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The Association Between Corporate Governance and Corporate Bond Liquidity: An Intraday Analysis

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Abstract
Extensive studies in the literature of market microstructure are dedicated to either verifying the informational efficiency of the market or exploring the relationship of relative efficiencies across different markets. However, little work has been done to examine the relation between asset liquidity and institutional details of firm and management team. The key research question of this study is whether or not the intraday corporate bond liquidity is associated with corporate internal governance, a governance mechanism stemming from within the top management team, shortly before earnings announcements when the information asymmetry is heightened. Building on the theoretical model of internal governance, the paper uncovers a hump-shaped relationship between internal governance measure and corporate bond liquidity before earnings announcements. The empirical results are generally persistent across a battery of robustness checks such as sensitivity check, subsample test and aggregation analysis. I employ the 2008 financial crisis as the main identification strategy. In face of the exogenous shock upon internal governance measure, the hump shape relationship still holds. This novel study contributes to the literature of financial economics, corporate governance and market microstructure. The study also provides evidence in support of the argument that the corporate bond market is informationally efficient.

Keywords: Internal Governance, Corporate Bond, Intraday Liquidity Measure, Market Microstructure

JEL Classification: D82, G14, G30, G32

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1. Introduction

Malkiel and Fama (1970) tells us that there are three forms of market efficiency. Extensive studies in the extant literature are dedicated to either verifying the informational efficiency of the individual market or exploring the relative efficiencies across different markets. However, limited work has been done to examine whether or not institutional details of firm and management team are related to the liquidity of traded securities. In this study, I examine the salutary effect of internal governance on the liquidity of corporate bond facing earnings announcements, a major corporate news release. Internal governance, initially theorized in (Acharya et al., 2011), is a mechanism through which lieutenant managers effectively constrain the myopic behaviors of the CEO, which also represents the overall efficacy of the top management team.

As such, the key research question of paper is whether or not the degree of efficacy of the management team is associated with the bond liquidity measures shortly before earnings announcements when the information asymmetry is heightened, and if so, beneficial or detrimental. Specifically, utilizing the bond turnover measure, the paper uncovers a hump-shaped relationship between internal governance and corporate bond liquidity before earnings announcements, which is aligned with the functional form of internal governance in the theoretical development by Acharya et al. (2011). The main findings of the hump shape relationship are robust to the sensitivity test of using different event windows for bond liquidity measure as well as to the sample splitting by bond characteristics such as trading frequency and

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credit rating, thereby validating the statistical inferences. The salutary effect of internal governance mechanism upon the corporate bond liquidity preserves even when the bond level data is aggregated to firm level in the econometric specification, which unavoidably obscure the degree of informational accuracy conveyed by the data. In addition, I further confirm the robustness of the hump shape relationship whereby utilizing a quasi-exogenous shock, the 2008 financial crisis, as the identification strategy. In particular, the quadratic functional form holds in face of the exogenous shock. The change of bond turnover measure and the change of internal governance are positively related when originally the internal governance measure is in the range of upward sloping part of the hump shape functional form before the shock. Similarly, the change of bond turnover measure and the change of internal governance are negatively related when originally the internal governance measure is in the range of downward sloping part of the hump shape functional form before the shock. As such, the exogenous shock identifies the casual relationship between internal governance and corporate bond liquidity.

The paper distinguishes from other two papers in a similar vein, Kanagaretnam et al. (2007) and Jain et al. (2016) both conceptually and methodologically. Firstly, Jain et al. (2016) focus on the equity market and use firm-year average liquidity measures. Based on the pricing parity of equity and credit, I pay particular attention to the corporate bond market through a lens of greater accuracy at the intraday level. Secondly, albeit using short event window, Kanagaretnam et al. (2007) only considered traditional corporate governance mechanism such as board characteristics whereas I concentrate on the marginal effect of internal governance, which is conceptualized in 2011 by Acharya, Myers and Rajan. To my best knowledge, this is the first paper that researches the linkage between corporate internal governance and corporate bond liquidity at extremely short window of intraday level during heightened market uncertainty. I believe the paper has the potential to fulfill the current gap in the literature of corporate governance and corporate bond liquidity. Moreover, the statistically significant relationship between internal governance mechanism and bond turnover measure indicates that market trading activities incorporate public information in addition to prices and thus provide side evidence that the corporate bond market is at least of semi-strong form efficiency.

2. Theoretical Background and Literature Review

Clearly the executive horizon of the incumbent CEO is much shorter than that of her immediate subordinates in the top management team who potentially will assume the CEO position, in the sense that the outgoing CEO is more likely to boost current earnings through myopic activities while the incoming CEO is more aligned her self-interest with the future value of the firm. Acharya et al. (2011) suggests a mechanism of internal governance that could mitigate the executive horizon problem. No matter how powerful the CEO is, unless she is the sole productive force of the firm, the individual still needs the assistance of the lower level managers to collaboratively and strategically implement the designated policy. As such, the degree to which the other members in the top management team share executive duties become the most conceptually consistent measure with Acharya et al. (2011) and the internal governance is said to be optimal when the power and cash-flow relevant tasks are distributed proportionally across the management team resulting in superior firm performance. The mechanism of internal governance can be illustrated as the following theoretical model in Acharya et al. (2011).

$$k^{SS} = \left[\gamma \left(1-\delta\right) \delta^{b-1} \frac{\theta^{b}}{\left(1+r\right)^{b-1}} \right]^{\frac{1}{1-\gamma b}}$$

in which k^{ss} is steady state investment, which is positively related to firm performance; $\delta = \frac{f}{f+g}$ is the internal governance measure; all other parametric components are kept positive, $b > 1, 1 - \gamma b > 0$; and the key variable is δ which denotes the fraction of cash flow relevant

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tasks assigned to the CEO. Clearly, if I perform an analysis of comparative statics whereby differentiating k^{ss} with respect to δ, the first order condition is as follows.

$$\frac{\partial k^{ss}}{\partial \delta}=\left[\gamma(1-\delta)\delta^{b-1}\frac{\theta^{b}}{(1+r)^{b-1}}\right]^{\left(\frac{1}{1-\gamma b}-1\right)}\left[\delta^{b-1}\left((b-1)\left(\delta^{-1}-1\right)\right)-1\right]\left[\gamma\frac{\theta^{b}}{(1+r)^{b-1}}\right]$$

Apparently, the sign of the comparative statics is determined by $\left[\delta^{b-1}\left((b-1)(\delta^{-1}-1)\right)-1\right]$. As δ goes from 0 to 1, the sign will turn from positive to negative, indicating that when internal governance is good, CEO is neither dominating nor powerless. The good internal governance should lie somewhere in the middle where executive powers and responsibilities are optimally balanced.

Moreover, from an information-processing perspective in Haleblian and Finkelstein (1993), the top management team can be thought of as an information-processing center of a firm, whose capability is dependent on the composition of the team and the distribution of the power. Internal governance has been shown relevant to the quality of information environment in the literature. Landier et al. (2009) shows that junior managers improve the information production inside the firm. Cheng et al. (2015) documents that non-CEO executives provide high quality of financial reporting. Taken together, good internal governance may promote accurate and reliable disclosure practices, which are informative to market participants and analysts for the actual announcement. Furthermore, Cheng et al. (2015) shows that good internal governance could effectively constrain activities of earnings management by myopic CEO, further reducing information asymmetry between the firm and the market.

In additional to the information processing channel, as indicated in Acharya et al. (2011), internal governance would optimize the investment policy for capital stock, which in turn lowers the financial and operational risks that underlie the firm, leading to stable and resilient performance facing turbulence and discontinuity of external business environment. Specifically, Adams et al. (2005) document that the financial performance is more volatile for firms led by dominating CEOs as measured by title, ownership and status, who are in general less disciplined by subordinate managers and other governance mechanisms. In contrast, the risk profile of the firm is lower in face of good internal governance, which in turn improves the prospects in the long run and enhances corporate bond liquidity during special times of heightened information asymmetry.

One effective way to examine the informational efficiency of the market is to check how the market reacts to the information flow. I propose to test the effect of internal governance on the firm's liquidity in the context of news announcements, where the information is heightened. In accordance with the fundamental intuition of basic finance model such as discounted cash flow model (DCF), earnings announcement is one of the major such events which conveys unobscured information regarding the mean and variance of the firm value. Studies have widely documented the influential effect of earnings managements on security price, trading volume and bid ask spread in the equity market whereby checking abnormal movements of trading surrounding the event (see, for example, Beaver, 1968; Lee, Mucklow and Ready, 1993).

Analogous to the equity market, earnings announcements also lead to heightened information for bond trading, especially for riskier and more "equity-like" corporate bonds. Specifically, there are three aspects of corporate bond pricing: interest rates and macro-economic conditions, contracting covenants of bond and the probability of default. Focusing on the probability of default, the canonical literature on the structure model of bond pricing (Black and Cox, 1976; Merton, 1974; Leland, 1994) regards corporate bonds as derivative securities written on the firm assets. As shown in the following model, the bond price in Merton (1974)

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expresses the bond price as a function of firm value and volatility of cash flows, $P(\tau) = F(V_t, \sigma^2, \tau, r, B)$.

$$P(\tau) = V_t N(-d_1) + Be^{-\delta\tau} N(-d_2)$$
$$d_1 = \left(\ln(V_t/B) + \left(r + \tfrac{1}{2}\sigma^2\right)\tau\right) / \sigma\sqrt{\tau} \qquad d_2 = d_1 - \sigma\sqrt{\tau}$$

In alignment with Modigliani and Miller theorem (Modigliani and Miller, 1956) and the pricing parity of equity and credit indicated by the strand of structure models, bond and equity are claims on the same underlying assets and thus are reflecting the same information regarding the risk and value of firms' assets. Hence, scheduled earnings announcements are indicative of updating bond prices according to the information innovations. As such, the potential risk of information asymmetry should be escalating in a certain short period before the actual announcement when the market participants hold heterogeneous expectations of the firm performance and interpretations of analyst forecasts, resulting in reduced trading volume and inflated liquidity premium (see, for example, Chae, 2005).

3. Hypotheses Development

With all being said, I hypothesize that there is a hump-shaped relationship between internal governance measure and corporate bond liquidity before earnings announcements. On the one hand, internal governance is shown arguably beneficial to the internal and external information environment of the firm (see, for example, Cheng et al., 2015; Landier et al. 2009). Assured and overseen by the good internal governance mechanism, the presumably high quality inside information production process and reliable outside financial reporting and disclosure together leads to the promotion of transparent corporate culture and the formulation of accurate market-wide earnings expectation, which significantly narrow down the informational discrepancy among market participants and foster consensus among analysts. Moreover, the risk management aspect of internal governance reduces financial and operational risks through optimizing the decision-making process, which improves the long-term prospects of the firm in face of dynamic business environments and market conditions. As a result, the information asymmetry and concerns of adverse selection among market participants before earnings announcements would be largely undermined and the market liquidity would therefore be improved. On the other hand, earnings announcements, as an official public statement of the firm's profitability, effectively convey information regarding the mean and variance of firm value. Based on the Modigliani and Miller theorem and the structured corporate debt pricing model, the pricing parity of equity and bond indicates that after the actual arrival of earnings announcements to the market, bond prices are of high risk of changing in accordance with the information content. As such, I shall expect to see, in general, heightened information asymmetry and undermined market liquidity shortly before earnings announcements (Chae, 2005).

Taken together, the two main channels and earnings announcements lead to a context of proliferated conflicts between the salutary force of good internal governance and detrimental force of heightened information asymmetry to corporate bond liquidity. Therefore, the empirical analyses focused on this particular time window of heightened market uncertainty could identify the causal relationship between internal governance measure and corporate bond liquidity.

4. Data, Measures and Methodology

4.1 Measures and Methodology

According to Acharya et al. (2011) internal governance works best when neither the CEO nor their subordinate managers are dominant. The authors define a variable $\delta = f/(f+g)$, which is the relative contribution of the CEO (f) to cash-flow generation when compared to the cash-flow contribution of her management team $(f+g)$. A fully decentralized team would have

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$\delta = 0$, and one where the CEO makes all the contribution is when $\delta = 1$. To operationalize this metric, I calculate the number of executive titles of the CEO (f) scaled by the total number of executive titles carried by the entire top management team of five executives $(f + g)$, which is the proxy used by Aggarwal et al. (2017) and Brick et al. (2019). Adopting the methodology developed in Brick et al. (2019), I use the regular expression (*regex*) procedure in R to calculate the number of titles for each executive. Please refer to the Appendix in Brick et al. (2019) for the technical details of data processing procedures.

The turnover of an asset is a typical measure of liquidity. In the context of bond liquidity, turnover is usually defined as the daily average of total trading volume (see, for example, Dick-Nielsen, 2009). Since I use narrow event window at intraday level, I define the main liquidity measure in the paper as bond turnover per event window, or in other words, sum of transactional bond trading volume, i.e.$Turnover_{bond,t} = \sum^{N} Q_j$, in which Q_j is the bond trading volume of transaction j and N stands for the number of transactions within the event window. Since bonds are, in general, traded infrequently, bonds with transactions in the short event window are distinguished greatly from those without, in terms of liquidity and transparency. To capture such information in the empirical test, I take the turnover of bonds issued by certain firms as zero if the bonds of the firm don't trade during the short event window but did trade during the month before the actual time of announcements. Alternatively, I use average transactional trading volume as an alternative measure of bond liquidity, i.e. $Intensity_{bond,t} = \frac{1}{N}\sum^{N} Q_j$, which emphasizes the trading intensity of the bond. However, one mechanical disadvantage of the intensity measure is that it unfairly punishes bonds that trade frequently with moderate volume and enormously rewards bonds that trade infrequently in large blocks which happen to execute within the event window. The latter case of bond trading in low frequency but with huge transactional volume is in fact more likely motivated by reasons aside from pure liquidity reason, but by inside information, collusion among institutional players and regulatory requirements (see, for example, Easley and O'Hara, 1987). As such, the measure of trading intensity is less resilient to confounding effects of the data, blurring the channel of informational transparency or financial risk management, especially when the degrees of trading frequency of the bonds in the sample are of considerable discrepancy. I will further introduce the empirical design that could confront such imperfections in the measures in the subsequent section. I choose not to use Amihud price impact as the liquidity measure because it is not suitable for intraday analysis of thinly traded corporate bond. The bond turnover measure is scaled by 1 million in plain linear regression models for convenience of interpretation.

According to the comparative statics of the theoretical model in Acharya et al. (2011), I utilize the following quadratic model specification for the main tests.

$$LiquidityMeasure = \beta_0 + \beta_1 IG_{it} + \beta_2 IG_{it}^2 + \beta_3 Controls_{it-1} + \eta_t + \lambda_k + \varepsilon_{it}$$

in which dependent variable is the bond liquidity measures, IG is internal governance measure, and $Controls_{it-1}$ represents a list of covariates of firm, board, and bond characteristics at the beginning of the fiscal year. To mitigate the effect of macro-economic condition and market level events, I include year fixed effects, n_t, in the model specification. Further, to mitigate the inconsistency concern about missing endogenous firm level variables, I include firm fixed effects dummies, λ_k, in the model specification. The standard error is two-way clustered at year and bond level.

4.2 Data and Sample Construction

I obtain the date and time stamp of quarterly earnings announcements of all the firms available on I/B/E/S (Institutional Brokers Estimate System) of chosen horizon from the beginning of 2007 through 2017, as total 10 years serving as the entire time horizon for the scope of this study. Such a horizon is by all means comprehensive in the sense that a) before 2006, TRACE is subject to rapid expansion and progressive implementation since its initiation in 2002 and I

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want to avoid the liquidity shocks and disturbances during the staggered roll-out of TRACE b) the data in TRACE enhanced is up to January, 2017, as of when the sample was composed. Further, I select a particular range from 2009 to 2014 within the complete time horizon as the main period to perform the majority of my empirical analyses. I choose such a period is because a) I want to avoid the main market level disturbances of 2007-2009 financial crisis and its shocks upon the efficacy of top management team b) I'm more interested in the bond market liquidity in recent years c) I want to avoid the regulatory shocks upon liquidity provisions and trading behaviors since 2014 such as Volcker Rule and the major expansion of TRACE by reporting 144A bonds. In essence, for the sake of mitigating confounding effects, I intend to focus particularly on the most stable period of the market and TRACE database for the main investigation. Moreover, the main horizon for investigation includes the exogenous shock of 2008 financial crisis for my identification strategy in the robustness check.

To accommodate the fact that only annual data is available for internal governance measure, in this study I only use the first quarterly earnings announcement in each fiscal year, which is presumably the one proliferating the most uncertainty on the market. To utilize the data available at intraday level and improve the accuracy of the test, I choose a very narrow window, 1 hour before earnings announcements, as the main event window. As defined in Hasbrouck (1999), the concept of information epoch starts from the beginning of information asymmetry and ends at the resolution of information asymmetry. In conformance with that philosophy, I intend to focus the main event window on the very left boundary of information epoch, beyond which the actual announcement will arrive and resolve the information asymmetry. As such, during the short window of 1 hour before earnings announcements, the opportunity cost of not trading for liquidity is so low, and the liquidity measures constructed based on the trades happened in between are less confounded by trades motivated by other reasons such as inside information, thereby representing the channel of informational transparency and financial risk management. However, one arguable weakness of the empirical design is that the short event window may probabilistically exaggerate the bias of the liquidity measure in face of a sample consisting of bonds with heterogeneous trading frequency. To further support my empirical design, I control for the trading frequency of the bonds in the sample construction, whereby including bonds that are active over 25%, 50%, 75% and 95% of days in the month before the announcement date. The rationale is that, by narrowing sample down to relatively actively traded bonds, the percentage of correct observations identified by the measure out of the filtered sample is improved.

If the actual announcements arrives market before normal trading hours, the last hour of trading prior to the announcement date is the chosen event window; on the contrary, if the arrival of news is late than the normal trading hours, I choose the last hour during normal trading hours of the day. Next, for each firm and the corresponding event window, I obtain the bond transaction data from the TRACE enhanced database. In essence, the sample of bond transaction is of longitudinal data with large cross section. One difficulty of execution is to efficiently download and effectively process the microstructure data from TRACE. To overcome such a problem, I design and operationalize a program which could exactly derive the relevant transactional level data according to the pair of firm and announcement time, calculate measures and manage memory efficiently. I utilize the standard method structured in Dick-Nielsen (2009, 2014) to mitigate the bias brought by trade correction, cancellation and reversal reports mixed in the data dissemination of TRACE.

I collect the identity of the CEO and subordinate managers, as well as their job titles and employment history from Execucomp. The collected data of executive background includes job titles of top five executives in the corresponding fiscal year (TITLEANN), and the CEO annual flag (CEOAN). The data of firm characteristics are obtained from Compustat, such as total assets, financial leverage and the corresponding performance measures at the beginning of the fiscal year (lagged). I take the logarithm of the total assets to mitigate the issue of skewness.

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Additionally, I collect data from ISS on board characteristics such as the number of outside directors, total number of directors and percentage of outside director who serve on the board. I merge the Execucomp, Compustat and ISS to construct the sample of control variables. I also control bond characteristics such as credit rating from FISD. In fact, since bond credit rating shouldn't vary much within firm and across the chosen time horizon, it is largely captured by firm fixed effects. I merge the sample of bond liquidity measures and controls by Compustat and I/B/E/S link table. The specific variable definition is shown in Table 1 and the summary statistics is in Table 2. The main sample is of over 10,000 bond-year observations, 968 unique firms, 8170 bonds, and average turnover of traded bonds around 1.4 MM.

Table 1: Variable definitions

Variable	Description
Bond Turnover	Total transactional trading volume per the selected intraday window
IG	It denotes the fraction of executive titles held by the CEO (δ), the proxy for the relative contribution of the CEO to the entire cash flow of the firm.
M/B	The industry adjusted M/B is defined as M/B minus the industry median level M/B. The median level is calculated for 2-digit SIC industry-year using the Compustat universe.
Leverage	(Long term debt + debt in current liabilities)/ at the beginning of the period (lagged)
Assets	Natural log of total Assets
RD	Research and development expenditures/ at the beginning of the period (lagged)
Director	Total number of directors serving on the board
Outsider	Percentage of outsider directors

Table 2: Summary statistics (Sample of Main Time Horizon 2009-2014)

	Mean	Median	p25	p75	Std.	Skewness	Kurtosis
Bond Turnover	1.461	0.100	0.025	0.608	16.015	58.939	3676.164
IG	0.262	0.250	0.222	0.300	0.069	0.551	3.787
M/B	1.172	0.422	-0.238	1.680	4.166	2.018	37.561
Leverage	0.246	0.222	0.071	0.359	0.246	14.685	878.622
Assets	7.738	7.633	6.516	8.861	1.722	0.365	3.270
RD	0.033	0.000	0.000	0.032	0.080	7.114	101.603
Director	9.484	9.000	8.000	11.000	2.510	0.963	6.301
Outsider	0.715	0.778	0.600	0.875	0.196	-1.013	3.302

5. Results and Analyses

5.1 Main Results

The main results of the paper are exhibited in Table 3. When using bond turnover as the liquidity measure, I observe the positive results consistent with the hypothesis that there is a hump-shaped relationship between internal governance measure and corporate bond liquidity before earnings announcements. For instance, Table 3 column (2) shows that the coefficient of internal governance measure is positive and significant at 1% and that of its quadratic term is of 1% statistical significance. The results in Column (2) confirm the relationship by controlling board characteristics. It is of important theoretical reason to do so since in the theoretical work of Acharya et al. (2011), the amount of internal and external governance mechanism is determined endogenously and according to Kanagaretnam et al. (2007), board governance contributes to reducing information asymmetry. The evidence indicates that, when information is heightened shortly before earnings announcements, the bonds of firms with good internal governance, or in other terms, balanced power distribution among top management team, are likely to enjoy higher degree of liquidity. The main channel for the enhanced bond liquidity stems from the beneficial effect of good internal governance upon information environment and risk profile of the firm. Qualitatively equivalent results are shown in Column (4) in which the liquidity

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measure is trading intensity. In sum, when the power distribution among the top management team is proportional and the internal governance is deemed to be effective, both the overall trading volume within the event window measured by turnover and the average transactional trading volume measured by trading intensity are significantly improved.

In panel B, I regress bond turnover against the full econometric specification using samples consisting of bonds with a variety of trading frequency. For conciseness, I only tabulate the results of regression in which the turnover measure is dependent variable. In general, the hump shape relationship uncovered in panel A is statistically insensitive to the choice of samples in panel B, indicating the robustness of the statistical inference. It is worth noting that, albeit not obviously, the smallest p-value, i.e., the highest level of statistical significance is obtained whereby using the bonds of highest trading frequency, which is aligned with the argument that a sample of frequently traded bonds could mitigate the potential bias in the empirical design.

Table 3: Main Results

Panel A	**1 Hour Window**			
	Turnover		**Intensity**	
	(1)	**(2)**	**(3)**	**(4)**
IG	11.495	13.911***	4.163	4.551***
	(0.77)	(3.69)	(0.82)	(2.85)
IG^2	-17.544	-20.791***	-5.962	-6.416***
	(-0.77)	(-3.69)	(-0.78)	(-2.69)
M/B	0.008	0.003	0.009	0.007
	(0.14)	(0.23)	(0.47)	(1.20)
Assets	0.815	0.592**	0.466	0.393***
	(0.78)	(2.00)	(1.31)	(3.13)
Leverage	0.251	-1.464	-0.261	-1.005**
	(0.07)	(-1.58)	(-0.23)	(-2.56)
RD	0.681	0.140	1.151	2.077
	(0.04)	(0.03)	(0.18)	(1.08)
Directors		0.111***		0.072***
		(2.73)		(4.16)
Outsider		-1.374**		-0.544*
		(-1.99)		(-1.86)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.245	0.138	0.242	0.140
N	7667	6727	7667	6727
Panel B	**Frequency**			
	25%	**50%**	**75%**	**95%**
IG	16.842***	22.029***	22.092***	52.824***
	(3.39)	(3.40)	(2.77)	(3.41)
IG^2	-25.456***	-33.567***	-33.751***	-79.103***
	(-3.36)	(-3.39)	(-2.77)	(-3.46)
M/B	0.003	0.000	0.019	-0.013
	(0.17)	(0.02)	(0.81)	(-0.29)
Assets	0.850**	1.046**	0.680	1.036
	(2.29)	(2.21)	(1.15)	(1.06)
Leverage	-2.215*	-2.362	-2.130	-2.170
	(-1.89)	(-1.57)	(-1.13)	(-0.68)
RD	0.462	-0.455	-3.906	-5.755
	(0.09)	(-0.07)	(-0.49)	(-0.39)
Directors	0.082	0.101	0.029	0.018
	(1.59)	(1.56)	(0.35)	(0.13)
Outsider	-1.714**	-2.299**	-2.309	-1.698
	(-1.98)	(-2.07)	(-1.61)	(-0.66)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.140	0.142	0.166	0.249
N	5095	3978	2887	1541

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

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5.2 Sensitivity analyses

The main results are obtained using the extreme short event window of 1 hour before earnings announcements. To further confirm the validity of the main results, I perform sensitivity test to examine the persistency and evolution of the hump-shaped pattern. As shown in Table 4, the hump-shaped relationship holds when controlling for the external board characteristics. This finding is in fact all the more striking in the sense that according to Calomiris et al. (2017), institutional traders prefer to trade around 3:00 PM and thus result in more trades driven by insider information instead of transparency or low risk profile.

Table 4: Sensitivity Test (1)

Panel A	**2 Hours Window**			
	Turnover		**Intensity**	
	(1)	**(2)**	**(3)**	**(4)**
IG	15.069	11.838***	3.848	3.795***
	(0.92)	(2.78)	(1.01)	(2.72)
IG^2	-23.144	-18.853***	-5.807	-5.679***
	(-0.97)	(-3.07)	(-1.05)	(-2.82)
M/B	-0.038	-0.006	0.001	-0.003
	(-0.52)	(-0.28)	(0.05)	(-0.54)
Assets	0.909	0.139	0.267	0.246**
	(0.74)	(0.38)	(0.93)	(2.03)
Leverage	-0.796	-1.884*	-0.490	-1.013***
	(-0.24)	(-1.87)	(-0.63)	(-3.06)
RD	8.192	4.919	2.402	3.133
	(0.34)	(0.80)	(0.43)	(1.56)
Directors		0.136***		0.032**
		(2.81)		(1.99)
Outsider		-0.668		0.157
		(-0.78)		(0.56)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.191	0.134	0.240	0.161
N	9395	8166	9395	8166
Panel B	**Frequency**			
	25%	**50%**	**75%**	**95%**
IG	14.843***	23.368***	22.265**	43.790***
	(2.63)	(3.08)	(2.34)	(2.78)
IG^2	-24.227***	-38.025***	-36.402**	-74.512***
	(-2.91)	(-3.30)	(-2.52)	(-3.11)
M/B	-0.008	-0.008	0.009	-0.015
	(-0.33)	(-0.29)	(0.26)	(-0.23)
Assets	0.227	0.385	-0.122	0.390
	(0.50)	(0.71)	(-0.18)	(0.37)
Leverage	-2.265*	-1.724	-1.509	-0.431
	(-1.84)	(-1.17)	(-0.85)	(-0.16)
RD	5.400	6.971	5.538	4.934
	(0.76)	(0.80)	(0.52)	(0.26)
Directors	0.128**	0.164**	0.140	0.103
	(2.12)	(2.20)	(1.45)	(0.67)
Outsider	-1.129	-1.908	-1.919	-1.469
	(-1.06)	(-1.44)	(-1.09)	(-0.50)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.132	0.136	0.155	0.264
N	6354	5026	3729	2039

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

Thus, the negative results for even longer window of 4 hours and 1 day in Column (1) - (2) of Table 5 and Table 6 become not surprising. One potential reason is that in a longer window, other factors such as private information may play a bigger role (Calomiris et al., 2017); the other one is that empirically the dependent variable follows a zero-inflated positively skewed distribution (long tail distribution), which undermines the efficiency of linear (in parameter)

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regression model. Theoretically, I could round the dependent variable to integer and utilize zero-inflated Poisson regression. Instead, I choose to use a straightforward $\ln(y+c)$ transformation, where *y* is the original data and *c* is some constant (usually unity). The method is widely used in ecological and biological sciences (Fletcher et al., 2005), where the data of such distribution are usually encountered. As shown in Column (3) – (4) of Table 5 and 6, the statistically significant quadratic relationship holds for longer event window when the log link function of data transformation is applied. Furthermore, in panel B of Table 5 and 6, I perform the same analyses with log transformation on samples consisting of bonds with different trading frequency. The main results of the hump shape relationship between bond liquidity and internal governance preserves. Note that the purpose of sensitivity test is to examine the resilience of the main results in face of confounding disturbances. Thus, the choices of longer event window are by no means theoretically sound and the log link functions should be regarded as an empirical modification rather than a full-fledged solution.

Table 5: Sensitivity Test (2)

Panel A	**4 Hours Window**			
	Turnover		**Log (Turnover+c)**	
	(1)	**(2)**	**(3)**	**(4)**
IG	14.366	11.111	41.349***	46.522***
	(0.56)	(0.92)	(8.90)	(9.68)
IG^2	-17.584	-14.166	-60.766***	-66.999***
	(-0.47)	(-0.80)	(-8.85)	(-9.55)
M/B	-0.135	-0.026	0.012	-0.006
	(-1.25)	(-0.50)	(0.59)	(-0.29)
Assets	0.460	-0.592	-0.896***	-1.988***
	(0.25)	(-0.60)	(-2.67)	(-5.03)
Leverage	-2.070	-2.998	-0.887	-1.162
	(-0.39)	(-1.06)	(-0.92)	(-1.04)
RD	12.017	7.929	-2.407	-0.049
	(0.33)	(0.47)	(-0.36)	(-0.01)
Directors		-0.110		0.308***
		(-0.85)		(5.95)
Outsider		-0.261		0.203
		(-0.11)		(0.22)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.129	0.075	0.575	0.592
N	10403	9105	10403	9105
Panel B	**Log (Turnover+c)**			
	25%	**50%**	**75%**	**95%**
IG	45.635***	54.363***	52.566***	50.237***
	(8.17)	(8.59)	(7.65)	(5.90)
IG^2	-67.178***	-76.592***	-71.674***	-71.771***
	(-8.06)	(-8.01)	(-6.89)	(-5.56)
M/B	0.003	-0.001	0.008	0.031
	(0.15)	(-0.05)	(0.37)	(1.03)
Assets	-1.739***	-1.644***	-2.091***	-0.898
	(-4.07)	(-3.65)	(-4.25)	(-1.58)
Leverage	-0.383	-0.913	-2.681**	0.838
	(-0.32)	(-0.72)	(-2.03)	(0.56)
RD	-1.617	5.696	12.317	18.582*
	(-0.23)	(0.78)	(1.63)	(1.85)
Directors	0.199***	0.229***	0.177***	-0.105
	(3.53)	(3.78)	(2.64)	(-1.26)
Outsider	0.190	-0.305	-1.979	0.037
	(0.19)	(-0.28)	(-1.58)	(0.02)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.522	0.487	0.478	0.537
N	7329	5913	4336	2282

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

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5.3 Aggregate analyses

In essence, internal governance is a firm level mechanism. Naturally, one alternative empirical specification is to aggregate bond liquidity measure to the firm level whereby taking a sum or average of all bond turnover data by firm.

Table 6: Sensitivity Test (3)

Panel A	**1 Day Window**			
	Turnover		**Log (Turnover+c)**	
	(1)	**(2)**	**(3)**	**(4)**
IG	21.012	12.470	58.495***	57.881***
	(0.76)	(0.98)	(12.13)	(11.60)
IG^2	-23.847	-12.793	-74.452***	-71.753***
	(-0.58)	(-0.68)	(-10.31)	(-9.70)
M/B	-0.125	0.003	0.014	0.015
	(-1.17)	(0.05)	(0.75)	(0.79)
Assets	0.030	-0.856	-1.747***	-1.659***
	(0.02)	(-0.87)	(-5.30)	(-4.33)
Leverage	-2.793	-3.257	-4.017***	-4.592***
	(-0.50)	(-1.13)	(-4.16)	(-4.08)
RD	15.536	9.460	-4.673	-8.406
	(0.40)	(0.55)	(-0.70)	(-1.25)
Directors		-0.048		0.452***
		(-0.37)		(8.99)
Outsider		-0.272		-1.937**
		(-0.12)		(-2.20)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.105	0.073	0.564	0.576
N	12195	10628	12195	10628
Panel B	**Log (Turnover+c)**			
	25%	**50%**	**75%**	**95%**
IG	52.764***	57.813***	66.273***	71.339***
	(9.31)	(9.06)	(9.03)	(7.13)
IG^2	-66.190***	-71.633***	-80.759***	-89.482***
	(-7.80)	(-7.44)	(-7.28)	(-5.89)
M/B	0.022	0.012	0.020	0.036
	(1.04)	(0.53)	(0.80)	(0.87)
Assets	-0.982**	-0.641	-0.356	1.905***
	(-2.35)	(-1.42)	(-0.68)	(2.73)
Leverage	-3.439***	-2.687**	-4.100***	-0.705
	(-2.80)	(-2.06)	(-2.84)	(-0.40)
RD	-5.050	1.375	10.675	16.233
	(-0.72)	(0.18)	(1.29)	(1.33)
Directors	0.354***	0.312***	0.262***	-0.065
	(6.39)	(5.16)	(3.67)	(-0.66)
Outsider	-2.228**	-3.130***	-4.511***	-0.443
	(-2.28)	(-2.91)	(-3.43)	(-0.24)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.520	0.515	0.510	0.566
N	8488	6703	4743	2310

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

Table 7 demonstrates the regression results using the sample of most actively traded bonds across event windows of a variety of length ranging from 1 hour to 1 day. The aggregation method chosen here is the average bond turnover by firm since the simple sum neglect the heterogeneity of bond issuances between firms as illustrated in Appendix. Note that it is by no means a rigorous proof but a heuristic econometric example for illustration purpose. Not surprisingly, the firm level aggregation analysis generally weakens the statistical significance of the hump shape relation. However, utilizing the narrow event window of 1 hour, I still observe statistically significant relationship between internal governance measure and bond turnover at 5 percent, indicating that when the trading frequency is controlled, the narrow event window of 1 hour remains the most effective for capturing the effect of internal governance on

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bond liquidity. As expected, the statistical significance of the hump-shaped relation decays as the window length become longer, wherein more confounding trades are present.

Table 7: Aggregate Analysis

	Frequency: 95%			
	Aggregation Analysis			
	1 hour (1)	**2 hours (2)**	**4 hours (3)**	**1 Day (4)**
IG	45.746	38.248	33.275	32.488
	(2.38) **	(2.06) **	(1.90) *	(1.32)
IG^2	-62.404	-60.024	-46.046	-37.931
	(-2.12) **	(-2.06) **	(-1.66) *	(-0.98)
M/B	-0.007	-0.004	0.010	-0.080
	(-0.15)	(-0.07)	(0.21)	(-0.84)
Assets	0.212	1.142	-0.534	2.657
	(0.20)	(1.14)	(-0.56)	(1.78) *
Leverage	3.149	1.365	2.748	2.057
	(0.88)	(0.51)	(1.07)	(0.50)
RD	-8.375	-0.946	5.731	-1.787
	(-0.54)	(-0.06)	(0.36)	(-0.10)
Directors	0.095	0.132	-0.115	-0.223
	(0.63)	(0.84)	(-0.76)	(-0.91)
Outsider	-4.217	-2.278	3.273	3.983
	(-1.46)	(-0.78)	(1.17)	(1.06)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.577	0.727	0.600	0.393
N	639	709	741	485

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

6. Robustness Check

6.1 Subsample analysis

All in all, the uncovered hump shape relationship between internal governance measure and corporate bond liquidity shortly before earnings announcements are confirmed on various dimensions. However, further development might be needed to demonstrate the robustness of the results and the rightfulness of the statistical inference. There are two causes of endogeneity issue: missing endogenous variables and reversed causality. One important aspect of the hypothesis is that earnings announcements are informative to bond pricing and price discovery. Clearly, when the bonds are more risky, they are more equity-like and reflect the information content of earnings announcements, and the salutary risk management effect of good internal governance is more likely to manifest in the corporate bond liquidity and trading activities. Therefore, to control the moderating factor of bond rating, I split the sample into investment grade bonds and non-investment grade bonds. The regression results are shown in Table 8. The statistical significances of the hump shape relation for investment grade bonds are in general weaker than those of non-investment grade bonds. Especially, when I use the sample of the most active bonds, the hump shape relationship between internal governance measure and bond liquidity vanishes, indicating that when the bias of event window is mitigated, the earnings announcements are less informative to bond value and internal governance no longer has statistically significant effect on bond liquidity through lowering the issuer's risk profile.

6.2 Potential Endogeneity

Modeling causal relation between internal governance and bond market liquidity empirically in a reduced form might be problematic since it ignores the potential endogenous feedback from bond market liquidity to internal governance. The issue of reversed causality is valid if internal governance and bond market liquidity are endogenously determined in one framework or if internal governance measure strongly reflect the feedback of corporate bond market. Current theoretical models and empirical evidence between security liquidity and corporate governance focus on the endogenous relation between stock market liquidity and external governance of block holders (Admati and Pfleiderer, 2009; Edmans, 2009; Edmans and Manso, 2011), which are not specifically related to this study. Nevertheless, I choose to use following approach of

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exogenous shock to further verify the results for potential reversed causality, even though the endogeneity claim on the results is disputable and not well-established theoretically.

Table 8: Subsample Analysis

Panel A	**Non-Investment Grade**			
	Turnover 1 Hour Window			
	25%	**50%**	**75%**	**95%**
IG	14.934***	20.087***	18.080**	44.817***
	(2.85)	(2.89)	(2.19)	(2.82)
IG^2	-20.944***	-28.510***	-24.196*	-61.523***
	(-2.61)	(-2.66)	(-1.91)	(-2.64)
M/B	-0.017	-0.021	-0.000	-0.011
	(-0.94)	(-0.94)	(-0.02)	(-0.25)
Assets	0.782**	1.017**	0.519	0.942
	(2.04)	(2.08)	(0.88)	(0.99)
Leverage	-1.660	-1.511	-0.488	-0.266
	(-1.38)	(-0.97)	(-0.26)	(-0.08)
RD	1.324	1.369	-1.950	-4.531
	(0.24)	(0.20)	(-0.24)	(-0.31)
Directors	0.066	0.083	-0.008	-0.065
	(1.23)	(1.22)	(-0.10)	(-0.48)
Outsider	-1.725*	-2.370**	-2.439	-1.032
	(-1.92)	(-2.02)	(-1.63)	(-0.39)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.144	0.144	0.182	0.277
N	4329	3350	2429	1310
Panel B	**Investment Grade**			
	25%	**50%**	**75%**	**95%**
IG	37.441**	41.649**	66.574**	8.864
	(2.17)	(1.99)	(1.99)	(0.15)
IG^2	-70.478***	-79.366**	-142.725***	-66.947
	(-2.69)	(-2.49)	(-2.75)	(-0.74)
M/B	0.144***	0.145**	0.189***	0.004
	(2.74)	(2.48)	(2.80)	(0.03)
Assets	-0.583	-1.630	-8.339**	-13.163**
	(-0.36)	(-0.80)	(-2.51)	(-2.30)
Leverage	-17.442***	-19.700***	-29.975***	-43.636***
	(-3.42)	(-3.26)	(-3.63)	(-2.86)
RD	-36.216	-50.749*	-58.051*	-96.479
	(-1.44)	(-1.70)	(-1.66)	(-1.28)
Directors	0.283	0.309	0.457	0.694
	(1.46)	(1.35)	(1.53)	(1.34)
Outsider	-2.069	-3.527	-3.481	-5.269
	(-0.65)	(-0.89)	(-0.73)	(-0.58)
Year & Firm FE	Yes	Yes	Yes	Yes
R^2	0.369	0.376	0.443	0.539
N	766	628	458	231

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

I utilize the approach of quasi-exogenous shock upon the internal governance measure. One event that I can think of as relatively exogenous is the 2008 financial crisis. The empirical evidence shows that after the crisis, the internal governance measure increases significantly (Aggarwal et al., 2017), which is either because CEOs take on more responsibilities of junior managers to reduce cost or because CEOs are not penalized by bad luck (Bertrand and Mullainathan, 2001; Garvey and Milbourn, 2006). Hence, to utilize the exogenous shock of 2008 financial crisis, I run the change of bond liquidity against change of internal governance measure after financial crisis as follows.

$$LiquidityMeasure = \beta_0 + \beta_1 \Delta IG_{it} + \beta_2 Controls_{it-1} + \eta_t + \gamma_k + \varepsilon_{it}$$

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in which I include firm fixed effects γ_k and time trend η_t to account for firm level unobservable individual effects and the market level conditions during crisis period. If the relationship holds, I expect that bond liquidity of firms that situated in the up-sloping part of the hump shape will increase in internal governance measure, while firms that situated in the down-sloping part of the hump shape will decrease in internal governance measure.

The empirical results in Table 9 and Table 10 reports empirical evidence supporting above predications. Table 9 column (2) confirms that, controlling for external governance, the hump shape relationship holds when I expand the time horizon to include the crisis period, which in itself is a fairly good proof of robustness.

Table 9: Robustness Check (1)

	Turnover 2007-2014	
	1 Hour Window	
	(1)	**(2)**
IG	4.537	9.541***
	(0.46)	(3.06)
IG^2	-7.420	-14.734***
	(-0.47)	(-3.06)
M/B	0.000	0.003
	(0.01)	(0.27)
Assets	0.296	0.137
	(0.52)	(0.67)
Leverage	1.338	0.184
	(0.65)	(0.26)
RD	-0.770	-1.850
	(-0.11)	(-0.94)
Directors		0.071**
		(2.05)
Outsider		-0.834
		(-1.55)
Year & Firm FE	Yes	Yes
R^2	0.239	0.130
N	10171	8546

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

Table 10 demonstrates the results of using 2008 median level of internal governance measure as the approximate cutoff point for the upward sloping part and downward sloping part. Using this cutoff point rather than the model estimated optimal point of internal governance measure (around 0.33) is because latter one results in too less data identified on the downward sloping part, leading to diminished statistical power. For the same reason, I don't use bond frequency to filter sample and instead, I only include bonds that have trades in the 1-hour event window either before or after the financial crisis. The results indicate that the hump shape relationship between internal governance measure and corporate bond liquidity holds in face of the exogenous shock upon internal governance.

7. Conclusion

In this study, the key research question of interest is whether or not the degree of efficacy of the management team measured by the internal governance mechanism is associated with the bond liquidity measures. Specifically, utilizing the bond turnover measure, the paper uncovers a hump shape relationship between internal governance and corporate bond liquidity before earnings announcements, which is aligned with the functional form of internal governance in the theoretical development by Acharya et al (2011) and is confirmed by sensitivity tests and aggregate analyses. The main identification strategy is quasi-exogenous shock of 2008 financial crisis. In face of an exogenous shock upon internal governance measure, the hump shape relationship still holds.

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Table 10: Robustness Check (2)

	Turnover During Crisis	
	1 Hour Window	
	Upward Sloping	**Downward Sloping**
ΔIG	225.995	-92.900
	(4.43) ***	(-3.32) ***
M/B	14.035	-3.952
	(0.99)	(-2.23) **
Assets	-0.536	2.003
	(-0.05)	(2.02) **
Leverage	47.391	-4.854
	(1.07)	(-0.59)
RD	-256.034	103.016
	(-0.97)	(2.29) **
Directors	-1.570	3.193
	(-0.22)	(2.18) **
Outsider	-28.701	-4.580
	(-1.32)	(-0.22)
Year & Firm FE	Yes	Yes
R^2	0.347	0.342
N	997	898

*, **, *** respectively corresponds to10%, 5% and 1% level of significance for all tables in the paper.

To my best knowledge, this is the first paper that coherently take together such interesting components as internal governance, earnings announcements, and corporate bond liquidity at intraday level. Hence, I believe the paper has the potential to fulfill the current gap in the literature. Moreover, the statistically significant relationship between internal governance mechanism and bond turnover measure are indicative of the fact that market trading activities incorporate public information besides prices and thus provide side evidence that the corporate bond market is of semi-strong form efficiency. Despite well-motivated, the paper does not intend to fully dissect the channels and economic rationales that underlie the uncovered functional relationship between corporate governance and corporate bond liquidity, leaving a fertile ground for future study. One promising direction of future research is to theoretically model or empirically disentangle the nexus of corporate bond, firm and management team, thereby identifying the most important channels from those posited in this study. Moreover, as illustrated in Karabag (2020), the pandemic of COVID-19 enormously shock every aspect of economic activities and business operations. COVID-19, as a truly exogenous event, significantly affects both the risk profile and the management efficacy of bond issuers, making it an effective empirical device for studies of internal governance as well as other corporate governance mechanisms on this matter.

References

Acharya VV, Myers SC, Rajan RG. 2011. The internal governance of firms. *The Journal of Finance* 66:3, 689-720.

Adams RB, Almeida H, Ferreira D. 2005. Powerful CEOs and their impact on corporate performance. *The Review of Financial Studies* 18:4, 1403-1432.

Admati AR, Pfleiderer P. 2009. The "Wall Street Walk" and shareholder activism: Exit as a form of voice. *The Review of Financial Studies* 22:7, 2645-2685.

Aggarwal RK, Fu H, Pan Y. 2017. An empirical investigation of internal governance. *AFA 2011 Denver Meetings Paper.*

Beaver WH. 1968. The information content of annual earnings announcements. *Journal of accounting research*, 67-92.

Bertrand M, Mullainathan S. 2001. Are CEOs rewarded for luck? The ones without principals are. *The Quarterly Journal of Economics* 116:3, 901-932.

Black F, Cox JC. 1976. Valuing corporate securities: Some effects of bond indenture provisions. *The Journal of Finance* 31:2, 351-367.

Brick EI, Palia D, Qiao Y. 2019. The Impact of Internal Governance on a CEO's Investment Cycle. *AFA 2020 San Diego Meetings Paper*.

Calomiris CW. 2017. Has Financial Regulation Been a Flop? (or How to Reform Dodd-Frank). *Journal of Applied Corporate Finance* 29:4, 8-24.

Copyright © 2020 JAEBR ISSN 1927-033X

Chae J. 2005. Trading volume, information asymmetry, and timing information. *The Journal of Finance* 60:1, 413-442.
Cheng Q, Lee J, Shevlin T. 2015. Internal governance and real earnings management. *The Accounting Review* 91:4, 1051-1085.
Dick-Nielsen J. 2009. Liquidity biases in TRACE. *The Journal of Fixed Income* 19:2, 43-55.
Dick-Nielsen J. 2014. How to clean enhanced TRACE data. *SSRN 2337908*.
Easley D, Kiefer NM, O'hara M, Paperman JB. 1996. Liquidity, information, and infrequently traded stocks. *The Journal of Finance* 51:4, 1405-1436.
Easley D, O'hara M. 1987. Price, trade size, and information in securities markets. *Journal of Financial economics* 19:1, 69-90.
Edmans A, Manso G. 2011. Governance through trading and intervention: A theory of multiple blockholders. *The Review of Financial Studies* 24:7, 2395-2428.
Fletcher D, MacKenzie D, Villouta E. 2005. Modelling skewed data with many zeros: a simple approach combining ordinary and logistic regression. *Environmental and ecological statistics* 12:1, 45-54.
Garvey GT, Milbourn TT. 2006. Asymmetric benchmarking in compensation: Executives are rewarded for good luck but not penalized for bad. *Journal of Financial Economics* 82:1, 197-225.
Haleblian J, Finkelstein S. 1993. Top management team size, CEO dominance, and firm performance: The moderating roles of environmental turbulence and discretion. *Academy of management journal* 36:4, 844-863.
Hasbrouck J. 1999. The dynamics of discrete bid and ask quotes. *The Journal of finance* 54:6, 2109-2142.
Jain P, Jiang C, Mekhaimer M. 2016. Executives' horizon, internal governance and stock market liquidity. *Journal of Corporate Finance* 40, 1-23.
Kanagaretnam K, Lobo GJ, Whalen DJ. 2007. Does good corporate governance reduce information asymmetry around quarterly earnings announcements? *Journal of Accounting and Public Policy* 26:4, 497-522.
Karabag SF. 2020. An unprecedented global crisis! the global, regional, national, political, economic and commercial impact of the coronavirus pandemic. *Journal of Applied Economics and Business Research* 10:1, 1-6.
Landier A, Sraer D, Thesmar D. 2009. Optimal dissent in organizations. *The Review of Economic Studies* 76:2, 761-794.
Lee CM, Mucklow B, Ready MJ. 1993. Spreads, depths, and the impact of earnings information: An intraday analysis. *The Review of Financial Studies* 6:2, 345-374.
Leland H. 1994. Bond prices, yield spreads, and optimal capital structure with default risk. *The journal of finance* 49:4, 1213-1252.
Malkiel BG, Fama, EF. 1970. Efficient capital markets: A review of theory and empirical work. *The Journal of Finance* 25:2, 383-417.
Merton RC. 1974. On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance* 29:2, 449-470.
Modigliani F, Miller MH. 1956. The Cost of Capital, Corporation Finance and the Theory of Investment. *American Economic Review* 48, 261-297.

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Appendix: An Econometric Example

Think of a simple regression model with *N* observations and *M* levels as follows.

$$y = a + bx_i + e \xleftrightarrow{Matrix} Y = X\beta + \varepsilon \quad i = 1,\ 2,\ \ldots N \quad N = \sum_j^M m_j$$

Thus, the parameter estimates are $\beta = (X'X)^{-1} X'Y,\ Var(\beta) = \sigma^2 (X'X)^{-1}$. For tractability, I assume the unity standard error, i.e. $\sigma^2 = 1$, and scale the estimated coefficients of the variable of interest, x_i, by its variance as follows.

$$\frac{b}{Var(b)} = \frac{\beta_2}{\sigma^2 \left[(X'X)^{-1} \right]_{2,2}} = -\frac{1}{N} \sum_i^N x_i \sum_i^N y_i + \sum_i^N x_i y_i$$

Such statistical measure is positively related to the statistical significance of the estimated parameter. Given the simple sum aggregation method used in the paper, we define $\gamma_j = \sum_i^{m_j} y_i$ as the firm level liquidity measure and the aggregate parameter estimate is represented as follows,

$$\frac{b_A}{Var(b_A)} = \frac{\beta_2}{\sigma^2 \left[(X'X)^{-1} \right]_{2,2}} = -\frac{1}{M} \sum_j^M x_j \sum_j^M \gamma_j + \sum_j^M x_j \gamma_j$$

in which $\sum_i^N y_i = \sum_j^M \gamma_j$ and $\sum_i^N x_i y_i = \sum_j^M x_j \gamma_j$. Clearly, we can rewrite the original estimator as $\frac{b}{Var(b)} = \frac{\beta_2}{\sigma^2 \left[(X'X)^{-1} \right]_{2,2}} = -\frac{1}{M} \sum_j^M m_j x_i \sum_j^M \gamma_j + \sum_j^M x_j \gamma_j$. The only difference between the original measure and aggregate measure is that when calculating the first moment of x_i, the weighted sum become the simple sum. Such simplification ignores the heterogeneity of bond issuance among firms, thereby leading to potentially biased empirical implications.

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