firm's stock market trading data. The daily PI, around the periods under study, is computed on a sample of companies reporting debt covenant violations in their filings to the Securities Exchange Commision over the period of July 2001 to June 2008. In the context of our model design, we investigate the impact of public disclosure of debt covenant violations on information asymmetry by testing whether there is a decline in the PI in the disclosure period against the non-disclosure period; or, if there is a decline in PI during the pre-disclosure period as opposed to the post-disclosure period.

In examining whether informed trader reactions to such violations differ between firms with different levels of information asymmetry pre disclosure, we provide evidence of informed trading on quintile subsamples based on trading volume (liquidity) and analyst coverage respectively. Both breakdown variables are used to proxy for the information asymmetry level embeded in the violating firms. The difference is, trading volume provides a market measure whereas the analyst coverage proxy is an intuitive accounting measure. Our evidence suggests that informed trader reactions vary with firm type. Informed traders trade on firms characterized with lower information asymmetry tend not to react abnormally in the announcement period, compared to the non-announcement period. However, this is not the case for firms with high information asymmetry i.e., firms in the quintile subsample with the lowest trading volume (based on trading volume breakdown) and with zero or one financial analyst following (based on analyst coverage breakdown). In this quintile, the probability of informed trading increases during the eleven-day announcement window [-5, +5], as opposed to the non-announcement period (one month prior to the announcements).

More significantly, the increase in informed trading clusters at the post-announcement period [+1, +5]. This timing evidence implies the violation disclosure deepens the information asymmetry gap in these firms. Hence, the disclosure of the violation does not mitigate the information asymmetry embeded in low liquidity (low analyst coverage) firms and rather, does the opposite. Our evidence is consistent with Kim and Verrecchia (1994) in which information asymmetry is higher after announcements due to an interpretation advantage of informed traders in the violation disclosure period. We also argue, in cases where informed traders know the violation is less serious, they wait until the public announcement before they trade. In cases where they know the violation to be serious, informed traders trade before the disclosure. Our results linking credit rating downgrading post announcement to the probability of informed trading provide support for this conjecture.

The paper is structured as follows. Section 2 provides background on the complex nature of debt covenant violations and the related literature. Sections 3 details the sample and Section 4 presents our modified market maker bid-ask spread model devolped by Bollen, Smith, & Whaley (2004). Sections 5 and 6 detail the summary statistics and empirical results respectively. Section 7 concludes.

2. Background and literature

Financial covenants are mainly accounting-based metric restrictions on a company's leverage, interest coverage, capital expenditures and net worth etc. set by the lenders. As a common feature of credit agreements, financial covenants are used to protect debt holders against activities that transfer wealth from them to shareholders[2]. Roberts & Sufi (2009b)

[2] As documented by Nini, et al (2009), financial covenants are the most common covenants to be violated. Affirmative covenants require the borrower to take certain actions, such as meeting GAAP accounting standards etc. and negative covenants prevent the borrower from taking certain actions, such as altering the fundamental nature of the business, disposing of assets, paying dividends, etc. Our sample is sourced from their data, which

show that 96% of all private credit agreements contain at least one financial covenant with leverage ratio and coverage ratio covenants being the most common. Breaches of financial covenants result in the borrower being in technical default on the loan and the lender, in theory, has the right to demand immediate repayment of the loan. Dichev & Skinner (2002) document that in practice, the violation incidence rarely leads to loan acceleration or bankruptcy. Roberts & Sufi (2009a) confirm this by showing that only one-third of all violations result in a change in the contractual terms of the loan (which does not mean liquidation) and the remainder of borrowers receive waivers with no amendment to the contract.

Breach of debt covenants are common and significant occurrences. SEC Regulation S-X stipulates that a breach of a covenant exists at the date of the most relevant balance sheet being filed where the breach has not been remedied and the breach must be stated in the notes to the financial statement[3]. More recently, in 2003, the SEC reinfored this requirment by stipulating that firms must also disclose material information indicating they are 'reasonably likely' to be in breach of covenants. Furthermore, such firms are required to analyze the impact of the impending violation on the company. Nini et al. (2012) show about 10% to 20% of public firms are in violation of a covenant during any particular year between 1996 and 2008. This high incident of violations and the crucial financing role played by debt has inspired most empirical papers in this area to investigate the long-run impacts to violator firms' investment (Chava & Roberts, 2008) stock return and corporate governance (Nini, et al., 2012); and financing behavior (Lemmon & Roberts, 2010); as well as other closely related fields such as covenant renegotiation (Roberts & Sufi, 2009b); and the relation to the probability of bankruptcy (Zhang, 2009).

The literature that relates informed trading to debt covenant violations is relatively new. Our work complements and extends this body of literature by examining the short-run impacts of covenant violations at the market microstructure level. Unlike previous studies, which primarily use monthly or daily abnormal stock returns (e.g., (Beneish & Press, 1995; Griffin, et al., 2012; Nini, et al., 2012), our model and tests are desgined to track average daily informed trading changes during the short-term violation diclosure periods (i.e., an eleven-day event window). Merely looking at stock returns cannot answer questions such as: are

excludes the rare occurrences of affirmative and other non-financial covenant violations because "they represent a deliberate breach by the borrower".

[3] SEC (1988): quoted in Beneish & Press (1993).

abnormal stock returns caused by informed or uninformed traders? Do informed traders exploit their information advantage by trading on that information? If so, when do they trade: before the violation disclosure or after? Indeed, only informed trading provides information to markets—not uninformed trading. We touch on these questions by examining the changes to the probability of informed trading during the periods under study.

Griffin et al., (2012) examine insiders' reaction to debt covenant violation announcements. They use monthly aggregate insider trading data to compute the imbalance ratio (buy-sell trade difference scaled by the total number of buy-sell trades) as an insider trading measure which is computed on a monthly and daily basis. They find that the net insider selling between one month before and one month after the disclosure is significantly correlated to cumulative abnormal returns around the disclosure date (i.e., 5-day window of [-2, +2] and 10-day window of [-5, +5]). The 10 day window is also tested in our study; however, we are interested in whether or not the probability of informed trading has changed during the disclosure period versus the non-reporting period. Any fluctuation in the probability of informed trading directly indicates the level of change in information asymmetry. Compared to the insider trading data used in Griffin et al. (2012), the data we use to compute the probability of informed trading includes quotes and trades information from all investors and thus is more complete and informative. Similar to Nini, Smith and Sufi (2012), Griffin et al provide evidence over a relatively longer period (i.e., they compute the net insider selling and buying over 2 to 24 months), however; we focus on the short-term impacts of the violations by observing the PI changes of an event window of 10 days.

3. The sample

We begin with covenant violation reporting dates from US nonfinancial firms in *Compustat* between July 2001 and June 2008[4]. Covenant violation reports are sourced from SEC 10-K (annual) and 10-Q (quarterly) filings. These two filings are required to be lodged electronically to SEC within 45 days (for 10-Q) and 90 days (for 10-K) after the end of the financial quarter or year. The filing immediately becomes publicly available (e.g. through EDGAR)[5]. Similar to Nini et al. (2012), we focus on initial financial covenant violations i.e., we only include violator firms that have not violated a covenant in the previous four quarters.

[4] We are grateful to Professor Amir Sufi from Chicago Booth for providing the data on violation announcement dates and violation (financial) quarters.
(See http://faculty.chicagobooth.edu/amir.sufi/data.html).
[5] Nini et al. (2012), use the relevant SEC filing (as reported by Edgar) as the official report date of the violation.

This is because it often takes a long time to remedy a violation[6], hence; "… [studying initial violations] provide the cleanest identification of the effect of violations on corporate behaviour" (Nini, et al., 2012).

The sample period begins in July 2001 to ensure all sample firm stocks are within the decimalization pricing regime[7]. Next, we download the intraday trade and quote data from NYSE TAQ file for the sample violating firms. To make the data valid, the following selection criteria are implemented on the sample firms: (1) sample firms must have traded at least five times each day over the window period; (2) quotes with a trading price falling outside the bid and ask price are ignored and; (3) quotes with the bid higher than the ask are ignored.

The final sample contains 1,348 first-time debt covenant violations from 1,147 firms announced over the period of July 2001 to June 2008. Figure 1 shows the distribution of violations over the sample period with the maximum number of recorded violations i.e., 273, between July 2001 and June 2002[8]. The remaining violation incidents are spread relatively evenly over the other years, ranging between 148 and 208.

In our base line test, we examine the average probability of information asymmetry over the reporting period against the benchmark of non-reporting period with defining the reporting period starting from one calendar week before and one calendar week after the disclosure including the disclosure day (i.e., [-5, +5]). Using a narrow reporting window like this we hope to capture the change in PIs; hence provide us some evidence of the impacts of debt covenant disclosure.

Our benchmark window is a non-reporting period which is considered as "normal period" and we expect the average PI over the benchmark period well indicates the information asymmetry level before the disclosure. We select the benchmark window of one calendar month (22 trading days) starting from two calendar months before the start of the reporting period till one calendar month before the start of reporting period (i.e., a trading window of [-49, -28]). The selection of such window is based on two considerations: first, to minimize the

[6] Nini et al. (2012) reports that 42% of the sample firms remain in violation of a covenant in the quarter after the violation, 32% remain in violation after one year, and about 20% of firms remain in violation of a covenant two years after the initial violation.

[7] NASDAQ is the last stock exchange to switch to a decimal pricing regime on 9 April 2001, following the NYSE and AMEX stock exchanges. Given our estimation period starts 2 months prior to the last event date (e.g. the possible earliest estimation date is 1 May 2001), all the estimation months are in the decimal pricing regime.

[8] Griffin, Lont and McClune (2012) use the sample period of 2000 to 2008 and also find more covenant violation disclosures occur in 2000 and 2001 (47.6%).

possible impacts from the previous quarterly filing announcements. Debt covenant violation information is sourced from SEC 10Q quarterly filings and usually there is a three-month gap between every two adjacent filings. If a chosen benchmark window overlaps with the previous 10Q filing announcement, we are not able to defence our results from possible contamination by the disclosure from last quarter. Second, it is unknown when informed traders will exploit the private information about debt covenant violation and trade more aggressively before the disclosure. Is it one week before the disclosure, or two weeks, or even earlier? If the length of the non-reporting period chose is relatively long (30 calendar days), we expect the average daily PI over this period will not deviate far from the true value of PI over the 'normal period'. Griffin et al., (2012) suggest that insiders exploit this private information and trade 12 month before the disclosure using disclosed insider trading data. However, their finding is harder to guard comparing with ours; because the impacts from other events during an extra 9 months can easily bias their results.

Following BSW and with ask and bid prices information at hand, we compute eight summary statistics for each stock each day (i.e., 11 days for each disclosure).

(1) Number of trades, *N*;

(2) The equal-weighted quoted spread, *EWQS*

$$Quoted\ spread_t = Ask_t - Bid_t \ ;$$

(3) The number of shares traded, *TV* (Trading Volume);

(4) The volume-weighted effective spread, *VWES*, is a volume weighted average of the effective spreads of the trades occurring throughout the day. In this metric, the bid-ask price midpoint proxies for the true stock price in each trade. The trade is only costly to the investor if the trade price deviates from the true price.

$$Midpoint_t = \frac{Ask_t + Bid_t}{2}$$

On a round-trip basis, the cost is incurred twice, therefore, the effective spread measure can be computed as:

$$Effective\ spread = 2|trade\ price_t - midpoint_t|;$$

(5) The end-of-day share price, *S*, the last bid/ask midpoint prior to 4:00 p.m. EST;

(6) The historical rate of return volatility, σ, for each stock. It is computed using daily returns over the 60 trading days before each event day. The returns are obtained from the CRSP daily return file. The daily return standard deviation is then annualized using the factor $\sqrt{252}$;

(7) The average time between trades, *t*. To be consistent with the annual volatility measure, the time between trades must be measured in years. We divide the number of minutes between trades by 390 (the number of minutes in a trading day) and then by 252 (the number of trading days in a year);

(8) The statistics (5), (6), and (7) along with bid and ask prices are used to compute the inventory holding premium for each stock.

$$IHP = S[2N\left(0.5\sigma E\left(\sqrt{t}\right)\right) - 1]$$

Here, S is the stock's average share price over the event period, σ is the annual historical rate of return volatility and $E(\sqrt{t})$ is the expected value of the square root of the time between trades.

4. The model

We adopt Bollen, Smith & Whaley's (2004) bid-ask spread structural model in order to provide a direct measure of the probability of informed trading in our sample periods. The BSW model decomposes the market maker's spread into costs attributable to: order processing, the inventory holding premium, adverse selection, and competition. The inventory holding and adverse selection cost components of the bid-ask spreads are modelled as an option with a stochastic time to expiration. Our focus is on the inventory holding premium (*IHP*) component, as this premium can be partitioned in a way that enables us to separately identify and estimate the inventory holding and adverse selection cost components. This is the advantage of using BSW—the model allows us to identify the probability of an informed trade.

In the original BSW study, data on the number of market makers is required to compute the Herfindahl index of concentration, as a proxy for competition costs. This data is only available for the *NASDAQ* market; not for the other stock exchanges used in our study. However, since our focus is the inventory holding premium component and we are not aiming to accurately capture all cost components of the spread, we exclude the competition component contained in the original BSW model. We do this by assuming perfect competition among market makers in US stock markets. The perfect competition assumption implies competition has no impact on spread.

Our baseline regression model takes the form:

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_i + \varepsilon_i \qquad (1)$$

Where $SPRD_i$, is the bid-ask spreads; $InvTV_i$ represents order-processing costs; IHP_i is the sum of the inventory holding and adverse selection components of the spread. ε_i is the *i.i.d.* residuals. In Model 1, the inventory holding premium is model as an in-the-money option with an exercise price equal to the bid-ask price midpoint.

As mentioned above, the probability of an informed trade can be inferred from the inventory holding premium (*IHP*) partition. Hence, we decompose IHP_i into two parts: $IHP_{I,i}$ for informed traders and $IHP_{U,i}$ for uninformed traders. From the market maker's perspective, the probability that he trades with an informed trader is p_I and the probability he trades with uninformed traders is (1- p_I) i.e.,[9]

$$IHP_i = (1 - p_I) IHP_{U,i} + p_I IHP_{I,i}$$

Transforming this relationship gives the following expression:

$$IHP_i = IHP_{U,i} + p_I (IHP_{I,i} - IHP_{U,i})$$

Our baseline model can now be rewritten as:

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 [IHP_{U,i} + p_I (IHP_{I,i} - IHP_{U,i})] + \varepsilon_i \qquad (2)$$

When we set the coefficient β_2 equal to 1, the probability of an informed trade (p_I) can be identified. BSW model the inventory holding premium of an uninformed trade, $IHP_{U,i}$, as a slightly out-of-money option premium. Later in our empirical tests, we also use an out-of-money option premium and assume the true stock price is the bid-ask midpoint with an exercise price of the bid or the ask depending on whether the customer is on the sale side or the purchase side. However, in modelling an in-the-money option to an informed trader, the true stock price is unknown to the market maker even though the exercise price is known

[9]The expectations operator has been dropped for expositional convenience.

(e.g., the ask price on a client purchase and the bid price on a client sale). In their empirical tests, BSW allow the true price to have a premium between 1% and 10% (percent ITM) below the option's exercise price. For simplicity, we report only the results for the 1% premium case.

In estimating the inventory holding premium, we use the average time between trades as a proxy for the market maker's expected holding period. However, with more than one market maker executing orders, the proxy underestimates the length of the holding period. To estimate the length of the holding period across market makers, BSW set the coefficient β_2 to one in Model 1. Also the length of the holding period τ_i is estimated by scaling each individual stock's average square root of time between trades, by a constant factor. With the time between trades, τ_i, set to make a coefficient value equal to one, the probability of informed versus uninformed trades across stocks can be estimated using Model 2. The coefficient p_I represents the probability of an informed trade.

To statistically diagnose the changes in the probability of informed trading, an indicator variable is added to distinguish comparison time periods, as well as its intersection terms with every regressor of Model 2. The indicator value equals one when the sample firms are in the study period and equals 0 in the benchmark period. We then have the regression model with dummy variables as follows:

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3\left(IHP_{I,i} - IHP_{U,i}\right) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7\left(IHP_{I,i} - IHP_{U,i}\right)d_t + \varepsilon_i \qquad (3)$$

As previously mentioned, when we set the time between trades, τ_i, to make the coefficient value of *IHP* equal to one in Model 1, the probability of informed versus uninformed trades across stocks, p_I, can be estimated using Model 2. Adding dummy variables does not change this feature of our baseline model. Hence, by examining the *t* statistics of β_7 in Model 3, we can test the null hypothesis of: no change to the probability of informed trading between the disclosure period and the benchmark period.

5. Summary statistics

Table 1 contains the summary statistics of the variables used in the analysis over the event window of [-5, +5] and the non-reporting period of [-49, -28] (one month prior to the reporting window). The average equally weighted quoted spread, *EWQS,* is 19.5 (19.8) cents while the average volume weighted effective spread, *VWES*, is about 11.4 (11.5) cents during the reporting window (the non-reporting period). It is expected that the effective spread is lower because many trades occur at prices between the bid-ask quotes. Over the reporting period, the average share price is $13 and the annualized standard deviation of stock returns is 65%. The average number of shares traded each day is 630,000 i.e., more than four times the median of 147,778 shares. The mean value is even higher than the 75 percentile value, which indicates the volume measure is largely skewed by a small number of highly liquid stocks. A similar pattern is exhibited over the non-reporting period. Maybe, the only distinguishing difference between the two periods is that the trading volume is higher over the reporting period against the non-reporting period with an increase of 15.58%. Correspondingly, the time between two trades is shorter (*square root time,* with a decrease of 6%)

Table 2 contains Pearson correlations on the variables used in the regression analysis. First, the correlation between the two spread measures, *EWQS* and *VWES*, is 0.851 and 0.771 in the reporting and non-reporting periods respectively. Given the high correlation between *EWQS* and *VWES*, the study focuses on *VWES* as it provides a better reflection of actual trading costs (Bollen et al., 2004). The inverse of trading volume is used to proxy order-processing costs in our modified BSW model; hence a higher *InvTV* value is associated with higher spreads. Similar to the order-processing cost measure, a positive correlation between the inventory-holding premium (*IHP)* and spreads is also suggested in the model. In the reporting period, the correlation value is 0.505 for *EWQS* and 0.455 for *VWES*. This figure is slightly lower in the non-reporting period. Given these correlations, we expect that *InvTV* and *IHP* play an important role in explaining a market maker's bid-ask spreads.

6. Empirical Results

6.1 Univariate results

We now employ *t*-tests on the changes in *bid-ask spread, trading volume* and *inventory holding premium* (*IHP*) during the reporting period [-5, +5], against the non-reporting period [-49, -28], one month prior to the announcement date; and at the pre-announcement period [-5, -1] as opposed to the post-announcement period [+1, +5]. Panels A and B of Table 3 show no significant changes in the three variables, except the *IHP* value. The *IHP* value is marginally, but significantly lower during the reporting period, compared to the non-reporting period. This can be due to the shorter time between trades during the event period.

Next, to find out whether insiders react in the same way across firms, we sort the sample firms into quintiles based on trading volume and analyst coverage. The breakdown is motivated by evidence in previous studies that infer a negative correlation between trading volume and information asymmetry (Bollen, et al., 2004; D Easley, Kiefer, O'Hara, & Paperman, 1996; David Easley & O'Hara, 2004). Given trading volume in stock markets differs with years, and the violations occur throughout 2001 to 2008, we sort the stocks into quintiles according to the stocks' daily average trading volume over the period of 2001 and 2008. The left hand side of Panel C shows average daily shares traded over the reporting period [-5, +5] for every equally-sized quintile subsample. It is observed that Quintile 5 stocks are actively traded with a trading volume about four times higher than its adjacent quintile.

The other information asymmetry proxy used in this study is analyst coverage. Brennan & Subrahmanyam (1995) find that firms with many analysts have smaller adverse selection costs. Easley et al. (1998) also show that stocks with more analysts experience lower information-based trading. To obtain analyst coverage quintiles, we use the number of distinct financial analysts who report forecasts for earnings per share (EPS) in the violation announcement year. This analyst coverage data is sourced from I/B/E/S. Panel C shows that the lowest analyst coverage Quintile 1 sample, with zero or one financial analyst following in the violation year, accounts for 26% of the overall sample. The value range of analysts' coverage can vary quite a lot; for example, a firm can have 42 analysts in the extreme case in Quintile 5. This, together with the range of trading volume, indicates that violating firms can be very different. This is consistent with the finding in Nini et al. (2012) and Roberts & Sufi (2009a).

6.2 Changes in the probability of informed trading

Panel A to C of Table 4 reports the regression result of Model 3 using the overall sample, trading volume quintile subsamples, and analyst coverage quintile subsamples, respectively. The significance of β_7 indicates whether the probability of informed trading changes between the reporting period and the non-reporting period. From the overall sample results in Panel A, we don't observe this change. While for trading volume Quintile 1, the probability of informed trading shows a significant increase (β =52%) at a 5% significance level. Although, this is not the case when analyst coverage quintile subsamples are tested with the *p*-value slightly out of a 10% level. Panel A to C findings suggest that insiders from firms with less actively traded stocks tend to trade more frequently around the reporting period against the non-reporting period.

The current literature on informed trading investigates events where insiders know the timing of corporate events and respond strategically to such disclosures (e.g.Chae, 2005). Hence, the investigation of market response to corporate events within the pre- and post-periods is necessary. Next, we run the same tests on samples at the pre-announcement period [-5, -1] against the post-announcement period [+1, +5]. As in Panel A of Table 5, we find no changes to the probability of informed trading on the overall sample. However, the first quintile subsamples (Quintile 1), based on trading volume and analyst coverage, both suggest that informed traders from firms characterized by less actively traded stocks, or with zero or low analyst coverage, tend to trade more after the announcement.

This result implies that public disclosure of the violations does not result in a reduction in the level of information asymmetry. On the contrary, the violation disclosure even deepens the information asymmetry gap in these firms. The same evidence is not found in other quintile subsamples. This difference indicates that insiders do not react in the same way to the violation disclosure across all firms.

6.3 Other tests: credit downgrading

After knowing that the insider's trading strategy differs with firm type, we turn to another test to investigate insiders' reaction upon violations with various levels of severity. Specifically, we conjecture that in serious violation cases the probability of informed trading will not increase right after the disclosure. For example, if the flagged violation is recognized by other shareholders to be truly 'bad' news in the future, then informed traders should be better off trading before the disclosure (although not necessarily right before the disclosure).

We search the firms that have experienced long-term bond credit downgrading within 12 months after the violation announcement dates from a subsample of low analyst coverage stocks[10]. For the overall sample, there are 394 out of 1,384 firms that have Standard & Poor's bond credit ratings in the violation reporting (calendar) month. About 23% of these stocks are rated investment grade (with ratings of 'BBB' or above) and the rest are rated speculative grade. In total, 120 out of the 394 stocks have experienced credit downgrading within 12

[10] We could use the downgraded firms from the subsample of high analyst coverage/ high trading volume stocks. But given no changes in informed trading observed in these subsamples, even if we find evidence of no changes in informed trading in the downgrading sample, the evidence does not help to address the issue here.

months after the violation. Only 10 stocks in the sample have experienced credit upgrading during the same period. This can be interpreted as further evidence of value deterioration in violating firms.

In the analyst coverage Quintile 1 subsample, only 45 out of 349 firms have Standard & Poor's bond credit ratings in the violation reporting (calendar) month; 24 of these 45 firms with bond ratings have experience credit downgrading. We run Model 3 again on the sample of 120 downgraded and 24 downgraded stocks respectively at the pre-disclosure against the post-disclosure period [-5, -1] vs. [+1, +5]. Table 6 shows no significant changes to the probability of informed trading around the post-announcement period when compared to the pre-announcement period in both cases. This supports our conjecture.

7. Conclusion

This study provides a sharp test to answer the questions: is information asymmetry mitigated by public disclosures of debt covenant violations? And, do informed traders react to the violation information in the same way across all firms? We distinguish firm types according to their embedded level of information asymmetry—proxied by level of analyst coverage and trading volume.

Specifically, we examine the change to the probability of informed trading surrounding the disclosure date. Using a bid-ask spread model developed by Bollen, Smith & Whaley (2004), and data for violating US nonfinancial firms over the period July 2001 to June 2008 we find: informed trading reaction to debt violation disclosure may vary depending on the embedded information asymmetry level of the reporting firms. For example, our results suggest no change to the probability of informed trading for actively traded stocks; while for low liquid stocks, this probability increases by over half during the eleven days reporting window [-5, +5], when examined against the non-reporting period (one month prior to disclosures). Also, the increase in the probability of informed trading clusters immediately after the disclosures (at the event window [+1, +5], when examined against the pre-disclosure window [-5, -1]). Again, this evidence only holds for stocks with low liquidity or low analyst coverage.

Our explanation considers the complicated and uncertain nature of debt covenant violation information. We argue, even when firms report the violations and analyze their impacts in the nearest quarterly filings, the information content can still be subtle to outside investors. For example, in most cases, violation firms receive waivers from their lenders but the waivers are usually associated with more restrictive debt terms in the renegotiated or new contracts. Such information may imply bad news; however, research shows, to the contrary, creditor's intervention can improve violating firms performance in the long run.

We argue that without other assisting information sources, ordinary investors have difficulty understanding the true value implication of the violations. Instead, informed traders have an interpretation advantage over uninformed investors and this advantage is greater in firms characterized by lower trading volume and with less analyst coverage. We also provided tests of credit downgrading; the evidence supports our information asymmetry explanation.

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Figure 1: Distribution of violations by year

This figure illustrates the distribution of financial covenant violations reported in SEC filings of a sample of US nonfinancial firms with reporting dates from July 2001 to June 2008. There are 1,438 violations in total and the numbers of violations are broken down in terms of reporting month year: 273 violations are reported between July 2001 to June 2002; 208 July 2002 to June 2003; 153 July 2003 to June 2004; 192 July 2004 to June 2005; 183 July 2005 to June 2006; 191 July 2006 to June 2007; and 148 July 2007 to June 2008.

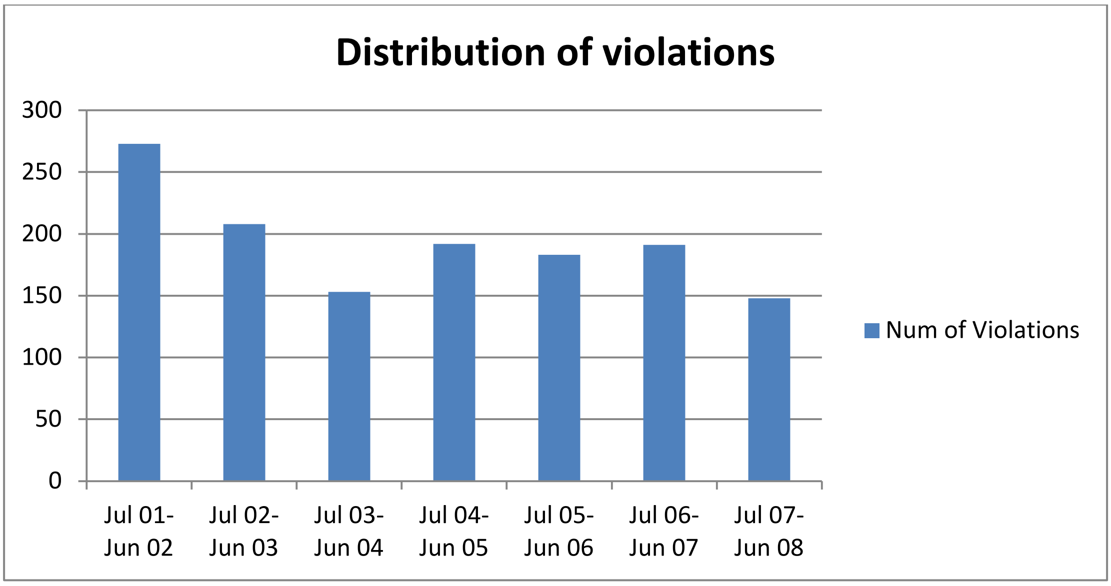

Table 1: Summary statistics of variables used in the regression analysis

This table summarizes the descriptive statistics of variables used in the bid-ask spread regression analysis for a sample of US nonfinancial firms reporting financial covenant violations from 2001 to 2008. We apply the event window of [-5,+5] and set the violation disclosure dates as event day 0 for each of the 1,348 violations. A benchmark non-reporting window of [-49, -28] for the same firms is chosen as one month prior to the reporting window. *EWQS* is the equal-weighted quoted bid-ask spread; *VWES* is the volume-weighted effective bid-ask spread; *S* is the share price; *TV* is the number of shares traded; *NT* is the number of trades; σ, the expected volatility, is proxied by the annualized return volatility of the stock computed over the most recent 60 trading days prior to the estimation day; $E(\sqrt{t})$, the expected value of the square root of the time between trades, is proxied by $\sqrt{t}$, the average of the square root of the number of seconds between trades; and *IHP* is expected inventory-holding premium as defined by:

$$IHP = S[2N\left(0.5\sigma E\left(\sqrt{t}\right)\right) - 1]$$

Each observation in the main sample is an average of the daily values of the variable across 5 days before/ after the violation reporting dates [-5, -1] or [1, 5]. To be included in the sample, the stock must have traded at least five times each day.

	Reporting Period [-5, +5] 11 trading days around the reporting date				Non-reporting Period [-49, -28] One month prior to the reporting window			
Variable	Mean	25%	Median	75%	Mean	25%	Median	75%
Spread measure								
EWQS	0.195	0.066	0.126	0.228	0.198	0.068	0.129	0.233
VWES	0.114	0.038	0.067	0.125	0.115	0.041	0.07	0.13
Determinants of spread								

S	13.097	3.451	8.265	17.672	13.395	3.790	8.809	18.251
TV	631,659	50,555	147,778	452,431	546,528	45,364	127,627	406,195
NT	1,291	92	309	1,094	1,083	86	286	959
σ	0.652	0.372	0.534	0.783	0.627	0.363	0.516	0.759
$\sqrt{t}$	1.592	0.635	1.222	2.302	1.688	0.675	1.293	2.448
IHP	0.009	0.003	0.006	0.011	0.010	0.004	0.007	0.012

Table 2: Pairwise Cross-correlations among Regression Variables

This table summarizes the descriptive statistics of variables used in the bid-ask spread regression analysis for a sample of US nonfinancial firms reporting financial covenant violations from 2001 to 2008. *EWQS* is the equal-weighted quoted spread, *VWES* is the volume-weighted effective spread, *InvTV* is the inverse of the number of shares traded, *IHP* is the expected inventory-holding premium, *NT* is the number of trades, *S* is the closing bid–ask price midpoint. The value of each variable is computed each trading day and averaged across all days during the five-day period preceding violation reporting and the five-day period after reporting. σ, the expected volatility, is proxied by the annualized return volatility of the stock computed over the most recent 60 trading days prior to the estimation day; the expected value of the square root of the time between trades is proxied by $\sqrt{t}$, the average of the square root of the number of seconds between trades; and *IHP* is expected inventory-holding premium as defined by:

$$IHP = S[2N\left(0.5\sigma E\left(\sqrt{t}\right)\right) - 1]$$

The values of *IHP* are averages across the five days in each period.

Panel A: Violation reporting period [-5, +5]

Variable	*EWQS*	*VWES*	*InvTV*	*IHP*	$\sqrt{t}$	*S*	σ	*NT*
EWQS	1							
VWES	0.851	1						
InvTV	0.234	0.180	1					
IHP	0.505	0.455	0.469	1				
$\sqrt{t}$	0.161	0.100	0.765	0.388	1			

S	0.399	0.390	-0.138	0.304	-0.358	1		
σ	-0.210	-0.175	-0.040	-0.017	0.155	-0.417	1	
NT	-0.118	-0.099	-0.193	-0.185	-0.355	0.258	-0.080	1

Panel B: Non-reporting period [-49, -28]

Variable	*EWQS*	*VWES*	*InvTV*	*IHP*	$\sqrt{t}$	S	σ	*ND*
EWQS	1							
VWES	0.771	1						
InvTV	0.224	0.176	1					
IHP	0.461	0.384	0.425	1				
$\sqrt{t}$	0.180	0.125	0.774	0.402	1			
S	0.350	0.350	-0.154	0.287	-0.359	1		
σ	-0.206	-0.190	-0.190	-0.020	-0.007	0.161	1	
ND	-0.125	-0.114	-0.188	-0.195	-0.360	0.281	-0.090	1

Table 3: Test for differences for study periods against benchmark periods

Panels A and B of this table show the *t*-test results for difference in volume-weighted effective bid-ask spread, trading volume, and inventory holding premium for a sample of 1,348 debt covenant violations in US markets from July 2001 to June 2008. Panel A, shows the value difference in the three variables between the covenant violation reporting period and non-reporting period; and Panel B, compares pre-announcement against post-announcement period. Panel C, shows some summary statistics for the quintile subsamples. The quintile subsamples are categorized by trading volume and analyst coverage.

Spread is the volume-weighted effective bid-ask spread (i.e. *VWES*); Trading volume, *TV*, is the average daily number of shares traded; and *IHP* is expected inventory-holding premium as defined by:

$$IHP = S[2N\left(0.5\sigma E\left(\sqrt{t}\right)\right) - 1]$$

The value of each variable is computed each trading day and averaged across all days during the five-day period preceding violation reporting and the five-day period after reporting. The values of *IHP* are averages across the five days in each period. *S* is the share price; σ, the expected volatility is proxied by the annualized return volatility of the stock computed over the most recent 60 trading days prior to the estimation day; $E(\sqrt{t})$, the expected value of the square root of the time between trades, is proxied by $\sqrt{t}$, the average of the square root of the number of seconds between trades. The *t*-statistics on the mean difference between the reporting period and non-reporting period are given in the last column.

Panel A: Overall sample: reporting period vs. non-reporting period case

Variables	Reporting period [-5, +5]	Non-reporting period [-49, -28]	Difference
Spread	0.114	0.115	-0.0008
Trading Volume	631,659	546,528	85,131
IHP	0.00895	0.00964	$-0.0007^{\$}$

Panel B. Overall sample: pre-announcement period vs. post-announcement period case

Variable	Pre-announcement period [-5, -1]	Post-announcement period [+1, +5]	Difference
Spread	0.113	0.115	-0.00231
Trading Volume	595,913	643,706	47,793
IHP	0.00904	0.00891	0.00013

The symbols $, *, **, and *** denote statistical significance at the 0.10, 0.05, 0.01 and 0.001 levels, respectively.

Panel C: Summary statistics for quintile subsamples based on trading volume (TV_Quintile 1-5) and analyst coverage (AC_Quintile 1-5)

Subsample	Size	Volume	Subsample	Size	Number of analysts
TV_Quintile 1	269	40,413	AC_Quintile 1	349	0, 1
TV_Quintile 2	271	122,610	AC_Quintile 2	223	2, 3
TV_Quintile 3	268	227,666	AC_Quintile 3	284	4,5,6
TV_Quintile 4	270	430,564	AC_Quintile 4	256	7-11
TV_Quintile 5	270	2,333,742	AC_Quintile 5	236	12-42

Table 4: Measuring changes to informed trading in the reporting period against the non-reporting period

This table reports several regression results using a sample of US companies reporting debt covenant violations between July 2001 and June 2008. Panels A through C compare the spread composites during the reporting period against the non-reporting period. An eleven-day reporting window of [-5, +5] is utilised against the non-reporting period of [-49, -28] which is one month prior to the reporting window. Panel A separates the inventory holding premium for uninformed traders and informed traders and measures informed trading on the overall sample of 1,348 violations. Panel B summarises the coefficient estimates and *t*-statistics of the probability of informed trading on trading volume quintile subsamples. Panel C summarises the coefficient estimates and *t*-statistics of the probability of informed trading on trading volume quintile subsamples. A modified Bollen, Smith and Whaley (2004) model is used for the regression analysis.

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3\left(IHP_{I,i} - IHP_{U,i}\right) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7\left(IHP_{I,i} - IHP_{U,i}\right)d_t + \varepsilon_i$$

$SPRD_i$ is the volume-weighted effective spread, $InvTV_i$ is the inverse of the number of shares traded, and IHP_i is the expected inventory holding premium. d_t is a dummy variable. Its value equals 1 in pre-event period and 0 in the non-reporting period. The value of each variable is computed each trading day and the values are then averaged across all days during each estimation period. $IHP_{U,i}$ is the expected inventory holding premium for trades with uninformed traders and $IHP_{I,i}$ is the expected inventory holding premium for trades with informed traders. For a trade at the bid, the value of $IHP_{k,i}$ is computed using Black and Scholes (1973) option premium model.

$$IHP_{k,i} = X_{k,i} N\left(\frac{0.5\sigma_i^2 \mathrm{t} - \ln\left(\frac{S_{k,i}}{X_{k,i}}\right)}{\sigma_i\sqrt{t}}\right) - S_{k,i} N\left(-\frac{0.5\sigma_i^2 \mathrm{t} + \ln\left(\frac{S_{k,i}}{X_{k,i}}\right)}{\sigma_i\sqrt{t}}\right), \qquad k = U\ or\ I$$

$IHP_{U,i}$ is valued as an out-of-money put option with an exercise price equal to the bid price and a stock price equal to the bid-ask midpoint. $IHP_{I,i}$ is valued as a 1% in-the-money put option with an exercise price equal to the bid price. For a trade at the ask, the *IHP* is valued using a call option formula with an exercise price equal to the ask price. The results are corrected for heteroskedasticity and autocorrelation.

No. of	Adjusted	Coefficient estimates / *t* statistics							
obs.	R-Squared	$\beta_0/t(\beta_0)$	$\beta_1/t(\beta_1)$	$\beta_2/t(\beta_2)$	$\beta_3/t(\beta_3)$	$\beta_4/t(\beta_4)$	$\beta_5/t(\beta_5)$	$\beta_6/t(\beta_6)$	$\beta_7/t(\beta_7)$

Panel A. Measuring changes to informed trading in the reporting period against the non-reporting period: Overall sample

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3 (IHP_{I,i} - IHP_{U,i}) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7 (IHP_{I,i} - IHP_{U,i}) d_t + \varepsilon_i$$

2,695	0.26	0.024*	234.033**	0.498***	0.31***	-0.011	189.97	0.042	0.149
		0.26	3.16	5.59	3.33	-0.74	1.51	0.33	1.18

Panel B. Measuring changes to informed trading: Trading volume quintile subsample evidence

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
β_7	0.52*	0.51$	0.03	-0.13	0.16
$t(\beta_7)$	2.04	1.70	0.33	-0.77	0.58

Panel C. Measuring changes to informed trading: Analyst coverage quintile subsample evidence

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
β_7	0.41	0.21	-0.17	0.30	0.09
$t(\beta_7)$	1.64	0.75	-0.65	1.59	0.35

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 levels, respectively.

Table 5: Measuring changes to informed trading at the pre-announcement period against the post-announcement period

This table reports several regression results using a sample of US companies reporting debt covenant violations between July 2001 and June 2008. Panels A through C compare the spread composites during the pre-announcement period [-5, -1] against the post-announcement period [+1,+5]. Panel A separates the inventory holding premium for uninformed traders and informed traders and measures the informed trading on the overall sample of 1,348 violations. Panel B summarises the coefficient estimates and *t*-statistics of the probability of informed trading on trading volume quintile subsamples. Panel C summarises the coefficient estimates and *t*-statistics of the probability of informed trading on trading volume quintile subsamples. A modified Bollen, Smith and Whaley (2004) model is used for the regression analysis.

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3\left(IHP_{I,i} - IHP_{U,i}\right) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7\left(IHP_{I,i} - IHP_{U,i}\right) d_t + \varepsilon_i$$

$SPRD_i$ is the volume-weighted effective spread, $InvTV_i$ is the inverse of the number of shares traded, and IHP_i is the expected inventory holding premium. d_t is a dummy variable. Its value equals 1 at the pre-announcement period and 0 at the post-announcement period. The value of each variable is computed each trading day and the values are then averaged across all days during each estimation period. $IHP_{U,i}$ is the expected inventory holding premium for trades with uninformed traders and $IHP_{I,i}$ is the expected inventory holding premium for trades with informed traders. For a trade at the bid, the value of $IHP_{k,i}$ is computed using Black and Scholes (1973) option premium model.

$$IHP_{k,i} = X_{k,i} N\left(\frac{0.5\sigma_i^2 \mathrm{t} - \ln(\frac{S_{k,i}}{X_{k,i}})}{\sigma_i \sqrt{t}}\right) - S_{k,i} N\left(-\frac{0.5\sigma_i^2 \mathrm{t} + \ln(\frac{S_{k,i}}{X_{k,i}})}{\sigma_i \sqrt{t}}\right), \qquad k = U \; or \; I$$

$IHP_{U,i}$ is valued as an out-of-money put option with an exercise price equal to the bid price and a stock price equal to the bid-ask midpoint. $IHP_{I,i}$ is valued as a 1% in-the-money put option with an exercise price equal to the bid price. For a trade at the ask, the *IHP* is valued using a call option formula with an exercise price equal to the ask price. The results are corrected for heteroskedasticity and autocorrelation.

No. of	Adjusted	Coefficient estimates / *t* statistics							
obs.	R-Squared	$\beta_0/t(\beta_0)$	$\beta_1/t(\beta_1)$	$\beta_2/t(\beta_2)$	$\beta_3/t(\beta_3)$	$\beta_4/t(\beta_4)$	$\beta_5/t(\beta_5)$	$\beta_6/t(\beta_6)$	$\beta_7/t(\beta_7)$

Panel A. Measuring changes to informed trading in the pre-reporting period against the post-reporting period: Overall sample

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3 (IHP_{I,i} - IHP_{U,i}) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7 (IHP_{I,i} - IHP_{U,i}) d_t + \varepsilon_i$$

2,695	0.23	0.018	201.963*	0.505***	0.384***	-0.014	167.87	0.067	0.148
		1.76	2.12	6.02	4.27	-0.74	1.22	0.14	1.05

Panel B. Measuring changes to informed trading: Trading volume quintile subsample evidence

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
β_7	0.71*	-0.15	-0.05	0.07	-0.06
$t(\beta_7)$	2.06	-0.38	-0.48	0.96	-0.20

Panel C. Measuring changes to informed trading: Analyst coverage quintile subsample evidence

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
β_7	0.62$	-0.22	-0.18	0.21	-0.04
$t(\beta_7)$	1.95	-0.65	-1.06	1.04	-0.14

The symbols $, *, **, and *** denote statistical significance at the 0.1, 0.05, 0.01 and 0.001 levels, respectively.

Table 6: Measuring changes to informed trading using a sample of bond credit downgrading stocks

This table presents the regression results on two samples of stocks that have experienced long-term bond credit downgrading within 12 months after debt covenant violation disclosure, over the period July 2001 to June 2008. In total, there are 394 out of 1,348 firms that have a long-term bond credit rating. Panel A includes all of the 120 out of 394 stocks that have experienced credit downgrading. It compares the probability of informed trading during the pre-announcement period [-5, -1] against the post-announcement period [+1, +5]. Panel B reports the probability of informed trading in the pre-disclosure period [-5, -1] against the post-disclosure period [+1, +5] using the same model on a sample of credit downgraded stocks (24 stocks), which are sourced from the low analyst coverage quintile sample only (Quintile 1sample). A modified Bollen, Smith & Whaley (2004) bid-ask spread model is used.

$$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3\left(IHP_{I,i} - IHP_{U,i}\right) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7\left(IHP_{I,i} - IHP_{U,i}\right)d_t + \varepsilon_i$$

Where *SPRD* is volume weighted effective spread, $InvTV_i$ is the inverse of the number of shares traded, and IHP_i is the expected inventory holding premium. d_t is a dummy variable. Its value equals 1 in the announcement period, and 0 in the non-reporting period in Panel A (1 in the pre-event period and 0 in the post-event period in Panels B and C). The value of each variable is computed each trading day and the values are then averaged across all days during each estimation period. $IHP_{U,i}$ is the expected inventory holding premium for trades with uninformed traders and $IHP_{I,i}$ is the expected inventory holding premium for trades with informed traders. For a trade at the bid, the value of $IHP_{k,i}$ is computed using the Black and Scholes (1973) option premium model.

$$IHP_{k,i} = X_{k,i} N\left(\frac{0.5\sigma_i^2 \mathrm{t} - \ln\left(\frac{S_{k,i}}{X_{k,i}}\right)}{\sigma_i\sqrt{t}}\right) - S_{k,i} N\left(-\frac{0.5\sigma_i^2 \mathrm{t} + \ln\left(\frac{S_{k,i}}{X_{k,i}}\right)}{\sigma_i\sqrt{t}}\right), \qquad k = U\ or\ I$$

$IHP_{U,i}$ is valued as an out-of-money put option with an exercise price equal to the bid price and a stock price equal to the bid-ask midpoint. $IHP_{I,i}$ is valued as a 1% in-the-money put option with an exercise price equal to the bid price. For a trade at the ask, the *IHP* is valued using a call option formula with an exercise price equal to the ask price. The results are corrected for heteroskedasticity and autocorrelation.

No. of	Adjusted	Coefficient estimates / *t* statistics							
obs.	R-Squared	$\beta_0/t(\beta_0)$	$\beta_1/t(\beta_1)$	$\beta_2/t(\beta_2)$	$\beta_3/t(\beta_3)$	$\beta_4/t(\beta_4)$	$\beta_5/t(\beta_5)$	$\beta_6/t(\beta_6)$	$\beta_7/t(\beta_7)$

Panel A. Measure changes to the probabilities of informed trading on a sample of stocks that have experienced credit downgrading within 12 months after the disclosure: the case of pre-disclosure period [-5, -1] vs. post-disclosure period [+1, +5]

	$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3 (IHP_{I,i} - IHP_{U,i}) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7 (IHP_{I,i} - IHP_{U,i}) d_t + \varepsilon_i$								
240	0.28	0.01	500.96$^{\$}$	0.53***	0.33**	0.02	-393.79	-0.19	-0.03
		1.29	1.81	4.07	2.85	1.41	-1.37	-1.16	-0.17

Panel B. Measure changes to the probabilities of informed trading on a sample of low analyst coverage stocks that have experienced credit downgrading within 12 months after the violation disclosure: the case of pre-disclosure period [-5, -1] vs. post-disclosure period [+1, +5]

	$SPRD_i = \beta_0 + \beta_1 InvTV_i + \beta_2 IHP_{U,i} + \beta_3 (IHP_{I,i} - IHP_{U,i}) + \beta_4 d_t + \beta_5 InvTV_i d_t + \beta_6 IHP_{U,i} d_t + \beta_7 (IHP_{I,i} - IHP_{U,i}) d_t + \varepsilon_i$								
48	0.48	0.00	-46.46	0.78***	-0.02	0.06*	43.36	-0.48**	0.27
		0.09	-0.16	6.15	-0.13	2.32	0.14	-2.85	1.35

The symbols *, **, and *** denote statistical significance at the 0.05, 0.01 and 0.001 levels, respectively.