CORPORATE GOVERNANCE AND INFORMATION CONTENT OF STOCK TRADES: EVIDENCE FROM S&P 100 COMPANIES

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ABSTRACT

This paper studies the relationship between firms' corporate governance quality and information content of stock trades. Following Hasbrouck (1991) method, a trade's information content is defined as persistent impact of trade innovation on stock price. Using firm-level governance data, we show that the information content is negatively correlated with firms' corporate governance quality for the S&P 100 companies. Further analysis shows that board of directors is the main governance mechanism contributing to the negative correlation, while audit, anti-takeover, and compensation do not play a significant role. Our results provide empirical evidence to support the theory that corporate governance improves firms' information environment. It provides guidance on governance system design to reduce information asymmetry.

JEL: G30, G34

KEYWORDS: Information Content, Corporate Governance, Governance Mechanisms, Vector Autoregression (VAR)

INTRODUCTION

Corporate governance is a set of mechanisms designed to minimize agency problems between investors and managers (Jensen, 1993, Shleifer and Vishny, 1997, Core et al., 2003, Armstrong et al., 2010, among others). Information asymmetry is suggested to be the main source of agency problems, and the relationship between corporate governance and information asymmetry has been studied extensively in corporate finance. Strong corporate governance at firm level can limit information asymmetry. Theoretically, higher corporate governance quality leads to lower information asymmetry. In other words, corporate governance should be negatively correlated with information asymmetry. Existing empirical studies provide conflicting evidence. Some studies (Bushman et al., 2004, Bebchuk, 2002, Cai et al., 2007, Demsetz and Lehn, 1985, Ferreira and Laux, 2007, Gillan, Harzell and Startks, 2003, Raheja, 2005, among others) suggest a negative correlation between information asymmetry and corporate governance, while others (Warfield et al., 1995, Ajinkya et al., 2005) provide contradictory results. This relationship is not entirely understood (Armstrong et al., 2010, Dechow et al., 2010). This study adds to our understanding of this important subject by examining the relationship between information asymmetry, which is captured by the persistent impact of trades, and firm-level corporate governance.

In a market with asymmetric information, trades convey information that are not anticipated by the market and cause persistent impact on security prices. The higher the information asymmetry is, the higher impact a trade would cause. Hasbrouck (1991, 1995) suggests that trades and price revision can be considered from an econometric perspective as a vector autoregression (VAR) system. Within this VAR framework, the information impact of a trade is defined as the ultimate impact on stock price due to the unexpected component of a trade. It is important to notice that only the persistent impact is defined as the information content because immediate impact is contaminated by transient liquidity effects (such as inventory and order processing cost). These transient liquidity effects would be corrected by the market in the long run, although often very quickly. Therefore, information content may be meaningfully measured as the persistent impact of the trade innovation on price. A larger information content of stock trades indicates a higher information asymmetry.

To examine the relationship between information content and corporate governance, we conduct our analysis using detailed firm-level corporate governance data from RiskMetrics database, which provides a comprehensive spectrum of 44 governance attributes. These 44 attributes cover four major governance mechanisms: board of directors, audit, anti-takeover, and compensation & ownership. Using this data set, we construct five governance indexes: a comprehensive governance index Gov44 that integrates all 44 attributes and four governance subindexes that captures a firm's take-over vulnerability, audit quality, board quality, and compensation & ownership incentives. We calculate the stock information content with NYSE's TAQ (Trades and Quotes) data using the VAR system. Both SAS® and EVIEWS® software are used to confirm the robustness of our VAR analysis. We use both correlation and regression analysis to study the relationship between corporate governance and information content of stock trades. We also address the potential endogeneity problem in our regression analysis using 3-Stage Least Squares (3SLS) method.

As theory anticipates, both correlation and cross-sectional regression analysis indicate a significant negative correlation between governance quality and information content. Our results are robust to different combinations of various control variables and industry effect. The 3SLS analysis also confirms our findings are robust to endogeneity between information content and governance quality. The results demonstrate that a lower information content (lower information asymmetry) is associated with a higher governance quality. We conduct further analysis to differentiate the impact from different governance mechanisms by regressing information content on governance subindexes. Our results suggest that not all governance mechanisms contribute equally to the negative correlation between governance and information content. We find that board of directors is the main mechanism negatively correlated to information content in all models, while audit, anti-takeover and compensation & ownership do not show significant effect.

Firm-level corporate governance mechanisms are often classified into two broad categories: external and internal mechanisms. Market for corporate control (anti-takeovers) and audit are often perceived as external governance mechanisms, while board of directors and compensation are usually considered as internal mechanisms. Our results indicate that the information content of stock trades is more closely related to internal governance mechanisms. It suggests that managerial monitoring (the main function of board of directors) is weighted more than the potential profit from takeovers in reducing asymmetric information. However, it is worth to notice that these results are based on the tests on 100 largest companies in the U.S. These firms are large, stable, and mature. They are less vulnerable to takeover events and not as open to market control as small companies. It is possible that market recognizes the nature of these companies and places less weight on the external governance mechanisms. This is one possible reason why we do not observe a significant correlation between anti-takeover governance mechanism and information environment as many previous studies demonstrate (Ferreira and Laux, 2007, Armstrong et al., 2011, among others).

Our study contributes to the literature in several ways. First, we document a negative correlation between governance quality and information content of stock trades. To the best of our knowledge, information content of stock trades has not been reported in the corporate governance literature. Our study provides further empirical evidence to support the theory that a higher corporate governance quality is associated with a better information environment. Second, we investigate a broad range of governance mechanisms. Unlike most of previous studies focusing on one mechanism, such as anti-takeover, this study not only considers a comprehensive measure of firm-level corporate governance but also uses governance subindexes to distinguish the impacts of different governance mechanisms on a firm's information environment.

The rest of the paper proceeds as follows. The next section provides a literature review of the subject of this study. Next, we describe data and methodology. Empirical results are presented in the following section. The paper closes with some concluding remarks.

LITERATURE REVIEW

Extensive studies have been conducted to investigate the empirical relationship between corporate governance and information asymmetry. Some studies have identified that higher quality of corporate governance is associated with higher firm value, higher profitability, and higher stock return and bond prices (Shleifer and Vishiny, 1997, Gompers, Ishii, and Metrick, 2003, Cremers and Nair, 2005, Cremers, Nair, and Wei, 2007). This positive impact of corporate governance is mainly due to its ability to reduce information asymmetry. Corporate governance can reduce a firm's asymmetric information through several channels. First, good corporate governance reduces insider trading and improves price discovery. Fishman and Hagerty (1992) show that insider trading leads to less efficient stock prices since it has adverse effect on the competitiveness of the market. Shareholders of a firm have strong incentives to limit insider trading. Their results suggest that firm-level corporate governance can enhance managerial monitoring and deter managerial expropriation, which promote information-based trading for outside investors. Second, strong firm-level governance improves the quality of information disclosure and reduces costs of acquiring information (Karamanou and Vafeas, 2005). Sound financial disclosure can diminish agency problem through bridging information gap between investors and managers. Third, strong firm level corporate governance (especially, antitakeover provisions) can affect a firm's information environment. Antitakeover provisions can influence private information gathering in the capital market (Ferreria and Laux, 2007). Larcker and Lys (1987) show that speculators are better informed about the possibility of a successful takeover. It suggests that speculators have collected and benefited from collecting private information. Strong antitakeover usually means a lower probability of a takeover. It reduces outside investors' incentive to collect private information in order to profit from takeover activities (Ambrose and Megginson, 1992). Bushman et al. (2004) study the availability of firm specific information to outside investors. They find that corporate governance, indeed, improve firms' information environment.

Bebchuck (2002) analyzes how asymmetric information affects firm's choice of governance arrangements when they go public. The author shows that information asymmetry leads firms to a corporate governance system that is regarded as inefficient by public investors as well as by those who take the firm public. Cai et al. (2006) investigate the impact of asymmetric information on three governance mechanisms, namely, board of directors, exposure to market discipline, and CEO compensation. They find that asymmetric information is less correlated to intensity of board monitoring but more to market discipline and CEO compensation. Ferreira and Laux (2007) examine the relationship among corporate governance, idiosyncratic risk, and information flow use a large number of panel data. Their results indicate that firms with fewer antitakeover provisions exhibit higher levels of idiosyncratic risk and private information flow. They conclude that exposure to the market of corporate control leads to more informative stock prices by encouraging the collection of and trading on private information. In other words, high quality governance reduces information asymmetry. However, not all empirical studies unanimously support this theory. For example, although higher managerial ownership is usually associated with higher information asymmetry, Warfield et al. (1995) suggest managerial ownership is positively associated with earnings explanatory power for returns and inversely related to the magnitude of accounting accrual adjustments. Their results also suggest that ownership is less important for regulated corporation.

Information asymmetry is not easy to measure directly. Literature uses the quality of accounting statements, analyst coverage, forecast errors, and variation of past performance as proxies. More relevant to this study, asymmetric information is also measured using information obtained from stock trading. Brennan and Subrahmanyam (1996) employ the adverse selection component of the bid-ask spread. It measures the extent to which stock prices are influenced by unexpected order flow. Easley et al. (2002) develop a measure of information asymmetry use the Probability of Informed Trade (PIN). Lakonishok and Lee (2001) and Frankel and Li (2004) use the intensity of insider trades to capture the degree of information asymmetry that exists between insiders and outsiders.

Information asymmetry is also suggested to be positively related to spread (McInish and Wood, 1992, Chiang and Venkatesh, 1988). However, there are several issues when spread is used to measure

information asymmetry. First, spreads are influenced by transaction costs. Second, the posted spread represents the prices available at a given time for transactions associated with a particular depth. Other studies, for example, Glosten and Harris (1988), concentrate on trade impact on stock prices. These studies typically assume serial independence of transactions, and no delay in the trade impact on price. These assumptions are unrealistic and questionable.

Hasbrouck (1991, 1995) develops a vector autoregressive system to model the interactions of security trades and quote revisions. Using this VAR system, the information content of stock trades can be meaningfully measured as the ultimate price impact of trade innovations. It focuses on trade innovations rather than total trade. The model is able to exclude the predictable portion from a trade and isolate the persistent impact from the transient effect. It suggests that the magnitude of the price effect for a given trade size is positively correlated to the proportion of potentially informed traders in the population, the probability that such a trader is in fact informed, and the precision of private information. The ultimate impact of trade innovation is largely determined by these factors. Therefore, the impact of trade on stock price may be referred to as the extent of information asymmetry.

DATA AND METHODOLOGY

We use RiskMetrics Global Governance Database to collect firm level governance data. RiskMetrics compiles 64 governance attributes for each U.S. firm annually. As in Aggarwal et al. (2009) study, we exclude 20 of the 64 attributes from our analysis because either firms fail to satisfy minimally accepted criteria for these attributes or RiskMetrics replaces them with other attributes at later dates. We therefore focus on 44 attributes, and these attributes cover four broad categories (governance mechanisms): 1) board of directors, 2) audit, 3) takeover, and 4) compensation and ownership. Appendix A lists the attributes associated with each category (For detailed description of RiskMetrics data, please refer to Brown and Caylor (2006) and Aggarwal et al. (2009).) Following Aggarwal et al. (2009) study, we construct the governance index in such way that the index increases by 1 if a company satisfies one governance attribute and zero otherwise. We express the index as a percentage. If a firm satisfies all 44 attributes, its index equals 100%. A higher index means a higher corporate governance quality. We apply the same method to construct five indexes: the comprehensive governance index GOV44 (including all the attributes) and four governance subindexes including GBD (board of directors), GAUD (audit), GAT (anti-takeover), and GCMP (compensation & ownership).

In this study, we use data from 2005 for S&P 100 companies as our sample set. The S&P 100 is a subset of the S&P 500. It includes 100 leading U.S. companies. S&P 100 companies represent about 57% of the market capitalization of the S&P 500 and almost 45% of the market capitalization of the U.S. equity markets. The companies in the S&P 100 tend to be the largest and well-established companies. The primary reason to use S&P 100 companies is data size. Transaction data usually have very large size. Quote data only exceeds 200GB for our sample in year 2005. Data beyond S&P 100 become very difficult to manage. In addition, S&P 100 includes 100 largest companies in the U.S. If there is a correlation between information content and governance quality, it is most likely to be observed in these firms.

To calculate information content of stock trades, we retrieve transaction data of the S&P 100 firms in year 2005 from the NYSE's TAQ (Trades and Quotes) database. All data are initially read into two data sets for trade and quote, separately. Trade data set includes transaction price, time stamp, and trading volume. Quote variables are bid and ask prices and the time when a quote is entered. This study applies standard practice to merge trade and quote data (Hasbrouck, 1991).[3] For VAR analysis, it is necessary to know whether a trade is initiated by a buyer or a seller. Following Lee and Ready (1991), we define a trade is buyer-initiated if the trade price is above prevailing quote midpoint and seller-initiated if it is below the midpoint.

Previous studies suggest that a firm's information environment is influenced by several firm-level variables (Piotroski and Roulstone, 2004, Chan and Hameed, 2006, Ferreira and Laux, 2007, and Fernandes and Ferreira, 2008). To control for the effects of firm characteristics, we include firm size (total assets), return on equity (ROE), volatility of ROE (standard deviation of past ten years' ROE), dividend yield, trading volume, and age in our analysis. We also control for firms' diversification (the number of business segments a firm operates in) and ratio of insider holdings (percentage of insider holdings over shares outstanding). All firm-level variables are collected from Standard & Poor's COMPUSTAT database.

In a specialist market, market-maker posts bid and ask quotes. A transaction is characterized by its signed volume xt, which is positive if a trade is a purchase (buyer-initiated) and negative if it is a sale (Husbrouck, 1991, 1995). Based on trades (transactions), the market maker posts new bid (q_t^b) and ask (q_t^a) quotes. If there are no transaction costs and the only update to public information set at time t is the announced trade, then the revision in quote prices at time t summarizes the information inferred from the observation of *xt*. The primary price variable used is the midpoint of the quotes as $p = (q_t^b + q_t^a)/2$. The information inferred from xt may be conveniently summarized as the subsequent revision in the quote midpoint:

$$rt = \frac{q_t^b + q_t^a}{2} - \frac{q_{t-1}^b + q_{t-1}^a}{2} \quad (1)$$

The dependence of *rt* on xt is assumed linear. Thus, $rt = bx_t + v_{1,t}$ where $v1,t$ is disturbance and reflect public information. Because many microstructure imperfections such as price discreteness, lagged adjustment to information, etc, cause lagged effects, a more flexible structure would be:

$$r_t = a_1 r_{t-1} + a_2 r_{t-2} + \cdots + b_0 x_t + b_0 x_{t-1} + \cdots + v_{1,t} \quad (2)$$

Trades can also be written in a similar fashion:

$$x_t = c_1 r_{t-1} + c_2 r_{t-2} + \cdots + d_1 x_{t-1} + d_2 x_{t-2} + \cdots + v_{2,t} \quad (3)$$

where $v2,t$ captures the unanticipated component of a trade. Comparing equation 1 and 2, we can see that price revision and trade are not determined simultaneously: price revision follows the trade, and price revision cannot contemporaneously influence x_t. Equations 2 and 3 comprise a bivariate vector autoregression model. It is assumed that the disturbances have zero means and are independent.

We do not use regular time frequency in this VAR system. Each firm has different time period, which depends on the frequency of the bid and ask prices being entered. Compared with usual VAR specification, this VAR system actually presents a structural model with a contemporaneous restriction, which eliminates identification problems. Thus, this structural model is identical to the usual VAR system in impulse response function if we follow the Cholesky decomposition method with recursive causal ordering $x_t \rightarrow r_t$. The persistent impact (i.e. cumulative impulse response) of price on trade is defined as the information content of stock trades. It can be interpreted as the information asymmetry inferred from stock trades.

After calculating the information content, we estimate the relationship between firm-level governance quality and information content using the following Ordinary Least Square (OLS) model. We control for a series of firm characteristics to avoid a spurious inference.

$$IC = c_0 + c_1 GOV\,44 + c_2 SIZE + c_3 MB + c_4 ROE + c_5 STDROE + c_6 DIVYIELD$$

$$+c_7 V\,OL + c_8 AGE + c_9 SEGMENT + c_{10} CLOSELY\,HELD + \varepsilon \quad (4)$$

where, IC is information content; GOV 44 stands for the comprehensive governance quality index. In this model, we control for firm size, market to book ratio (MB), return on equity (ROE), volatility of ROE (STDRORE), dividend yield (DIVYIELD), trading volume (VOL), age, and business segment (SEGMENT), and insider holdings (CLOSELYHELD).

The VAR model presented above (Equation 1 and 2) is linear. If xt is expressed as a signed volume, the results will be highly impacted by the variable magnitude. To achieve a stable VAR system and reduce impacts from few very large trades, literature has suggested to use trade direction ($xt = 1$ for a buy, $xt = -1$ for a sell, and $xt = 0$ for undefined) to replace the trading volume (Hasbrouch, 1991). We follow this convention in this study. All VAR estimations use ordinary least squares method. We use SAS® software to conduct our analysis due to its flexibility in handling data in panel format. We also crosscheck SAS® results using EVIEWS®.

It is well known that stock price follows random walk. The price revision, i.e. the first difference of price p, is a stationary process. We use the Augmented Dicky Fuller (ADF) test to confirm that price has unit root and use the ERS test (Elliot, Rothenberg, and Stock, 2001) to show that price revision are stationary for each stock. We use Akaike (AIC) information criteria to make lag length selection. SAS R program is able to automatically choose the optimal lag for each firm based on AIC. The lag lengths differ among firms with a minimum of 2 lags to a maximum length of 20. Most of lag lengths are around 5 to 10 time periods. After each firm's VAR system is defined, we calculate the characteristic polynomial roots of each firm. All of the modulus are less than 1, which indicate stationary condition is satisfied for each VAR system in our analysis.

RESULTS

We use ALCOA INC. (Ticker symbol: AA) as an example to illustrate the estimates of VAR system. Table 1 presents the coefficient estimates through 8 lag lengths. The coefficients of $b's$ indicate the effect of a trade on price revision. The coefficient of b_0 implies that on average the quote midpoint is raised by roughly \$0.038 immediately after a buy order. This positive impact of a buy order on stock price has been suggested to be true for every stock in general (Hasbrouch, 1991). Not surprisingly, we find significant positive coefficients existed for all firms. Another important observation is the strong positive autocorrelation in trades as measured by coefficient $d's$. It suggests that a buy tends to follow a buy, and a sell tends to follow a sell. It is typical to observe this pattern stronger at low lags as indicated by $d1, d2,$ and $d3$ in Table 1.

The information content of stock trades is defined as the persistent impact of trade innovation on price revisions and is measured as the accumulative impulse response. In this study, we use Cholesky decomposition method to obtain the accumulative impulse response. Although each stock's accumulative response converges at different time period depending on the bid/ask updating frequency, 20 time periods is found to be adequate for all S&P 100 firms to achieve convergence. Because the accumulative impulse response is a function of stock price, it is necessary to normalize the impulse response before comparison. Following Hasbrouck (1991), we divide accumulative response by stock price before trades to normalize the measurement. This persistent impact is due to the trade innovation that is not anticipated by the market. The same trade innovation would have a higher impact (information content) on stock price for a firm with higher information asymmetry.

We summarize the descriptive statistics of the main variables in Table 2. One important observation is that our sample selection captures large variations in various firm-level variables. For instance, information content (IC) varies from 0.01 to 0.321, and corporate governance index (GOV44) varies from 0.558 to 0.900. Except for audit (GAUD) (there are only three attributes in audit governance category. All firms adopt at least 2 attributes.), the other governance subindexes, board of directors (GBD), anti-

takeover (GAT), and compensation & ownership (GCMP) also exhibit large variations. In addition, firm-level variables that have potential effects on information content also exhibit large variations among firms, such as the number of business segments (diversification) from 1 to 10, insider holdings from 0.00% to 54.89%, and firm age from 2 to 81 years old, etc.

Table 1: Estimates of VAR Model for Firm ALCOA, INC.

	Coeff.	T-Stat		Coeff.	T-Stat
a_1	-0.314	-30.073	c_1	0.270	2.823
a_2	-0.172	-15.677	c_2	0.040	0.394
a_3	-0.053	-4.791	c_3	0.022	0.217
a_4	-0.047	-4.226	c_4	-0.049	-0.481
a_5	-0.015	-1.307	c_5	0.048	0.474
a_6	0.013	1.156	c_6	0.085	0.838
a_7	-0.017	-1.557	c_7	0.049	0.486
a_8	-0.033	-3.322	c_8	-0.044	-0.484
b_0	0.038	37.73			
b_1	-0.008	-6.829	d_1	0.316	30.288
b_2	-0.001	-0.439	d_2	0.089	8.069
b_3	-0.001	-0.472	d_3	0.050	4.531
b_4	0.001	1.219	d_4	0.018	1.664
b_5	0.002	1.372	d_5	0.020	1.806
b_6	0.003	2.270	d_6	0.023	2.107
b_7	0.002	1.315	d_7	0.009	0.849
b_8	0.002	1.380	d_8	0.020	1.903
$R^2(r_t)$	0.162		$R^2(x_t)$	0.115	

VAR model is defined as: $rt = \sum_{i=1}^{8} a_i r_{t-i} + \sum_{i=0}^{8} b_i r_{t-i} + v_{1,t}$, $xt = \sum_{i=1}^{8} c_i r_{t-i} + \sum_{i=1}^{8} d_i r_{t-i} + v_{2,t}$, *where* rt *is the price (quote-midpoint) change;* xt *is a trade indicator variable (+1 for a buy order and -1 for a sell order); t indexes transactions. The results are for firm ALCOA, INC. for the year of 2005.*

Table 2: Summary of Descriptive Statistics of S&P 100 Companies in Year 2005

Variable	Mean	Std. Dev.	Min.	Max.
IC	0.053	0.072	0.010	0.321
GOV44	0.743	0.065	0.558	0.900
GBD	0.707	0.078	0.400	0.880
GAUD	0.975	0.089	0.667	1.000
GAT	0.524	0.176	0.167	0.833
GCMP	0.774	0.103	0.500	0.900
AGE	43.65	25.49	2	81
CLOSELYHELD (%)	7.28	12.25	0	54.89
DIVYILED (%)	2.97	2.77	0.79	13.37
MB	3.97	2.37	1.31	13.81
ROE (%)	18.11	19.10	-71.65	41.27
SEGMENT	5.31	2.21	1	10
SIZE (In Millions)	125,657	268,539	3,696	1,494,037
STDROE (%)	7.22	5.28	1.19	29.24
VOL (In Millions)	3,053	3,782	119	16,828

This table summarizes descriptive statistics of the main variables of S&P 100 firms in 2005. IC represents information content. GOV44 stands for the comprehensive corporate governance index using 44 attributes. GBD, GAUD, GAT, and GCMP stand for the corporate governance subindexes on board, audit, anti-takeover, and compensation & ownership category, respectively. SIZE is the total assets. AGE is firm age as of year 2005. CLOSELYHELD stands for the percentage of insider holdings over total number of shares outstanding. MB is the market to book ratio. ROE and STDROE stand for return on equity and standard deviation of past ten years ROEs. DIVYIELD is the dividend yield. SEGMENT represents the number of business segments a firm operates in. VOL is trading volume.

Table 3 presents the correlation coefficient matrix among the main variables. Since we anticipate that high quality corporate governance would reduce information content of stock trades, a negative relationship between these two variables is expected. As shown in Table 3, we observe such negative correlation between IC and GOV44 and it is significant at 5% level.

Table 3: Correlation Analysis of Information Content, Corporate Governance, and Firm Characteristic

	IA	GOV44	SIZE	AGE	CLOSELY HELD	MB	ROE	DIVYILED	VOL	STDROE
GOV44	-0.39									
	(0.03)									
SIZE	-0.2	0.16								
	(0.29)	(0.41)								
AGE	0.15	-0.12	-0.28							
	(0.43)	(0.54)	(0.13)							
CLOSELYHELD	-0.03	0.37	0.05	-0.02						
	(0.88)	(0.05)	(0.8)	(0.93)						
MB	0.08	-0.19	-0.32	0.31	0.05					
	(0.69)	(0.32)	(0.09)	(0.11)	(0.81)					
ROE	0.1	-0.26	-0.26	-0.01	-0.55	0.79				
	(0.59)	(0.16)	(0.16)	(0.98)	(0)	(0)				
DIVYILED	-0.02	0.1	0.1	-0.14	0.26	0.02	-0.43			
	(0.9)	(0.59)	(0.61)	(0.45)	(0.17)	(0.9)	(0.02)			
VOL	-0.1	0.3	-0.12	-0.28	0.02	0.06	0.03	0.48		
	(0.6)	(0.11)	(0.52)	(0.14)	(0.91)	(0.77)	(0.86)	(0.01)		
STDROE	0.09	0.22	-0.1	0.38	0.39	0.04	-0.68	0.53	0.14	
	(0.64)	(0.24)	(0.6)	(0.04)	(0.03)	(0.84)	(0)	(0)	(0.46)	
SEGMENT	-0.42	0.01	0.04	0.32	-0.02	0.1	-0.09	0.16	0.01	0.22
	(0.02)	(0.98)	(0.85)	(0.09)	(0.93)	(0.6)	(0.65)	(0.41)	(0.98)	(0.26)

This table presents correlation coefficients and corresponding p values from Pearson correlation analysis among information content, corporate governance, and firm characteristics. IC represents information content. GOV44 stands for the comprehensive corporate governance index using 44 attributes. SIZE is the total assets. AGE is firm age as of year 2005. CLOSELYHELD stands for the percentage of insider holdings over total number of shares outstanding. MB is the market to book ratio. ROE and STDROE stand for return on equity and standard deviation of past ten years ROEs. DIVYIELD is the dividend yield. SEGMENT represents the number of business segments a firm operates in. VOL is trading volume.

We also observe that information content is negatively correlated with firms' business diversification (SEGMENT) and the correlation is significant. There are two contradicted views regarding the impact of diversification on firms' information content. On one hand, since more diversified firms have less idiosyncratic risk, stock trades will have less impact on stock prices. One could expect diversification to be negatively correlated with information content. On the other hand, more diversified firms are more opaque to outside investors. The complex structure in such firms usually requires higher costs to collect/interpret information. Therefore, a higher information content is expected due to a higher information asymmetry in such firms. Theoretically, it is unclear what the net effect of diversification would be. However, our results suggest that the effect of opaqueness of diversification outweighs the effect of reduction in idiosyncratic risk.

Although correlation analysis demonstrates a negative correlation between information content and corporate governance, this relationship could be driven by other firm-level characteristics. To minimize the possibility of spurious inference, we apply regression analysis in this section. Table 4 reports the results from regression analysis, which is the main finding of this study. In our base model, we regress information content (IC) on corporate governance measure (GOV44) controlling for firm-level characteristics using ordinary least square (OLS) model (Model 1 in Panel A). Model 2 and 3 in Panel A report the results with additional control variables (diversification for model 2 and insider holdings for Model 3). We observe a significant negative relationship between information content and corporate governance in all models. Results in Model 2 suggest that diversification has a significant negative impact on firms' information content. Model 3 shows that insider holdings do not have significant impact on information content. As shown in these models, the negative correlation between information content and

corporate governance are robust to different combinations of control variables. These results are consistent with the theory and our correlation analysis.

Table 4: Regression Analysis of Information Content on Corporate Governance

	Panel A			Panel B		
	1	2	3	4	5	6
INTERCEPT	0.531**	0.569**	0.657***	0.855*	0.931**	1.026**
	(1.994)	(2.445)	(2.685)	(1.66)	(2.227)	(2.2)
GOV44	-0.66**	-0.638**	-0.775**	-1.02*	-0.983**	-0.93**
	(-2.001)	(-2.205)	(-2.474)	(-1.882)	(-2.078)	(-1.965)
SIZE	-0.009	-0.001	-0.001	-0.023	-0.005	-0.004
	(-1.510)	(-1.008)	(-0.133)	(-0.910)	(-0.614)	(-0.096)
MB	-0.001	0.001	-0.001	0.017	0.011	0.027
	(-0.112)	(0.016)	(-0.119)	(0.754)	(0.418)	(0.64)
ROE	0.037	-0.001	0	-0.005	-0.002	-0.005
	(0.134)	(-0.06)	(-0.04)	(-1.086)	(-0.4)	(-0.609)
STDROE	0.007	0.007	0.007	0.01	0.01	0.014**
	(1.341)	(1.452)	(1.619)	(1.363)	(1.506)	(2.296)
DIVYIELD	-0.002	0.001	0.001	-0.019	-0.021	-0.037
	(-0.289)	(0.214)	(0.215)	(-0.662)	(-0.947)	(-1.251)
VOL	-0.043	-0.052	-0.016	0.035	0.074	0.082
	(-0.088)	(-0.12)	(-0.036)	(0.33)	(0.603)	(0.081)
AGE	-0.017	0.001	0.001	0.001	-0.001	-0.001
	(-0.195)	(0.66)	(0.767)	(0.67)	(-0.058)	(-0.209)
SEGMENT		-0.018***	-0.017***		-0.019	-0.029
		(-2.956)	(-2.874)		(-1.204)	(-1.369)
CLOSELYHELD			0.172			-0.707
			(1.105)			(-1.149)
INDUSTRY EFFECT				Yes	Yes	Yes
R^2	0.231	0.246	0.255	0.753	0.825	0.846

*This table presents the estimates of regression analysis of information content on corporate governance ratings controlling for firm level characteristics. IC represents information content. GOV44 stands for the comprehensive corporate governance index using 44 attributes. SIZE is the total assets. AGE is firm age as of year 2005. CLOSELYHELD stands for the percentage of insider holdings over total number of shares outstanding. MB is the market to book ratio. ROE and STDROE stand for return on equity and standard deviation of past ten years ROEs. DIVYIELD is the dividend yield. SEGMENT represents the number of business segments a firm operates in. VOL is trading volume. Panel A lists results using OLS regression. Panel B reports results controlling for industry effects. The numbers in parentheses are t values. *, **, *** represents significance level at 10% ,5%, and 1%, respectively.*

Information asymmetry varies significantly among different industries (Ferreira and Laux, 2007). To address the impact of industry classification on our analysis, we conduct the same analysis but with control for industry fixed effect. We present results in Panel B (Model 4, 5, and 6) in Table 4. Although the introduction of industry classification reduces the significance level slightly, for instance, the t-value of coefficient of variable GOV44 decreases from -2.001 to -1.882, the negative impact of GOV44 is still evident in all models.

RiskMetrics reports firm level data in four governance mechanisms, namely, board of directors, audit, anti-takeover, and compensation & ownership. It would be interesting to test how information content is influenced by individual mechanism. Table 5 presents regression results on these different mechanisms. Panel A shows the results using OLS regression and Panel B reports the results with control for industry.

Table 5: Regression Analysis of Information Content on Corporate Governance Subindexes

	Panel A				**Panel B**			
Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
INTERCEPT	0.46**	0.007	0.124	0.147	0.991***	1.228***	0.292	0.297
	(2.419)	(0.027)	(1.486)	(0.931)	(4.168)	(2.791)	(0.895)	(0.696)
GBD	-0.476**				-0.802***			
	(-1.977)				(-3.688)			
GAUD		0.092				-0.112*		
		(0.698)				(-1.801)		
GAT			-0.105				0.103	
			(0.930)				(0.290)	
GCMP				-0.088				0.114
				(-0.45)				(0.302)
SIZE	-0.014	-0.014	-0.009	-0.020	-0.012	-0.003	-0.008	-0.011
	(-0.861)	(-0.902)	(-0.501)	(-1.213)	(-0.653)	(-0.076)	(-0.113)	(-0.137)
MB	-0.002	-0.003	-0.001	0	0.036	0.02	0.018	0.018
	(-0.178)	(-0.029)	(-0.097)	(0.027)	(1.603)	(0.552)	(0.455)	(0.422)
ROE	-0.005	0.001	0.001	0.001	-0.007	-0.003	-0.001	-0.001
	(-0.193)	(0.252)	(0.378)	(0.244)	(-1.744)	(-0.358)	(-0.069)	(-0.047)
STDROE	0.005	0.005	0.006	0.006	0.013***	0.017**	0.012	0.01
	(1.155)	(0.946)	(1.1)	(1.113)	(3.514)	(2.458)	(1.105)	(0.912)
DIVYIELD	0.005	0.005	0.004	0.004	-0.041***	-0.051	-0.038	-0.036
	(0.693)	(0.615)	(0.474)	(0.461)	(-3.035)	(-1.565)	(-0.918)	(-0.855)
VOL	0.018	-0.036	-0.034	0	0.03	-0.002	-0.004	0.003
	(0.004)	(-0.758)	(-0.75)	(-0.785)	(0.488)	(-0.15)	(-0.019)	(0.17)
AGE	0.001	0.001	0.001	0.001	0	-0.006***	-0.004	-0.004
	(1.217)	(0.733)	(0.562)	(0.569)	(-0.273)	(-3.636)	(-0.973)	(-1.182)
SEGMENT	-0.02***	-0.018***	-0.017**	-0.017**	-0.038***	-0.038*	-0.034	-0.033
	(-3.255)	(-2.593)	(-2.447)	(-2.386)	(-3.181)	(-1.708)	(-1.203)	(-1.144)
CLOSELYHELD	0.119	0.013	0.058	0.033	-1.014***	-1.275	-0.97	-0.864
	(0.772)	(0.079)	(0.351)	(0.199)	(-2.859)	(-1.614)	(-0.929)	(-0.897)
INDUSTRY EFFECT					Yes	Yes	Yes	Yes
R^2	0.208	0.337	0.368	0.346	0.886	0.853	0.784	0.78

This table presents the regression analysis of information content on corporate governance ratings based on four subindexes controlling for firm level characteristics. GBD, GAUD, GAT, and GCMP stand for the corporate governance subindexes on board, audit, anti-takeover, and compensation & ownership category, respectively. The other variables are the same as the ones in Table 4.

Results from Model 1 indicate that governance quality on board of directors is the only mechanism having negative and significant correlation with information content. It suggests that market considers board of director as the primary governance mechanism to reduce information asymmetry. After introducing industry classifications, audit also becomes a mechanism (t-value of 1.801) that reduces the level of information asymmetry as shown in model 6 in Panel B. We also find that the number of business segments of a firm has a negative correlation with information content in most models.

We do not find other governance mechanisms, i.e. anti-takeover, reduce information content of stock trades. These results are inconsistent with previous findings, especially for anti-takeover mechanism (Ferreira and Laux, 2007; Armstrong et al. 2011; among others). There are two possible explanations for the inconsistency. First, the information content measured in this study is calculated from posted trades and it focuses on the persistent impact, which is free of transient effects. Information content obtained from stock trades captures different aspect of stock information environment from other measures, such as PIN. PIN measures the probability of informed trading. It is based on the assumptions that information events occur independently; only one event occurs each day; and informed investors react on the event at the same day. Whether persistent or transient effects are captured might have caused different results. Second and more likely, our results may be driven by our sample selection. Our analysis covers S&P 100 companies. These firms are large, stable, and mature, which make them not very open to market control (i.e. not very vulnerable to takeover events). Anti-takeover mechanism may not be weighted as much as the board of director mechanism in reducing information asymmetry. Therefore, we do not observe anti-takeover mechanism plays an important role in reducing information content of stock trades.

One complexity of our analysis is that firm's governance quality and information environment are simultaneously determined. To address the potential endogeneity problem, we use the 3SLS method to check if the negative correlation is robustly significant. We first regress each endogenous variable (information content (INFO) and governance quality (GOV44)) on all other (exogenous) variables. We then regress each endogenous variable on the fitted value of the other one from the first stage, plus the exogenous variables. We then run Generalized Least Squares (GLS) with the covariance matrix that allows for correlation across the two equations. We use capital expenditure normalized by sales as our choice of instrument that influences governance quality (through costs and benefits of board monitoring) (Gillan et al., 2006), but not directly influence information content of stock trades. The results are provided in Table 6. Both equations indicate a negative correlation between information content and governance quality. For the model with INFO as dependent variable, the negative correlation is significant at 5% level, while it is significant at 10% level for the model with GOV44 as dependent variable. We also observe that firms' business diversification negatively influence information content in the model with INFO as dependent variable, which agrees with our previous findings. 3SLS analysis provides evidence that our findings are not affected by potential endogeneity.

Over all, we document a strong negative correlation between information content and corporate governance. Our analysis at governance subindex levels suggests that internal governance mechanism (managerial monitoring provided by the board of directors) is the main factor that reduces asymmetric information. It seems that for well-established firms, the market considers board of director as a more effective mechanism than audit, anti-takeover, and compensation to improve firms' information environment. These results provide further empirical evidence to support the theory that firms with higher governance quality offer a better information environment for investors.

Table 6. Three-Stage-Least-Square Analysis of Information Content and Corporate Governance

	Dependent Variable	**Dependent Variable**
	INFO	GOV44
INTERCEPT	0.599	0.389**
	(0.784)	(2.151)
GOV44	-0.498*	
	(-1.955)	
INFO		-0.089*
		(-1.694)
CPAX/SALE		-0.102
		(-0.397)
LAT	-0.012	0.034
	(-0.582)	(2.561)
MB	0	0
	(-0.042)	(0.027)
ROE	0	0
	(0.121)	(-0.284)
STDROE	0.004	0.006
	(0.752)	(1.757)
DIDYLD	0.005	-0.005
	(0.718)	(-1.023)
VOL	0	0
	(-0.685)	(1.039)
AGE	0.001	0
	(0.644)	(-0.572)
SEGMENT	-0.017**	-0.001
	(-2.483)	(-0.265)
CLOSELYHELD	0.024	0.133
	(0.147)	(1.243)

*This table summarizes the results of 3-stage least square regression of information content and corporate governance. INFO represents information content of stock trades. IC represents information content. GOV44 stands for the comprehensive corporate governance index using 44 attributes. SIZE is the total assets. AGE is firm age as of year 2005. CLOSELYHELD stands for the percentage of insider holdings over total number of shares outstanding. MB is the market to book ratio. ROE and STDROE stand for return on equity and standard deviation of past ten years ROEs. DIVYIELD is the dividend yield. SEGMENT represents the number of business segments a firm operates in. VOL is trading volume. The numbers in parentheses are t values. CAPX/Sale is the ratio of capital expenditure over sales and serves as instrument. *, **, *** represents significance level at 10%, 5%, and 1%, respectively.*

CONCLUDING COMMENTS

In this study, we examine the relationship between corporate governance quality and information contents of stock trades. We apply a vector autoregression model to measure the information content, which is defined as the persistent impact of trade innovations on price revision. We use detailed firm-level governance data to measure governance quality. We show that information content is negatively correlated with firms' corporate governance quality. Corporate governance is a collection of mechanisms designed to minimize information asymmetry. Our results provide strong support for this theory. We also show that board of directors is the main mechanism to reduce the information content of stock trades for well-established companies. This study adds to our understanding on how high quality governance

reduces information asymmetry by documenting new evidence that has not been reported in the literature. It provides strong implications on how to design an effective governance system. Board of directors should be the primary focus for firms when information asymmetry is a main concern.

One limitation of current study is that it only covers large and well-established companies in U.S. market. Due to the data limitation, it only tests the stock trades' impacts on prices in year 2005. In addition, this study does not examine the relationship of information content of stock trades between other popular information asymmetry measures, such as PIN. Current study can be improved in several ways by addressing the limitations. One possible direction for future research is to examine more firms, especially the small firms, across countries. Since small firms and other countries usually have different governance systems from large firms and U.S., we anticipate that different observation might emerge. The differences would give us more opportunities to understand how corporate governance improves firm information environment in depth at a wider spectrum.

APPENDIX

Appendix A: Governance Attributes

BOARD
All directors attended 75% of the board meetings or had a valid excuse
CEO serves on the boards of two or fewer public companies
Board is controlled by more than 50% independent outside directors
Board size is at greater than 6 but less than 15
CEO is not listed as having a related-party transaction
No former CEO on the board
Compensation committee comprised of solely of independent outsiders
Chairman and CEO are separated or there is a lead director
Nominating committee comprised solely of independent directors
Governance committee exists and met in the past years
Shareholders vote on directors selected to fill vacancies
Governance guidelines are publicly disclosed
Annually elected board (no staggered board)
Policy exists on outside directorships (four or fewer boards is the limit)
Shareholders have cumulative voting rights
Shareholder approval is required to increase/decrease board size
Majority vote requirement to amend charter/bylaws (not supermajority)
Board has the express authority to hire its own advisors
Performance of the board is reviewed regularly
Board approved succession plan in place for the CEO
Outside directors meet without CEO and disclose number of times met
Directors are required to submit resignation upon a change in job
Board cannot amend bylaws without shareholder approval or can only do so under limited circumstances
Does not ignore shareholder proposal
Qualifies for proxy contest defenses combination points

AUDIT
Consulting fees paid to auditors are less than audit fees paid to auditors
Audit committee comprised solely of independent outsiders
Auditors ratified at most recent annual meeting

ANTI-TAKEOVER
Single class, common
Majority vote requirement to approve mergers (not supermajority)
Shareholders may call special meetings
Shareholder may act by written consent
Company either has no poison pill or a pill that was shareholder approved
Company is not authorized to issue blank check preferred

COMPENSATION & OWNERSHIP
Directors are subject to stock ownership requirements
Executives are subject to stock ownership guidelines
No interlocks among compensation committee members
Directors receive all or a portion of their fees in stock
All stock-incentive plans adopted with shareholder approval
Options grants align with company performance and reasonable burn rate
Company expenses stock options
All directors with more than one year of service own stock
Officers' and directors' stock ownership is at least 1% but not over 30% total shares outstanding
Repricing is prohibited

This Appendix presents forty-four governance attributes divided into four subcategories: Board, Audit, Anti-takeover, and Compensation & Ownership. Definitions for these attributes are obtained from RiskMetrics Global Governance Database.

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