Impacts of Corporate Governance on Stock Liquidity: A Panel Quantile Regression

Jutamas Wongkantarakorn
Thammasat Business School, Thammasat University, Thailand and
College of Innovation Management, Rajamangala University of Technology
Rattanakosin, Thailand
Chaiyuth Padungsaksawasdi[*]
Department of Finance, Thammasat Business School, Thammasat University, Thailand
Tatre Jantarakolica
Faculty of Economics, Thammasat University, Thailand

Abstract

Dissimilar to previous studies, the present article considers the positively skewed distribution of the Amihud's (2002) stock illiquidity measured by employing random-effects Tobit and fixed-effect quantile regression models. We find a significant impact of the Thai Institute of Directors' corporate governance index (i.e., no star, 3-star, 4-star, and 5-star) on the stock liquidity in the Stock Exchange of Thailand. In general, good corporate governance improves firm transparency, thereby inducing increased trade. Robustness tests using a nonparametric measure of rank correlation and a random-effects ordered Probit model confirm our findings.

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[*] **Correspondence author:** Address: 2 Prachan Road, Phra Borom Maha Ratchawang, Phra Nakhon, Bangkok 10200. Email: chaiyuth@tbs.tu.ac.th.

1. Introduction

Corporate governance affects stock liquidity through asymmetric information flow, which causes adverse selection and subsequently influences a frequency of stock trading (Glosten and Milgrom, 1985). Prior literature on the relationship between corporate governance and stock liquidity demonstrates that high corporate governance is associated with high liquidity (Chung et al., 2010, 2012; Prommin et al., 2014). Specifically, high corporate governance improves corporate transparency, leading to low information asymmetry. Meanwhile, Lei et al. (2013), who investigate the relationship among stock liquidity, corporate governance, family firms, and state-owned enterprises in China, find similar evidence. However, one of the possible drawbacks of previous studies includes a use of a specific characteristic or few corporate governance dimensions to represent an overall corporate governance of a firm. This practice may yield biased findings, as corporate governance is a mechanism or a system. Thus, this paper attempts to address this issue.

This study focuses on a panel analysis for corporate governance and stock liquidity in Thailand for the period of 2006–2017. The main objective of this study is to assess whether corporate governance has an impact on the stock liquidity in the Thai equity market. We employ data from the Thai Institute of Directors (IOD) corporate governance index as the overall corporate governance index of a listed firm and the Amihud's (2002) stock illiquidity measure. Random-effects Tobit and fixed-effect quantile regression models are used to capture the positively skewed distribution of stock liquidity.

The main result confirms prior findings that firms with high corporate governance have high stock liquidity. In addition, the positive impact of corporate governance on stock liquidity is pronounced in firms with satisfactory corporate governance scores (i.e., 3, 4, and 5 stars). Thai listed firms with high corporate governance scores have low levels of information asymmetry, which increase stock liquidity. Moreover, confident investors are more willing to trade in highly liquid stocks.

This paper is organized as follows. Section 2 describes the theoretical framework and reviews pertinent literature. Section 3 demonstrates data and methodology used in the study. Section 4 presents and discusses the empirical results, and the last section summarizes and concludes the paper.

2. Related theoretical framework and pertinent literature

2.1 Trading under information asymmetry and adverse selection

Information asymmetry causes friction in security markets. Theory of adverse selection describes an influence of asymmetric information on market liquidity as follows. Given the fact that a lack of information transparency weakens trading decisions, informed traders normally acquire additional benefits at the cost of counterparties. To protect their interests, uninformed traders and market makers widen bid–ask spreads to ensure the risk of missing information (Copeland and Galai, 1983; Glosten and Milgrom, 1985). This solution is reconfirmed by Kavajecz (1999), who show that market makers lower bid and ask prices in order to manage their exposure to information opacity. Therefore, information asymmetry deteriorates market width and market depth, which are key measures of market liquidity.

Previous studies have suggested the strong linkage between information asymmetry and corporate governance practices. Leuz and Verrecchia (2000) focus on changes in financial reporting standards in German companies and argue that asymmetric

information in firms is reduced under improved disclosure environments. Diamond (1985) and Verrecchia (2001) specify that voluntary disclosure enhances firms' public information, decreasing information costs and asymmetric information. However, voluntary disclosure is influenced by ownership structure and board composition (Eng and Mak, 2003). Ajinkya, Bhojraj, and Sengupta (2005) and Karamanou and Vafeas (2005) examine the effect of board structure, institutional ownership, and audit committees on the quantity and quality of earnings forecasts and indicate that information fairness is improved by corporate governance policies. Moreover, Kanagaretnam, Lobo, and Whalen (2007) identify that board independence, board activity, and corporate insiders' stock holdings lessen bid–ask spreads, which are used as proxies for information asymmetry. Recent studies (Cormier, Ledoux, Magnan, and Aerts, 2010; Elbadry, Gounopoulos, and Skinner, 2015; Cai, Liu, Qian, and Yu, 2015) support the same findings.

On the other hand, good governance can escalate information asymmetry when a cost of disclosure is high (Bamber and Cheon, 1998; Verrecchia, 1983). Furthermore, sophisticated investors possess better information-processing abilities than naïve investors, which intensify an information gap given an arrival of new information (Coller and Yohn, 1997; Kim and Verrecchia, 1994; Lee, Mucklow, and Ready, 1993).

2.2 Corporate governance and liquidity

Owing to complications from numerous governance dimensions, several attempts have been made to create a governance measure (Jackson, 2013; Lei et al., 2013; Prommin et al., 2014; Tang and Wang, 2011). Researchers have constructed governance indices mainly by employing equally weighted techniques. Literature on associations among corporate governance, information asymmetry, and liquidity is abundant. Diamond and Verrecchia (1991), Welker (1995), and Healy, Hutton, and Palepu (1999) demonstrate that information disclosure diminishes asymmetric information, encouraging investors to trade stocks and increasing stock liquidity. Moreover, Bacidore and Sofianos (2002), Brockman and Chung (2003), and Chung (2006) conclude that the regulatory environment, as an external corporate governance factor, enhances market liquidity.

Chung, Elder, and Kim (2010) are among pioneers to study an impact of internal corporate governance attributes on stock liquidity. Using the U.S. data from 2001 to 2004, they construct an index based on 24 governance standards. The results of panel regression models reveal that stock liquidity is significantly improved by corporate governance policy. Several studies in international markets are also widely documented. Employing selected corporate governance characteristics and liquidity proxies in the Malaysian listed companies, Foo and Zain (2010) support the findings of Chung et al., (2010). The same conclusions are found in 155 French stocks from 2008 to 2009 (Karmani and Ajina, 2012). Chung, et al. (2012) indicate a positive impact of shareholder protection right on stock liquidity using survey data from 25 international markets from 2003 to 2010. Furthermore, Li et al. (2012) assert that liquidity enhances corporate governance in the Russian market. Tang and Wang (2011) and Lei, Lin, and Wei (2013), supporting the findings of Chung et al. (2010), propose the effect of different types of agency conflicts on the relationship between corporate governance and stock liquidity.

Employing the Amihud illiquidity measure with panel regression, Edmans et al. (2013) find a positive relationship between liquidity and a likelihood of blockholder formation. Meanwhile, Cueto and Switzer (2013) demonstrate that dominant shareholders do not decrease market liquidity in the Chilean and Brazilian markets, as they must maintain low-cost exit strategies. Jackson (2013) show conflicting findings by presenting 71 Caribbean firms with concentrated ownerships linked to low stock liquidity

from 2005 to 2011. By constructing a corporate governance measure from four dimensions, Prommin et al. (2014) and Prommin, Jumreornvong, Jiraporn, and Tong, (2016) reaffirm the results of Chung, Elder, and Kim (2010), who find a positive relationship between governance quality and liquidity at the firm level. However, they investigate the relationship using only the 100 largest stocks in Thailand for a relatively short period of study. Given that prior studies are mostly affected by limited samples and inadequate liquidity proxies, Ali, Liu, and Su (2017) examine an influence of a corporate governance quality index on various types of liquidity measure by using 1,207 Australian listed firms during the period of 2001–2013. They show a positive relationship between corporate governance and stock liquidity.

3. Methodology

3.1 Data

In this study, we use annual data, as corporate governance indices provided by the Thai Institute of Directors are publicly available on a yearly basis. The indices are generally used by mutual funds with good-governed company investment objectives. Additionally, monthly data are employed for the calculation of stock illiquidity in the Stock Exchange of Thailand. The data are obtained from Thomson Reuters Eikon, comprising 364 companies (2,977 firm-year observations) for the period of 2006–2017.

We adopt the stock illiquidity measure suggested by Amihud (2002) as follows.

$$ILLIQ_{iy} = \frac{1}{D_{iy}} \sum\nolimits_{t=1}^{D_{iy}} \left| R_{iyd} \right| / VOLD_{iyd} \, , \tag{1}$$

where R_{iyd} represents the return on stock i on day d in year y, $VOLD_{iyd}$ is the respective daily trading volume, and D_{iy} is the number of trading days of stock i in year y. Firm characteristics as control variables in the model below include total assets, stock price, stock returns, stock return volatility, firm age, and institutional ownership.

3.2 Panel random-effects linear regression model

This study employs a panel random-effects linear regression model in order to analyze an impact of a firm's level of corporate governance on its level of stock illiquidity. Following Chung et al. (2010) and Lei et al. (2013), the panel random-effects regression model is presented as

$$ILLIQ_{it} = X_{it}\beta + u_{it} \tag{2}$$

And $u_{it} = v_i + \varepsilon_{it}$, $i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$,

where *ILLIQ* is the Amihud's (2002) illiquidity measure, and X_{it} is the matrix of independent and control variables.
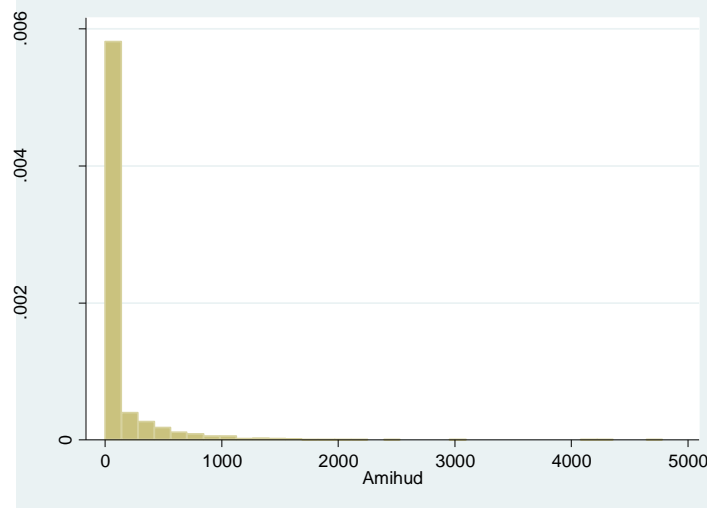
$$X_{it} = \left[GovIndex_{it} \quad \frac{1}{price_{it}} \quad Return_{it} \quad Volatility_{it} \quad FirmSize_{it} \quad Age_{it} \quad TradingVolume_{it} \quad InstOwn_{it} \right] \tag{3}$$

GovIndex$_{it}$ is the corporate governance index of stock i in year t, which is provided by the Thai IOD; *Price$_{it}$* is the price of stock i in year t; *Return$_{it}$* is the return of stock i in year t; *Volatility$_{it}$* is the stock return volatility of stock i in year t; *FirmSize$_{it}$* represents firm size, which is measured by the total assets of stock i in year t; *Age$_{it}$* is the firm age of stock i in year t; *TradingVolume$_{it}$* is the trading volume of stock i in year t; *InstOwn$_{it}$* is non-institutional ownership of stock i in year t; v_i is the cross-sectional random effects of stock i; and ε_{it} is the stochastic random error term of stock i in year t.

3.3 Panel random-effects Tobit model

However, because the dependent variable, $ILLIQ_{it}$ (illiquidity ratio), shows a positively skewed distribution with extreme values, a random-effects upper bound Tobit model is employed to avoid possible biased results. Figure 1 depicts the distribution of the Amihud's stock illiquidity ($ILLIQ_{it}$), which obviously shows a positively skewed distribution.

Figure 1: Histogram of the Amihud's Illiquidity Measure ($ILLIQ_{it}$)

Source: Author's calculations.

The random-effects upper bound Tobit model is presented as

$$ILLIQ_{it} = \begin{cases} X_{it}\beta + u_{it} & if \ ILLIQ_{it} < \lambda \\ \lambda & if \ ILLIQ_{it} \geq \lambda \end{cases} \tag{4}$$

$$\text{and } u_{it} = V_i + \varepsilon_{it}$$

where λ represents the upper limit censored point. Maximum likelihood estimation using the Gauss–Hermite quadrature method is employed.

3.4 Panel fixed-effect quantile regression model

We employ a panel fixed-effect quantile regression model as an alternative to cope with the positively skewed distribution of the dependent variable as shown above, which is

$$Q_\tau(ILLIQ_{it}) = \alpha_i + X_{it}\beta_\tau + \varepsilon_{it} \tag{5}$$

where $Q_\tau(ILLIQ_{it})$ represents the τ quantile of *ILLIQ* of stock *i* at year *t*, and α_i is a cross-sectional fixed effect. Markov Chain Monte Carlo (MCMC) methods are employed for the estimation, which help provide more robust estimated results (both estimated coefficients and standard errors).[1]

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[1]An inclusion of firm specific fixed-effects causes incidental parameters problem leading to multidimensional functions and computational complexity, which rely heavily on restrictive assumptions on how the fixed effects affect the quantiles. The generalized quantile regression estimation approach has an advantage of being easy to implement even in large problems and it allows the individual effects to affect the entire distribution rather than being just location shifters (Powell, 2014). Additionally, since

3.5 Robustness

Goodman and Kruskal's gamma is employed as a nonparametric test to examine the robustness of the results. This method attempts to test the rank correlation between two ordinal variables. Given that the Thai IOD corporate governance index is measured as an ordinal-level variable, rank-order correlation is an appropriate technique for investigating the relationship. The procedure is as follows. First, *ILLIQ* is transformed from a ratio-level measure to an ordinal-level measure based on its quartile, to *ILLIQ_Level*, with values ranging from one to four. Second, Goodman and Kruskal's gamma of the rank correlation between *GovIndex* and *ILLIQ_Level* is then computed and determined as follows.

$$Gamma = \frac{N_c + N_d}{N_c - N_d} \qquad (6)$$

where *Gamma* is the rank correlation with values between minus one and positive one; N_c is the total number of concordant pairs; and N_d is the total number of discordant pairs.

Additionally, a multivariate analysis of the ordinal-level measure of the Amihud's illiquidity, i.e., *ILLIQ_Level* is estimated using the random-effects ordered Probit model. The model is given as

$$I_{it} = X_{it}\beta + u_{it} \qquad (7)$$

and $u_{it} = v_i + \varepsilon_{it}$

$$
\begin{aligned}
\Pr(ILLIQ\_Level_{it} = 1) &= \Phi(I_{it} + \tau_1) \\
\Pr(ILLIQ\_Level_{it} = 2) &= \Phi(I_{it} + \tau_1 + \tau_2) - \Phi(I_{it} + \tau_1) \\
\Pr(ILLIQ\_Level_{it} = 3) &= \Phi(I_{it} + \tau_1 + \tau_2 + \tau_3) - \Phi(I_{it} + \tau_1 + \tau_2) \\
\Pr(ILLIQ\_Level_{it} = 4) &= 1 - \Phi(I_{it} + \tau_1 + \tau_2 + \tau_3)
\end{aligned}
\qquad (8)
$$

where I_{it} is a latent variable of the ordered probit model, $\Phi(.)$ is the cumulative normal probability distribution function, τ_j is the threshold value at the level *j*, and *j* = 1, 2, 3. Maximum likelihood estimation using the Gauss–Hermite Quadrature method is employed.

Furthermore, since the Thai IOD revised and improved its CG indices in 2011 by including more aspects of board responsibility and sustainability of the listed companies into index evaluation,[2] sub-period analyses of 2007-2011 and 2012-2017 are separately investigated.

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estimation and calculation of standard errors can sometimes pose numerical challenges, employing Markov Chain Monte Carlo (MCMC) methods help obtain more robust estimated results in terms of both estimated coefficients and their estimated standard errors (Powell, 2016).

[2] In 2011, in order to internationalize the corporate governance score, the Thai Institute of Director (IOD) has raised the standard of CG star followed the ASEAN CG Score Card. A new CGR score card requires more documents on Corporate Governance Report of Thai Listed Companies (CGR), which emphasizes more on roles of stakeholders and board responsibilities and disclosers. For examples, major additional requirements on roles of stakeholders consist of policies and practices to all stakeholders in details, especially on acknowledgements and treatments including, employee business partners, suppliers, business competitors, creditors, environment, and community.

4. Empirical results

Panels A and B of Table 1 show summary statistics of the monthly and annual data, respectively. Mean and median of the Amihud's illiquidity measure between the two frequency datasets differ at the level of corporate governance. Groups with high levels of corporate governance, i.e., 4- and 5-star firms, have low Amihud's illiquidity mean and median values, thereby implying higher liquidity compared with groups with low levels of corporate governance. Additionally, difference between the mean and median of the Amihud's illiquidity measure shows a positively skewed distribution with a large positive extreme value. The positively skewed distribution suggests that the econometric model of the dependent variable should be either a panel random-effects Tobit or a panel fixed-effect quantile regression model.

Descriptive statistics of the control variables, including price inverse, stock return volatility, firm age, firm size, and turnover by volume, show relatively symmetric distributions, as their mean and median values are less different with relatively moderate standard deviations.

Table 1: Descriptive statistics.

Panel A: Annual data

Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
Illiq	2,977	112.7085	3.5022	302.1050	0.0000	4783.2490
CG No-star	811	116.8941	4.1077	280.1586	0.0000	2396.8790
CG 3-star	902	155.8630	6.1194	333.8065	0.0000	4359.7980
CG 4-star	901	92.2577	3.0384	319.4313	0.0002	4783.2490
CG 5-star	363	46.8856	0.2432	183.3089	0.0001	2084.5550
1/Price	2,977	0.4894	0.1980	1.2567	0.0013	33.3333
Return Volatility	2,977	0.0553	0.0287	0.3947	0.0013	12.4128
Firm age	2,977	23.4068	23.8028	8.2900	10.8389	42.9972
Ln(Firm Size)	2,977	15.6822	15.3448	1.6965	11.2037	21.8458
Ln(Volume)	2,977	10.8437	10.8766	4.4799	0.5596	23.5943

Panel B: Monthly data

Variable	Obs.	Mean	Median	Std. Dev.	Min	Max
Illiq	53,479	94.6613	0.5273	356.2681	0.0000	9881.1620
CG No-star	18,752	135.9254	0.7901	438.7916	0.0000	9881.1620
CG 3-star	15,189	104.4503	1.2660	361.5682	0.0000	7774.7830
CG 4-star	14,131	59.6603	0.3453	274.0753	0.0000	5905.4650
CG 5-star	5,407	15.5283	0.1035	92.2504	0.0000	2175.2220
1/Price	53,479	0.7366	0.1905	3.8962	0.0003	100.0000
Return Volatility	53,479	0.0956	0.0510	0.2335	0.0000	15.0625
Firm age	53,479	17.1174	17.2868	8.6402	0.0411	42.6585
Ln(Firm Size)	53,479	11.0066	11.3318	2.8721	1.2321	24.0579
Ln(Volume)	53,479	8.9640	9.6499	3.4891	-2.3026	19.3114

Note: This table shows descriptive statistics of variables employed in this study during the year 2006-2017. Illiq is the Amihud's illiquidity measure. CG-star score is the rating of firm's overall corporate governance by the Thai Institute of Directors. 1/Price is an inverse of stock price. Return Volatility is the standard deviation of stock returns. Firm age is the age of the firm since the IPO date. Ln(Firm Size) is measured by the logarithm of total assets. Ln(Volume) is measured by logarithm of turnover by volume.
Source: Author's calculations.

4.1 Estimated Results of Econometric Models

Estimated annual and monthly results of the random-effects linear, random-effects Tobit, and fixed-effect quantile regression models are illustrated in Table 2. On

the annual basis, the estimated results of the random-effects linear model reveal the positive and significant impact of a 3-star corporate governance score on the Amihud's illiquidity, which is opposite to the direction suggested by the theory, and the insignificant negative impact of 4- and 5-star scores. These unfavorable results may be caused by the positively skewed distribution of the dependent variable (the Amihud's illiquidity).

Table 2: Estimated results of random-effects linear model, random-effects Tobit model, and fixed-effect quantile regression model using annual data.

	RE-Linear	RE-Tobit	FE-QReg
CG 3-star	24.8099 *	0.2229	-1.6147 ***
CG 4-star	-7.0201	-0.4572 **	-12.0614 ***
CG 5-star	-0.3996	-1.3231 ***	-3.2254 ***
1/Price	17.5850 ***	0.4501 ***	23.5305 ***
Return Volatility	49.9615 ***	0.9726 ***	23.6517 ***
Firm Age	-0.7653	-0.0728 ***	0.1354 ***
Ln(Firm Size)	2.1368	0.0753	2.2712 ***
Ln(Volume)	-30.4129 ***	-1.1105 ***	-11.6510 ***
Constant	410.1833 ***	18.1968 ***	
Sigma_u		1.7872 ***	
Sigma_e		3.3717 ***	
N	2977	2977	2977
No Group	364	364	364
Chi-square Test	777.1872 ***	2733.6048 ***	
Overall R^2	0.2075		

Note: RE-Linear, RE-Tobit, and FE-QReg are the random-effects linear model, the random-effects Tobit model, and the fixed-effect quantile regression model, respectively. CG 3-star, CG 4-star, and CG 5-star are dummy variables of the Thai IOD corporate governance index. The dummy variable is equal to one when a firm is rated as 3-star, 4-star, and 5-star, respectively, otherwise zero. 1/Price is an inverse of stock price. Return Volatility is the standard deviation of stock returns. Firm age is the age of the firm since the IPO date. Ln(Firm Size) is measured by the logarithm of total assets. Ln(Volume) is measured by logarithm of turnover by volume. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.
Source: Author's calculations.

The random-effects Tobit and fixed-effect quantile regression models are estimated to cope with this problem. According to the results of the random-effects Tobit model, a 3-star corporate governance score indicates an insignificant positive coefficient whereas 4-star and 5-star scores report significant negative impacts on illiquidity. The negative impact of corporate governance is also confirmed by the estimated results of the fixed-effect quantile regression model. With more robust estimated results of fixed-effect quantile regression model using MCMC model, all corporate governance variables (3-star, 4-star, and 5-star scores) have negative significant impacts on the Amihud's illiquidity. These results imply that good corporate governance can lead to the high stock liquidity. This conclusion is confirmed by the estimated results of all three models using monthly data. Table 3 shows that estimated results of all three models, which illustrate the negative impact of corporate governance index on the Amihud's illiquidity.

Based on the estimated results of the annual and monthly data, all control variables show significant impacts on the Amihud's illiquidity, as suggested by the theory. An inverse of stock price (1/Price), volatility of stock returns (Return Volatility), and size of the firm (Ln[Firm Size]) have a significant positive influence on the Amihud's illiquidity. A change in stock prices is along with a change in a frequency of trades. An increase in the volatility of stock returns results in a reduction in the stock liquidity. Small firms tend to have higher levels of liquidity than bigger firms.

The age of a firm (Firm age) and the stock turnover (Ln[Volume]) have significant impacts on the Amihud's illiquidity. As expected, companies listed for longer periods have more liquidity than those with shorter listed periods. A high stock turnover leads to a low stock liquidity.

Table 3: Estimated results of random-effects linear model, random-effects Tobit model, and fixed-effect quantile regression model using monthly data.

	RE-Linear	RE-Tobit	FE-QReg
CG 3-star	-4.0607**	-0.0453	-2.7144***
CG 4-star	-2.2887	-0.2215***	-3.8422***
CG 5-star	-2.7418	-0.1668**	-4.2833***
1/Price	0.7860***	0.0180***	0.5381***
Return Volatility	149.0707***	1.5877***	370.1578***
Firm age	-0.2912	-0.0500***	-0.3468***
Ln(Firm Size)	2.8783***	0.0410***	0.8160***
Ln(Volume)	-19.7908***	-1.0099***	-5.7240***
Constant	201.7362***	13.2204***	
Sigma_u		2.1887***	
Sigma_e		2.5556***	
N	53479	53479	53479
No Group	364	364	364
Chi-square Test	2527.76***	16356.04***	
Overall R^2	0.1965		

Note: RE-Linear, RE-Tobit, and FE-QReg are the random-effects linear model, the random-effects Tobit model, and the fixed-effect quantile regression model, respectively. CG 3-star, CG 4-star, and CG 5-star are dummy variables of the Thai IOD corporate governance index. The dummy variable is equal to one when a firm is rated as 3-star, 4-star, and 5-star, respectively, otherwise zero. 1/Price is an inverse of stock price. Return Volatility is the standard deviation of stock returns. Firm age is the age of the firm since the IPO date. Ln(Firm Size) is measured by the logarithm of total assets. Ln(Volume) is measured by logarithm of turnover by volume. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.
Source: Author's calculations.

4.2 Robustness Tests

Robustness tests are also performed to confirm the findings in previous sections. Nonparametric annual and monthly results of the Gamma-ranked correlation between the Thai IOD corporate governance index (*GovIndex*) and the level of illiquidity (*ILLIQ_Level*) as shown in Tables 4 and 5 indicate a significant negative rank correlation between the two ordinal-measured variables. Gamma values of −0.1964 and −0.2032 imply that firms with high Thai IOD corporate governance scores shows low values of the Amihud's illiquidity measure (or high liquidity).

The random-effects ordered Probit model is estimated using both annual and monthly data to reconfirm the robustness of the rank correlation as shown in Table 6. The significant and negative estimated coefficients of the corporate governance dummy variables confirm that high corporate governance scores lead to a low rank in the Amihud's illiquidity.

According to the robustness test results shown in Tables 4, 5, and 6, the ordinal-level measure of the illiquidity analyses helps confirm the impact of good corporate governance on the stock liquidity.

Table 4: Frequency of firm-year categorized by the Thai IOD corporate governance Index (*GovIndex*) and level of illiquidity (*ILLIQ_Level*).

GovIndex	ILLIQ_Level				Total
	1	2	3	4	
CG No-star	158	220	213	220	811
	19.5%	27.1%	26.3%	27.1%	100%
CG 3-star	160	217	224	301	902
	17.7%	24.1%	24.8%	33.4%	100%
CG 4-star	230	241	247	183	901
	25.5%	26.8%	27.4%	20.3%	100%
CG 5-star	185	73	61	44	363
	51.0%	20.1%	16.8%	12.1%	100%
Total	733	751	745	748	2,977
	24.7%	25.2%	25.0%	25.1%	100%
					Gamma = -0.1964***

Note: CG 3-star, CG 4-star, and CG 5-star are dummy variables of the Thai IOD corporate governance index. The dummy variable is equal to one when a firm is rated as 3-star, 4-star, and 5-star, respectively, otherwise zero. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Source: Author's calculations.

Table 5: Frequency of firm-month categorized by the Thai IOD corporate governance Index (*GovIndex*) and level of illiquidity (*ILLIQ_Level*).

GovIndex	ILLIQ_Level				Total
	1	2	3	4	
CG No-star	3,421	4,655	4,525	6,151	18,752
	18.2%	24.8%	24.1%	32.8%	100%
CG 3-star	2,091	3,670	4,595	4,833	15,189
	13.8%	24.2%	30.3%	31.8%	100%
CG 4-star	3,240	4,182	3,895	2,814	14,131
	22.9%	29.6%	27.6%	19.9%	100%
CG 5-star	2,109	1,681	1,201	416	5,407
	39.0%	31.1%	22.2%	7.7%	100%
Total	10,861	14,188	14,216	14,214	53,479
	20.3%	26.5%	26.6%	26.6%	100%
					*Gamma = -0.2032***

Note: CG 3-star, CG 4-star, and CG 5-star are dummy variables of the Thai IOD corporate governance index. The dummy variable is equal to one when a firm is rated as 3-star, 4-star, and 5-star, respectively, otherwise zero. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Source: Author's calculations.

In addition, the subperiod analyses shown in Table 7 demonstrate an average change in the Amihud's illiquidity (*ILLIQ*) caused by one-level changes in the Thai IOD corporate governance index (*GovIndex*) during two subperiods (2007–2011 and 2012–2017). During the first subperiod of 2007–2011, cases of one-level changes in the Thai IOD corporate governance scores, i.e., from no star to 3-star, from 3-star to 4-star, and from 4-star to 5-star, have positive means (increase) in the Amihud's illiquidity (102.663, 3.180, and 0.930), with high standard deviations (446.413, 459.553, and 373.120), respectively. Given that the medians of the changes are less than the means, the magnitudes of the changes in the Amihud's illiquidity caused by one-level changes in the Thai IOD corporate governance scores are implied to have a positively skewed distribution with a high positive extreme value (maximum). Based on the second

subperiod of 2012–2017, all cases of one-level changes in the Thai IOD corporate governance scores have negative means (decrease) in the Amihud's illiquidity (−20.514, −35.417, and −4.455), with moderate standard deviation levels (75.107, 131.842, and 22.906), respectively. The medians of the changes are greater than the means, which indicate the negatively skewed distribution of the changes in the Amihud illiquidity with a low negative extreme value (minimum).

Table 6: Estimated results of the random-effects ordered Probit model using annual and monthly data.

Liquidity level	Annual Data	Monthly Data
CG 3-star	0.1079	-0.0499 ***
CG 4-star	-0.0423	-0.0533 ***
CG 5-star	-0.4179 ***	-0.1383 ***
1/Price	0.1218 ***	0.0521 ***
Return Volatility	0.4347 ***	0.5012 **
Firm Age	-0.0263 ***	-0.0394 ***
Ln(Firm Size)	-0.1300 ***	0.0405 ***
Ln(Volume)	-0.3884 ***	-0.6028 ***
τ_1	-8.1586 ***	-7.7730 ***
τ_2	-6.6801 ***	-5.9117 ***
τ_3	-5.1983 ***	-3.9149 ***
Sigma2_u	0.5391 ***	0.8298 ***
N	2977	53479
No Group	364	385
Log-likelihood	-2584.9623	-34739.7548
Overall Chi-square Test	1587.4671	19072.9855
Chi-square-Bar	237.34 ***	8295.53 ***

Note: This table shows the estimation of the random-effects ordered Probit model using annual and monthly data. CG 3-star, CG 4-star, and CG 5-star are dummy variables of the Thai IOD corporate governance index. The dummy variable is equal to one when a firm is rated as 3-star, 4-star, and 5-star, respectively, otherwise zero. 1/Price is an inverse of stock price. Return Volatility is the standard deviation of stock returns. Firm age is the age of the firm since the IPO date. Ln(Firm Size) is measured by the logarithm of total assets. Ln(Volume) is measured by logarithm of turnover by volume. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.
Source: Author's calculations.

Table 7: Descriptive statistics of a change in the Amihud's Illiquidity (*ILLIQ*) after a change in the Thai IOD corporate governance index (*GovIndex*) during the periods of 2007-2011 and 2012-2017.

Period	2007-2011			2012-2017		
CG-Change	0 → 3	3 → 4	4 → 5	0 → 3	3 → 4	4 → 5
Firm-year (# obs.)	74	70	32	96	119	71
Mean	102.663	3.180	0.930	-20.514	-35.417	-4.455
Median	67.553	-1.981	-1.563	-0.008	-0.001	-0.001
Std. Dev.	446.413	459.553	373.120	75.107	131.842	22.906
Minimum	-972.357	-1723.934	-569.291	-508.400	-702.241	-146.127
Maximum	1187.658	1390.975	1833.472	12.596	13.193	5.623

Note: 0 → 3 represents the case that the Thai IOD corporate governance score of the firm increases one level from no-star to 3-star. 3 → 4 represents the case that the Thai IOD corporate governance score of the firm increases one level from 3-star to 4-star. 4 → 5 represents the case that the Thai IOD corporate governance score of the firm from 4-star to 5-star.
Source: Author's calculations.

The opposite direction of the impact of the improvement of corporate governance during the first subperiod of 2007–2011 and the second subperiod of 2012–2017 indicates that before 2012, the impact of the improvement of corporate governance scores does not

help increase the liquidity of a stock, but reduces it. After 2012, the improvement of corporate governance scores by one level helps increase the stock liquidity. Therefore, these findings confirm the relationship between good corporate governance and liquidity.

To reconfirm impacts of the improvement of IOD's Corporate Governance Index on level of illiquidity (*ILLIQ_Level*), a dummy variable of Year>2011 and a dummy variable of institution investor and several interaction terms are added into further analysis.

Table 8. Estimated results of random-effects ordered Probit model with year dummy and institution investor dummy variables using annual and monthly data

Liquidity level	Annual Data	Monthly Data
Year>2011	-2.6852 ***	-0.0878 ***
Institution	0.5720	-0.1784
Institution*Year>2011	-0.2069	-0.0802
Institution*Year>2011*CG3	-0.4020 *	-0.1870 *
Institution* Year>2011*CG4	-0.2137 *	-0.3402 ***
Institution* Year>2011*CG5	-0.6428 **	-0.6700 ***
CG 3-star	0.1071	-0.0482 ***
CG 4-star	-0.0393	-0.0707 ***
CG 5-star	-0.2247 *	-0.1568 ***
1/Price	0.0459	0.0685 ***
Return Volatility	0.2405 **	0.4682 **
Firm Age	-0.0105	-0.0305 ***
Ln(Firm Size)	-0.2725 ***	0.0393 ***
Ln(Volume)	-0.2220 ***	-0.6179 ***
τ_1	-10.4558 ***	-7.8755 ***
τ_2	-8.7769 ***	-5.9718 ***
τ_3	-6.4438 ***	-3.9344 ***
Sigma2_u	0.6463 ***	0.8098 ***
N	2977	51445
No Group	364	365
Log-likelihood	-2152.2316	-33050.7787
Overall Chi-square Test	1597.9981	18981.5448
Chi-square-Bar	307.5668 ***	8025.2786 ***

Note: Year>2011 is a dummy variable, which equals to one after the year 2011 (after the improvement of the Thai IOD corporate governance score) and zero otherwise. Institution is a dummy variable of institutional investor ownership, which equal to one for an existence of institution ownership and zero otherwise. CG 3-star, CG 4-star, and CG 5-star are dummy variables of the Thai IOD corporate governance index. The dummy variable is equal to one when a firm is rated as 3-star, 4-star, and 5-star, respectively, otherwise zero. 1/Price is an inverse of stock price. Return Volatility is the standard deviation of stock returns. Firm age is the age of the firm since the IPO date. Ln(Firm Size) is measured by the logarithm of total assets. Ln(Volume) is measured by logarithm of turnover by volume. *, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.
Source: Author's calculations.

Table 8 shows negative significant impacts of interactions of Year>2011, Institution and Corporate governance dummy variables (Institution*Year>2011*CG3, Institution*Year>2011*CG4, Institution*Year>2011*CG5), implying that after the improvement of the Thai IOD corporate governance index, institutional investors are more confident on high CG score firms, then investing more on these firms and leading to high stock liquidity (or lower level (rank) of Amihud's illiquidity).

5. Discussion and Conclusion

This study provides evidence on the relationship between good corporate governance and stock market liquidity. Based on information asymmetry and the adverse

selection, listed companies deliver investors with improved operating performance information by sending signals via good corporate governance practices (Chung et al., 2010; Prommin et al., 2014; Prommin et al., 2016). Satisfactory corporate governance scores of stocks help reduce information asymmetry. Thus, investors are confident in these stocks, thereby trading them and increasing the trading volumes and stock market liquidity.

Contradicting to other studies, this paper considers the positively skewed distribution of the Amihud's stock illiquidity measure by employing random-effects Tobit and fixed-effect quantile regression models to avoid a potential bias of estimated results. Moreover, the findings in this study reveal the significant impact of corporate governance measured by the Thai IOD corporate governance index (no-star, 3-star, 4-star, and 5-star) on stock liquidity, which is in line with previous studies (Chung et al., 2010; Prommin et al., 2014; Prommin et al., 2016). Similar to Chung et al. (2010), the results suggest that listed companies alleviate information-based trading and improve stock market liquidity by raising their corporate governance scores, ultimately helping reduce information asymmetry.

By changing the scale of the measurement of liquidity to the ordinal level, the robustness tests using nonparametric rank correlation and a random-effects ordered Probit model reveal the ordinal-level relationship between the Thai IOD corporate governance scores and the level of liquidity. The findings are remarkably robust to alternative statistical tests and different scales of liquidity measurements.

Additionally, an improvement in corporate governance scores leads to a high stock liquidity. Based on the subperiod analyses, investors in the Stock Exchange of Thailand do not place value on the Thai IOD corporate governance index during the period of 2007–2011, as it shows a positive average change in the Amihud's illiquidity measure. After the year 2011, the Thai IOD improve the construction method of the corporate governance index, which encourages mutual fund managers to use for their portfolio formation and allocation. Thus, the improvement in corporate governance scores during the period of 2012–2017 reveals a negative average change in the Amihud's illiquidity measure, which ultimately increases stock liquidity. Furthermore, similar to previous studies (Foo and Zain, 2010; Chung et al., 2010; Karmani and Ajina, 2012; Chung et al., 2012; Lei et al., 2013), all control variables in the models show impacts on stock liquidity.

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