

University of New Orleans

ScholarWorks@UNO

University of New Orleans Theses and
Dissertations

Dissertations and Theses

Fall 12-17-2011

Analyzing Earnings Management for Cross-listed Firms and Interaction between Two Futures Exchanges

Chia-Sheng Chen

University of New Orleans, fupun@hotmail.com

Follow this and additional works at: <https://scholarworks.uno.edu/td>



Part of the [Corporate Finance Commons](#), and the [Finance and Financial Management Commons](#)

Recommended Citation

Chen, Chia-Sheng, "Analyzing Earnings Management for Cross-listed Firms and Interaction between Two Futures Exchanges" (2011). *University of New Orleans Theses and Dissertations*. 1402.
<https://scholarworks.uno.edu/td/1402>

This Dissertation-Restricted is protected by copyright and/or related rights. It has been brought to you by ScholarWorks@UNO with permission from the rights-holder(s). You are free to use this Dissertation-Restricted in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Dissertation-Restricted has been accepted for inclusion in University of New Orleans Theses and Dissertations by an authorized administrator of ScholarWorks@UNO. For more information, please contact scholarworks@uno.edu.

Analyzing Earnings Management for Cross-listed Firms and Interaction between Two Futures
Exchanges

A Dissertation

Submitted to the Graduate Faculty of the
University of New Orleans
in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy
in
Financial Economics

by

Chia-Sheng Chen

B.S. Providence University, 2003
M.S. University of Wisconsin in Milwaukee, 2006
M.S. University of New Orleans, 2009

December, 2011

Copyright©2011, Chia-Sheng Chen

Dedication

To my parents, Mei-Yun Chiou and Jin-Chiuag Chen

Acknowledgements

I sincerely thank to my chairs and committee members for their advice and guidance. I appreciate for Dr. Wei's support and encouragement. I also appreciate the comments from Drs. Tarun Mukherjee, Gerald Whitney, Wei Wang, and Yun-Chia Yan. This research would not have been possible without all my professors' support. Lastly, I would like to thank to my parents, sisters, and husband, who share my joy and sadness during the PhD program.

Table of Contents

List of Tables	vii
List of Figures	viii
Abstract	ix
Essay I: Earnings Management of Foreign Firms in the U.S.	1
1. Introduction.....	1
2. Literature Review.....	5
2.1 Earnings Management and Investor Protection	5
2.2 Cross-listing and Investor Protection.....	7
2.3 Accounting Standards	8
3. Data and Methodology.....	10
3.1 Sample and Data Sources.....	10
3.2 Measures of Earnings Management.....	11
3.3 Measures for Investor Protection and Market Monitoring	12
3.4 Hypotheses and Methodology.....	13
4. Results.....	17
4.1 Earnings Management across Firms and Countries.....	17
4.2 Summary Statistics.....	18
4.3 Univariate Analysis.....	21
4.4 Market Comparisons and Comparison of Pre and Post Listing Earnings Management	24
4.5 The Roles of Investor Protection, Market Monitoring, and Liquidity in Earnings Management: Regression Analyses	30
4.6 Country-Level Regression	37
5. Conclusions.....	40
6. Appendix A The Progress of IFRS	42
7. Appendix B Characteristics of Home Countries for Cross-listed Firms.....	43
8. Appendix C Measures of Earnings Management by Region.....	47
9. Appendix D Correlation of Earnings Management, Investor Protection, and Market Monitoring	48
10. Appendix E Correlation of Earnings Management and Control Variables	49
11. Appendix F Univariate Analysis of Home country (Home) and the U.S. Market (ADR): By country.....	50
12. Appendix G Comparison of Pre-listing Period and Post-listing Period by Country	53
13. References.....	56
Essay II: Does A More Liquid Currency Futures Market Tend to be More Informative.....	60
1. Introduction.....	60
2. Literature Review.....	62
2.1 Liquidity and Information Discovery	62
2.2 Return and Volatility Spillovers	64
2.3 Currency Spot and Futures Markets	65
3. Data.....	66
4. Methodologies.....	69
4.1 Estimating Information Share	69

Table of Contents

4.2 Role of Trading Characteristics on Information Share	71
5. Results.....	72
6. Conclusions.....	82
7. Appendix A EURO/USD Currency Futures Contract Specifications.....	84
8. References.....	85
Vita.....	88

List of Tables

Tables for Essay I: Earnings Management of Foreign Firms in the U.S	
Table 1 Variables Description	16
Table 2 Descriptive Statistics of Earnings Management Measures	19
Table 3 Measures of Earnings Management by Country.....	20
Table 4 Summary Statistics of Investor Protection, Market Monitoring, and Control Variables.....	22
Table 5 Univariate Analysis of Investor Protection and Earnings Management.....	25
Table 6 Univariate Analysis of Market Monitoring and Earnings Management.....	26
Table 7 Effects of Accounting Standards	27
Table 8 Comparison of Home Country and the U.S. Market	28
Table 9 Comparison of Pre-listing Period and Post-listing Period	29
Table 10 Comparison of Stocks Listed in U.S Major Stock Markets and OTC.....	30
Table 11 Regression Analysis of Earnings Manage	32
Table 12 Regression Analysis of Earnings Management with Fixed Effect	34
Table 13 Regression Analysis of Earnings Management with GMM Estimation.....	35
Table 14 Regression Analysis of Earnings Management with Interaction Terms.....	36
Table 15 Country Level Regression Analysis of Earnings Management	38
Table 16 Country Level Regression Analysis of Earnings Management with GMM Estimation	39
Tables for Essay II: Does A More Liquid Currency Futures Market Tend to be More Informative	
Table 1 Summary Statistics of Prices	67
Table 2 Average Number of Quotes per Hour on CME and ICE.....	68
Table 3 Information Shares of CME.....	73
Table 4 Summary Statistics of Liquidity Variables	80
Table 5 Regression Analysis of Share of Price Discovery	81

List of Figures

Figures for Essay II: Does A More Liquid Currency Futures Market Tend to be More Informative

Figure 1 Hasbrouck Information Share.....	74
Figure 2 CME and ICE EURO/USD Futures Volume of Quotes.....	75
Figure 3 CME and ICE EURO/USD Futures Quoted Spread	76
Figure 4 CME and ICE EURO/USD Futures Price Volatility.....	78

Abstract

The first essay examines the impact of investor protection, market monitoring, and liquidity on the firm-level and country-level earnings management using a sample of 432 firms from 34 countries cross-listed in the U.S. The major findings are as follows: First, cross-listed firms from countries with strong legal system, strong outside investor rights, more institutional investors, and higher financial transparency are less likely to engage in earnings management. In addition, in countries with strong investor protection or market monitoring, the level of earnings management is more pronounced for illiquid firms as compared to liquid firms. Second, cross-listed firms following IFRS have lower propensity in earnings management than those following the U.S. GAAP. Third, the degree of earnings management for cross-listed firms is greater in the home country than in the U.S. market. Fourth, cross-listed firms have higher earnings management in the pre-listing period than in the post-listing period. Fifth, foreign firms listed in U.S. major markets have lower propensity to engage in earnings management than those listed in the OTC market. The findings remain robust with the inclusion of industry fixed effects and GMM estimation. All findings are largely consistent with my hypotheses that better investor protection, greater market monitoring, and higher liquidity reduce the extent of earnings management.

The second essay examines the relative contribution to price discovery process of EURO/USD currency futures traded on two major exchanges: Chicago Mercantile Exchange (CME) and Intercontinental Exchange (ICE), using the intraday data in 2010. The relative contribution to price discovery is estimated using the information share approach of Hasbrouck (1995). Empirical findings indicate that CME accounts for approximately 87% of price discovery in the EURO/USD market and its contribution is substantially larger in the morning

than that in the afternoon. This study also examines the effect of trading characteristics, including volume, quoted bid-ask spread, and price volatility, on information share. CME's price discovery leadership is attributed to its high trading activity, low transaction costs, and lower volatility. The results support the liquidity hypothesis that a market with greater liquidity contributes more to price discovery.

Keywords: Earnings Management, Market Monitoring, Cross-listed Firms, Information Share, Liquidity

1. Introduction

Earnings management refers to the manipulation of earnings by corporate managers, motivated by either managerial self-interests or by financing needs.¹ Several studies suggest that earnings management can be mitigated by a country's strong legal protection of investors. More specifically, Leuz, Nanda, and Wysocki (2003), Shen and Chih (2007), Nabar and Boonlert-U-Thai (2007), Cahan, Liu, and Sun (2008), and Chin, Chen, and Hsieh (2009) compare the extent of earnings management across countries and generally find that countries with stronger degrees of legal protection tend to be associated with lesser degrees of earnings management. This paper extends the studies in three ways, as discussed below.

First, the study restricts the sample firms to international firms cross-listed in the U.S.² The advantage of analysing cross-listed firms is that cross-listed firms represent a more homogeneous group and a cleaner sample. This is so because they are likely larger,

¹ Studies generally view that earnings management is motivated by capital market motivations (Cotton, 2008; Perry and Williams, 1994; DeAngelo, 1988) or contracting motivations (Cheng and Warfield, 2005; Healy and Wahlen, 1999; Watts and Zimmerman, 1978). For heavily regulated industries, regulatory motivations are also important (Beatty et al. 1995; Collins et al., 1995). Managers have incentives to deviate shareholder's interests to control more private benefits. The contracting hypothesis argues that when managers have more discretionary powers to control private benefits, managers are more likely to engage in managing earnings. Cheng and Warfield (2005), Bergstresser and Philippon (2006), and Baker, Collins, and Reitenga (2003) document a relation between earnings management and equity-incentives: that managers are more likely to engage in earnings management when their compensation is stock- or option-based. This implies that managers manage reported earnings not only to control private benefits but also to communicate incorrect information on firm performance to stakeholders. Specifically, managers will reveal favorable performance but conceal unfavorable performance from stakeholders through their accounting discretion.

² Foreign firms can be listed in US major stock exchanges (NYSE, NASDAQ, and AMEX) or in the over-the-counter (OTC), and stocks traded in the OTC are subject to a lesser degree of regulation. Hence, it is hypothesized that earnings management tends to be greater for stocks traded in OTC. However, this test is doable only if data for a sufficient number of OTC stocks is available. These cross-listed shares are also called American Depository Receipts (ADRs), classified into four categories. Level 1 share can only be traded on the OTC market. Level 1 does not require full SEC registration and the company does not have to report its accounts under U.S. Generally Accepted Accounting Principles (GAAP) or provide full Securities and Exchange Commission (SEC) disclosure. Level 2 shares must file a registration statement with the SEC and is subject to SEC regulation. Level 3 shares have the same features as level 2 except that Level 3 can issue shares to raise capital. Level 4 stocks operate under Rule 144A and Regulation S without SEC regulation. Only Levels 2 and 3 can be listed on U.S. stock exchanges, such as NYSE, NASDAQ, and AMEX, and are regulated by the SEC.

internationally known, have less information asymmetry, and face similar accounting standards and liquidity for their shares listed in the U.S. This cleaner sample might produce cleaner results. Leuz et al. (2003) acknowledge potential problems in their study such as different accounting standards in different countries. The problem of different accounting standards is non-existing for cross-listed shares that need to follow the US listing and accounting standards to be listed. Moreover, some studies have documented wide cross-country variations in terms of information asymmetry (Bhattacharya and Daouk, 2002; Jin and Myers, 2006), market liquidity (Lesmond, 2005), accounting standards (Speidell and Bavishi, 1992), degree of investor protection (Dyck and Zingales, 2004; Djankov, La Porta, Lopez-de-Silanes, and Shleifer, 2008), and concentration of firm size. For instance, Speidell and Bavishi (1992) study the 900 largest global companies, and conclude that differences in accounting standards can result in considerable differences in earnings.³ Lesmond (2005) shows large cross-country variations in bid-ask spreads; for instance the bid-ask spread averages 1% in Taiwan and 47% for the Russian market. Furthermore, information asymmetry around the world's equity markets can be partially explained by the differences of insider trading laws and enforcement (Bhattacharya and Daouk, 2002).

Second, in addition to legal protection, this study also examines whether the extent of institutional holdings, number of financial analysts, the degree of audit quality, and stock liquidity can affect earnings management. The rationale to include these is that it is reasonable to expect that managers might be more (less) hesitant to practice earnings management when outside monitoring is strong (weak). As suggested by Ferreira and Matos (2008), institutional investors prefer to invest in firms or countries with strong corporate governance. A country with high percentage of institutional holdings indicates increased governance of firm management.

³ For example, after the adjustment to the international standard, the net change in income increases by 60% and 40%, respectively, for Sweden and Germany companies.

The number of analysts is a proxy for the amount of private information acquired by financial analysts because financial analysts specialize in interpreting firms' financial reports and collecting information from stakeholders. Audit quality is a measure of the credibility of financial disclosures (Bushman, Piotroski, and Smith, 2004). Enhanced audit quality or more number of analysts indicates higher financial transparency. High equity market liquidity implies that more investors participate in the market. A firm or country with high liquidity has more investors to monitor its performance. Since greater institutional holdings, the number of analysts following, audit quality, and liquidity typically reflect greater capital market monitoring, I incorporate these four factors in the analysis. It should be emphasized that legal protection and market monitoring is not necessarily correlated. For example, Switzerland and Finland are under the civil law which tends to be associated with weak legal investor rights but their degree of market development is high (La Porta et al., 1998; Djankov et al., 2008).⁴ The hypothesis here is that firms in countries with strongest investor protection, market development, institutional holdings, financial transparency, and high liquidity are less likely to practice earnings management.

Third, firms often follow either International Financial Reporting Standards (IFRS) or U.S. Generally Accepted Accounting Principles (GAAP). The former is a "principle-based" approach so it emphasizes that the accounting disclosures fairly represent the company's financial position. For instance, IFRS requires firms to recognize losses in a timely manner. The latter is a "rule-based" approach and therefore emphasizes regulatory compliance. Overall, IFRS requires publicly traded companies to reveal their accounting information to investors in a

⁴ Legal aspect alone might not completely explain cross-country variations in earnings management. Since legal system rarely changes, it is difficult to explain variations of earnings management across firms in the same country.

correct and efficient manner. It is reasonable to expect that firms from countries that follow IFRS are less likely engaged in earnings management. However, Holthausen (2009) argues that even if all countries follow the same accounting standards, the financial reporting outcomes across countries would not be similar unless the institutional, economic, and regulatory forces that govern the quality of financial reporting become similar as well. Thus, legal system, market monitoring, or accounting standards alone would not be sufficient to discourage manipulation of accounting reports. All these three forces are important to explain variations in earnings management across firms and across countries.

Fourth, cross-listed firms produce financial statements for both their home countries and the U.S. market. I compare statements from the same set of firms across countries. As indicated by Ferreira and Matos (2008), institutional ownership in the U.S. accounts for 65.7 percent per market capitalization, which is the highest among 27 countries. Doidge, Karolyi, and Stulz (2004) conclude that foreign firms cross-list shares in the U.S. partly because of strong investor protection. Therefore, U.S. is likely the country where the combined level of investor protection, market development, and institutional holdings is the strongest. I hypothesize that the degree of earnings management is less for statements reported in the U.S.

As a summary, the empirical evidence indicates the following: First, cross-listed companies from the countries with weak legal protection, institutional monitoring, financial transparency, and lower liquidity are more likely to engage in earnings management. Second, in countries with strong investor protection and market monitoring, illiquid cross-listed firms are less hesitant to engage in earnings management than liquid ones. Third, cross-listed firms using IFRS accounting standards have lower level of earnings management than those using U.S.GAAP. Fourth, the degree of earnings management for cross-listed firms is greater in the

home country than in the U.S. Fifth, cross-listed firms have higher earnings management in the pre-listing period than in the post-listing period. Last, foreign firms cross-listing shares in U.S. major stock markets have lower propensity to engage in earnings management than those firms cross-listed in the over-the-counter (OTC) market. Some additional tests that are more limited in scope include a pooled time-series cross-sectional analysis; these are more limited in scope because earnings reports are low-frequency data, hence not well-suited for time series analysis.

This study is also related to Lang, Raedy, and Wilson (2006), who compare earnings management between cross-listed firms and U.S. firms. They find that cross-listed firms tend to be more associated with earnings management than U.S. firms. Since U.S. firms and ADRs are subject to the same regulation, this finding implies that factors other than regulation affect the extent of earnings management, and it is hypothesized here that outside monitoring and market development are some of those other factors. While Lang et al. also analyze cross-listed firms, they primarily investigate the difference between US firms and ADRs. That is, their study does not directly compare cross-listed firms with strong and weak investor protections.

The remainder of this paper is organized as follows: Section 2 reviews literature regarding investor protection and earnings management. Section 3 describes the data, hypotheses, and the methodology. Section 4 discusses empirical results, and Section 5 concludes the paper.

2. Literature Review

2.1 Earnings Management and Investor Protection

In a seminal paper, La Porta et al. (1998) find that the degree of investor protection is associated with the country's legal system, country development, and ownership concentration. Weak investor protection can provide managers more discretion in earnings reporting and more opportunities in acquiring private benefits. The relation between earnings management and

investor protection has been studied by Leuz, Nanda, and Wysocki (2003), Shen and Chih (2007), Nabar and Boonlert-U-Thai (2007), Cahan, Liu, and Sun (2008), and Chin, Chen, and Hsieh (2009). These studies are described next.

Leuz, Nanda, and Wysocki (2003) investigate 31 countries over the period of 1990 to 1999. They separate the countries into three categories: insider economies with weak legal system, insider economies with strong legal system, and outsider economies with strong legal system. The aggregate earnings management index is constructed by both earning smoothing and earning discretion measures. The results show that minority investor protection and legal enforcement have significant effects on earnings management. In particular, outsider economies with strong investor protection lower the level of earnings management. Shen and Chih (2007) analyze the relation between corporate governance and earnings management in Asian Emerging markets from April 2001 to February 2002. They employ corporate governance index that covers seven categories: management discipline, transparency, independence, accountability, responsibility, fairness, and social awareness. The results indicate a negative relation between corporate governance and earnings management; that is, good corporate governance can mitigate the degree of earnings management. Also, strong anti-director rights are negatively associated with earnings management, which is consistent with Leuz et al. (2003). Finally, they find that large firms or growth firms are prone to engage in earnings management.

Several other studies also look at earnings management across countries, although with a different focus. Nabar and Boonlert-U-Thai (2007) study the impact of investor protection and culture on earnings management. Using a sample of firms in Taiwan, Chin, Chen, and Hsieh (2009) document a positive relation between corporate international exposure and earnings management. The level of earnings management tends to be less if a firm has assets in countries

practicing common law or countries with high investor protection. Cahan, Liu, and Sun (2008) study 44 countries over the period of 1993 to 2002. Similar to previous evidence, they find that firms operating in countries with weak investor protection engage more in earnings smoothing; in addition, they find that firms in countries with strong investor protection are aimed to convey private information about future earnings.

2.2 Cross-listing and Investor Protection

Several studies including those of Coffee (1999), Stulz (1999), Black (2001), Abdallah and Goergen (2008), and Roosenboom and Dijk (2009) hypothesize a bonding effect by cross-listing: foreign firms, especially firms from countries with weak investor protection, choose to cross-list their shares in countries with higher investor protection standard to enhance minority shareholders rights. Supposedly, cross-listed firms on U.S. major exchanges are subject to stringent U.S. laws and SEC regulations, and therefore under strong corporate governance.⁵ Roosenboom and Dijk (2009) analyze valuation effects of cross-listing using a sample of 526 cross-listings from 44 different countries on eight major stock exchanges. Cross-listing on US exchanges generate a relatively high average return of 1.3% around the announcement date comparing to cross-listing on London Stock Exchange, continental Europe, and Tokyo Stock Exchange. Greater value creation by cross-listing on U.S. exchanges can be explained by better

⁵ There still exist a controversy that whether U.S. regulations indeed improve corporate governance of cross-listed firms. In practice, reputation bonding is more pronounced than regulatory bonding as documented by Siegel (2005), Lang, Raedy, and Wilson (2006), and Burns, Francis, and Hasan (2007). Siegel (2005) find that the SEC regulations have not effectively enforced on cross-listed firms. Burns, Francis, and Hasan (2007) argue that the importance of regulatory bonding is more limited than expected. Lang, Raedy, and Wilson (2006) show that under SEC regulation, cross-listed firms from countries with weak investor protection still exhibit higher earnings management than the matched U.S. firms. This implies that the bonding mechanism is not strongly effective. Further, Abdallah and Ioannidis (2010) study the motivation of cross-listing in US using the sample of 1165 cross-listed firms from 47 countries over the period of 1976-2007. Evidence does not support the investor protection hypothesis.

investor protection and improved information disclosure. The degree of investor protection might depend on the destination market. Pagano, Randl, Röell, and Zechner (2001) find European firms have the propensity to cross-list in U.S. due to better investor protection, efficient courts and bureaucracy.

O'Connor (2006) uses the change in dividend payout as a proxy for corporate governance. He finds that the dividend payout is negatively associated with the level of investor protection. Investors of cross-listed firms on U.S/ major exchanges are better protected and receive lower ordinary dividend payout than investors of cross-listed firms on OTC or Rule 144a. Conversely, investors of cross-listed firms on OTC or Rule 144a receive sizable dividend as compensation for weak governance.

2.3 Accounting Standards

La Porta et al. (1998) contend that accounting standard is a complement of investor protection. The greater the ability to provide protection to minority investors, the less discretion in accounting managers can exercise. The Center for International Financial Analysis and Research rate the quality of accounting standards based on general information, income statement, balance sheet, cash flow statement, accounting standards, stock data, and special items. Countries with better accounting standards have dispersed ownership and thereby better investor protection. It implies that high quality of accounting standards effectively lowers the degree of earnings management. Barth, Landsman, and Lang (2008) find significant improvement of accounting quality in the pre- and post- the adoption of International Accounting Standards (IAS) in 21 countries.⁶ IAS firms have higher accounting quality and thereby exhibit less earnings

⁶ International Accounting Standards (IAS) is the former name of International Financial Reporting Standards (IFRS).

management than non-IAS firms. Moreover, Lang, Raedy, and Wilson (2006) find even though cross-listed firms on U.S. major exchanges fully comply with the U.S. GAAP, these firms engage in earnings management in a greater degree than comparable US firms. That is, even under the same accounting standards, the degree of earnings management is still dependent on firms' originality.

The effectiveness of IFRS on the quality of accounting reports and more precisely on earnings management is not entirely clear because the adoption of IFRS around the world is still in progress as shown in Appendix A. Several studies including Chen, Tang, Jiang, and Lin (2010), Iatridis (2010), and Zhou, Xiong, and Ganguli (2009) find evidence that the adoption of IFRS reduces the scope of earnings management. Chen, Tang, Jiang, and Lin (2010) investigate the improvement of accounting quality during the pre- and post-adoption of IFRS for all publicly traded firms in fifteen states of the European Union. After controlling for firm characteristics, the quality improvement is primarily attributed to IFRS. Zhou, Xiong, and Ganguli (2009) compare the degree of earnings management for the adopting IFRS firms and non-adopting IFRS firms. They conclude that IFRS-adopting firms are less likely to engage in smoothing earnings mainly due to the requirement of loss recognition in a timely manner. The increase of the quality of accounting information improves transparency. However, other papers related to IFRS and earnings management have the opposite arguments. Jeanjean and Stolowy (2008) examine the first IFRS adopter countries, including Australia, France, and United Kingdom, contending that earnings management remains pervasive, especially France. Management incentives and institutional factors play important roles in financial reporting as well. Van Tendeloo and Vanstraelen (2005) examine the differences of German GAAP and IFRS, concluding that IFRS adopters are not associated with lower earnings management in Germany. Therefore, high

quality accounting standards serve as a necessary condition for high quality information, but not a sufficient condition. This is consistent with the findings of Ball et al. (2003) and Pagano, Randl, Roell, and Zechner (2001).

3. Data and Methodology

3.1 Sample and Data Sources

The sample consists of cross-listed firms in U.S. major stock markets (NYSE, NASDAQ, and AMEX) and over-the-counter market during the period of 2000-2009. The cross-listed firm names, stock ticker and CUSIP, ratio of ADR to ordinary share, listed exchange and level, region, industry, originality, underlying stock exchange, depository bank, and effective date are obtained from the ADR universe on www.adr.com. The sample of cross-listed firms is cross-checked with depository banks, such as Banks of New York Mellon, Citibank, J.P. Morgan Chase, Computershare Trust Co. of New York, Deutsche Bank, as well as the Compustat.

The financial data is from the Compustat North America and Compustat Global. Firms in financial services industry (SIC code: 6000s) and in utility industry (SIC between 4400 and 5000) are excluded from the sample. Firms with government ownership are excluded as well. To be included in the sample, each firm must have financial statements for at least three consecutive years. In this study, the total number of cross-listed firms is 432 from 34 countries. Legal origin, legal enforcement indices, and importance of equity market are taken from La Porta et al. (1998). Outside investor rights index is obtained from Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008). Country average institutional holdings data is available from Ferreira and Matos (2008). The number of financial analysts and the degree of audit quality are obtained from Bushman, Piotroski, and Smith (2004). Appendix B shows the ADRs come from 34 countries with great

variations in terms of the legal systems, institutional holdings, the number of analysts following, and audit quality. The adopted Accounting Standards across countries are from Compustat Global. Daily return data are from Compustat Global Security daily.

3.2 Measures of Earnings Management

Measures of earnings management follow that of Leuz et al. (2003) and Burgstahler and Dichev (1997): 1) the ratio of standard deviation of operating earnings and standard deviation of cash flow from operations; 2) the Spearman correlation between changes in accruals and changes in operating cash flow; 3) the absolute value of firms' accruals scaled by cash flow from operations. More details of these measures are given next.

The first earnings management measure is notated as EM1, a measure of earnings smoothing. This measure is a ratio of the firm-level standard deviation of operating earnings and the firm-level standard deviation of cash flow from operations.

Cash flow from operations = operating earnings – accruals (*eq. 1*)

Accruals_{it} = ($\Delta CA_{it} - \Delta Cash_{it}$) – ($\Delta CL_{it} - \Delta STD_{it} - \Delta TP_{it}$) - Dep_{it} (*eq. 2*)

where ΔCA_{it} = changes in current assets at time t for the ith firm

$\Delta Cash_{it}$ = changes in cash at time t for the ith firm

ΔCL_{it} = changes in current liabilities at time t for the ith firm

ΔSTD_{it} = changes in short-term debt at time t for the ith firm

ΔTP_{it} = changes in income taxes payable at time t for the ith firm

Dep_{it} = depreciation and amortization expense at time t for the ith firm

Second, managers can conceal firm performance from stakeholders using accounting discretion in two ways: understating the reported earnings by increasing accruals or overstating the reported earnings by decreasing accruals. Either case creates a negative correlation between changes in accruals and changes in operating cash flows. The second measure of earnings management, EM2, is the Spearman correlation between changes in accruals and changes in operating cash flow. The higher the magnitude of correlation indicates less of earnings management. The third measure is denoted EM3; it measures the magnitude of accruals, computed as the absolute value of firms' accruals. This measure is scaled by the absolute value of cash flow from operations. The aggregate index of earnings management is constructed by the above three measures. Specifically, each firm is first ranked from high to low level of earnings management for each of three measures. Then, the aggregate earnings management index is calculated by the average of the firm rankings under the three measures. EM1 and EM2 are associated with earnings smoothing while EM3 is associated with earnings discretion.

3.3 Measures for Investor Protection and Market Monitoring

In Leuz, Nanda, and Wysocki (2003), investor protection is ranked by the following six categories: legal origin, legal enforcement, outside investor rights, importance of equity market, ownership concentration, and disclosure index. Each component of investor protection is described in La Porta et al. (1998) and Leuz, Nanda, and Wysocki (2003). Legal origins include common-law, civil-law, Scandinavian, and German-civil-law countries. Legal enforcement includes efficiency of judicial system, the assessment of rule of law, and the corruption index. Outside investor rights refers to the anti-director rights index, composed by proxy by mail allowed, shares not blocked before meeting, cumulative voting, oppressed minority, preemptive

right to new issues, and percentage of share capital to call an extraordinary shareholder meeting. The importance of equity market includes the ratio of the aggregate stock market capitalization held by minorities to gross national product, the number of listed domestic firms relative to the population, the number of IPOs relative to the population.

To measure the extent of market monitoring, I include institutional holdings, number of analysts, and audit quality in the analysis. Accounting standards (IFRS/GAAP) is also used as a proxy for market monitoring because it can be served as a measure of financial transparency.

3.4 Hypotheses and Methodology

The following hypotheses are tested:

H1: Cross-listed companies from the countries with weak legal protection, market development, institutional monitoring, and analyst following, are more likely to engage in earnings management.

H2: In a country with strong investor protection or strong market monitoring, illiquid cross-listed companies are more likely to engage in earnings management than liquid one.

H3: Cross-listed firms using IFRS accounting standards have lower level of earnings management than cross-listed firms using U.S.GAAP.

H4: The degree of earnings management for cross-listed firms is greater in the home country than in the U.S.

In addition, it is reasonable to expect that firms will be more hesitate to practice earnings management after listing in the US. Therefore:

H5: Cross-listed firms have higher earnings management in the pre-listing period than in the post-listing period.

H6: Foreign firms cross-listing shares in U.S. major stock markets have lower propensity to engage in earnings management than those listed in the OTC market.

A cross-sectional regression analysis is used to test the above hypotheses. The dependent variable is the firm-level aggregate earnings management index (*AggEM*). Country-level explanatory variables consist of legal origin (*origin*), outside investor rights (*outsider*), importance of equity market (*equ*), institutional holdings (*inst*), disclosure (*dis*), the number of analysts (*ana*), and audit quality (*aud*). Firm-level explanatory variables consist of stock liquidity, measured by the inverse of Amihud liquidity ratio (*liq*). The Amihud illiquidity ratio is derived by Amihud (2002) and defined as the absolute (percentage) price change per dollar of annual trading volume. Also included are three dummy variables for accounting standards (*IFRS/GAAP* = 0 for GAAP and 1 for IFRS), whether the stock is traded in U.S. market (*us* =1 for U.S. market and 0 for home country), and whether the stock is traded in a U.S. major exchange (*exch* =1 if traded in a major stock market and 0 if traded in OTC). To control for firm characteristics, market-to-book ratio (*mb*), total assets (*at*), and debt to equity ratio (*dr*) are included. To check for robustness, only one of multiple variables of similar nature (e.g., legal origin and outside right) is used in alternative regression specifications. Table 1 provides further details of the

variables and their predicted signs based on my hypotheses. The regression, when all variables are included, is stated as follows.

$$AggEM_i = \alpha_{i,c} + \beta_1 origin_{i,c} + \beta_2 outsider_{i,c} + \beta_3 inst_{i,c} + \beta_4 ana_{i,c} + \beta_5 aud_{i,c} + \beta_6 liq_i + \beta_7 IFRS/GAAP_i + \beta_9 mb_i + \beta_9 at_i + \beta_{10} dr_i + e_{i,c} \quad (eq.3)$$

where i stands for the i^{th} firm in the c^{th} country and e is the error term.

The above regression is purely cross-sectional, mainly because many variables such as legal system seldom underwent a major change. For robustness check, the country-level cross-sectional regression analysis will be presented later.

As an alternative specification, investor protection index is transformed into a dummy that takes the value of 1 for above-average investor protection and 0 otherwise. Each market monitoring variable likewise is transformed in to dummy with value = 1 for strong market monitoring and 0 otherwise. Specifically, the set of dummy variables includes D_origin , $D_outsider$, D_inst , D_ana , and D_aud for legal origin, outside investor rights, institutional holdings, number of analysts, and audit, respectively. The interaction terms of investor protection and liquidity and the interaction terms of market monitoring and liquidity are also included to capture the slope changes.

$$\begin{aligned} AggEM_i = & \alpha_{i,c} + \beta_1 D_origin_{i,c} + \beta_2 D_outsider_{i,c} + \beta_3 D_inst_{i,c} + \beta_4 D_ana_{i,c} \\ & + \beta_5 D_ana_{i,c} + \beta_6 liq_i + \beta_7 D_enforce_{i,c} \times liq_i + \beta_8 D_outsider_{i,c} \times liq_i \\ & + \beta_9 D_inst_{i,c} \times liq_i + \beta_{10} D_ana_{i,c} \times liq_i + \beta_{11} IFRS/GAAP_i + \beta_{12} mb_i + \beta_{13} at_i \\ & + \beta_{14} dr_i + e_{i,c} \end{aligned}$$

(eq. 4)

Table 1 Variables Description

Variable	Symbol	Predicted sign	Variable explanation	Data Source
Legal origin	<i>origin</i>	- (H1)	1: German-civil-law, 2: French-civil-law, 3:Scandinavian-civil-law, 4: Common-law	La Porta et al. (1998)
Legal enforcement	<i>enforce</i>	- (H1)	The index is constructed by three measures: 1. the efficiency of the judicial system, 2. rule of law, and 3. the corruption index.	La Porta et al. (1998)
Outside investor rights	<i>outsider</i>	- (H1)	The anti-director rights index is composed by proxy by mail allowed, shares not blocked before meeting, cumulative voting, oppressed minority, preemptive right to new issues, and percentage of share capital to call an extraordinary shareholder meeting. This is a measure of minority shareholder rights. The index ranges from zero to five.	Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008)
Importance of equity market	<i>equ</i>	- (H1)	It is composed by three variables: 1. the ratio of the aggregate stock market capitalization held by minority shareholders to gross national product, 2. the ratio of listed domestic firms to the population, and 3. the ratio of IPOs to the population.	La Porta et al. (1998)
Institutional ownership	<i>inst</i>	- (H1)	Institutional ownership is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization.	Ferreira and Matos (2008)
Disclosure	<i>dis</i>	- (H1)	The index is evaluated by seven categories, including general information, income statement, balance sheets, cash flow statement, accounting standards, stock data, and special item.	La Porta et al. (1998)
Number of analysts	<i>ana</i>	- (H1)	Number of analysts following the companies in a country	Bushman, Piotroski, and Smith (2003)
Audit	<i>aud</i>	- (H1)	The percentage of firms in the country audited by the big 5 accounting firms. Audit equals 1, 2, 3, or 4 if the percentage ranges between (0, 25%), (25, 50%), (50, 75%), and (75, 100%), respectively.	Bushman, Piotroski, and Smith (2003)
Amihud liquidity ratio	<i>liq</i>	- (H2)	The inverse of the absolute price change per dollar of trading volume	Compustat Global Security Daily
Accounting standards	<i>IFRS/ GAAP</i>	- (H3)	1: IFRS 0: U.S. GAAP	Compustat Global
U.S. market	<i>us</i>	- (H4)	1: U.S. market 0: Home country	Compustat Global and Compustat North America

Table 1 continued

Post-listing	<i>post</i>	- (H5)	1: Post-listing 0: Pre-listing	Compustat Global and Compustat North America
Variable	Symbol	Predicted sign	Variable explanation	Data Source
Exchange	<i>exch</i>	- (H6)	1: U.S. major stock market 0: U.S. OTC	Compustat North America
Market-to-book	<i>mb</i>		Market value of equity over book value of equity	Compustat Global
Total assets	<i>at</i>		Logarithm of total assets	Compustat Global
Debt-to-Equity ratio	<i>dr</i>		Total liability over total stockholder's equity	Compustat Global

where i stands for the i^{th} firm in the c^{th} country and e is the error term.

In other alternative specifications to alleviate potential endogeneity problem, I incorporate a fixed industry effect and Generalized Method of Moments (GMM) estimation into the analysis. Firm and country fixed effects cannot be implemented because the explanatory variables of investor protection and market monitoring in the models are country-level variables. GMM is a commonly used method because GMM estimation does not require any distributional specifications for consistency and its estimated coefficients are consistent, unbiased, and efficient.

4. Results

4.1 Earnings Management across Firms and Countries

The summary statistics for the firm-level EM1, EM2, EM3 and aggregate earnings management index for 432 cross-listed firms for the period from 2000 to 2009 are shown in Table 2. The average aggregate earnings management score is 176.688 and the median is 174.667. The variation across firms is 57.080. The skewness of the aggregate EM is 0.132,

indicating the distribution is not highly skewed. The negative kurtosis of -0.18 shows the distribution has a lower wider peak around the mean and thinner tail.

The country-level degree of earnings management is presented in Table 3.⁷ The first column shows the number of cross-listed firms from each country. The highest aggregate earnings management score falls on India (32.333), followed by Germany (31.000), Portugal (30.667), Japan (30.667), and Greece (30.667). This result might be explained by either weak legal system or weak market monitoring in these five countries. For example, in Japan investor protection is strong but market monitoring is relatively weak. This finding suggests that legal factor alone is not able to explain variations in earnings management. In contrast, countries with the lowest aggregate earnings management score in order are Ireland (5.000), New Zealand (7.667), Australia (9.333), United Kingdom (11.333), and Denmark (13.667). The commonalities of these countries are strong legal protection and high quality of audit. Therefore, the patterns suggest that both investor protection and market monitoring have effects on the degree of earnings management.

4.2 Summary Statistics

Summary statistics of country level investor protection and market monitoring across 34 countries are displayed in Table 4. Panel A of Table 4 presents the investor protection variables, including legal enforcement and outside investor rights. The average legal enforcement is 8.320

⁷ Appendix C reports the earnings management across five regions based on the Morgan Stanley Capital International (MSCI) classification. Five regions include America Emerging, Asia Developed, Asia Emerging, Europe Developed, and Europe Emerging, Israel, and South Africa. Since Cayman Islands and Luxembourg are not included in the MSCI classification, so the number of firms drops to 416 from 432. The Asia Emerging countries have the highest aggregate EM of 212.667, followed by Asia Developed (197.333). On average, European countries have the less earnings management.

Table 2 Descriptive Statistics of Earnings Management Measures

Measures of earnings management are computed for 432 cross-listed firms across 34 countries over the period of 2000 to 2009. The method of computing earnings management measures is based on Leuz, Nanda, and Wysocki (2003). Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for these three earnings management measures.

Measure	Number of firms	Mean	Median	Standard deviation	Skewness	Kurtosis
EM1	432	0.166	0.001	3.995	23.575	554.854
EM2	432	-0.720	-0.829	0.328	1.980	4.448
EM3	432	0.684	0.601	0.575	8.483	107.316
Aggregate EM	432	176.688	174.667	57.080	0.132	-0.180

out of 10.0 and its median is 9.053 out of 10.0, indicating that most countries have efficient judicial system and low corruption index. The outside investor right has the mean of 3.979 out of 5.0 with standard deviation of 1.02, so legal system on average does offer some protection to minority shareholders. Panel B of Table 4 reports summary statistics for the market monitoring variables. The mean of the importance of equity market is 44.256. Variations in the importance of equity market are large and this is partially attributable to the variation in population. For instance, the population in China is approximately 1,400 million so that the importance of equity market is low at 22.11. The average percentage of institutional ownership in a country is 19.459%. The average disclosure quality is 66.378 out of 100.0. The average number of financial analysts following companies in a country is 18. The percentage of firms in a country audited by the large five accounting firms is between 50% and 75%. Overall, it appears that the degree of financial transparency for firms around the world is moderate. Panel C reports the summary statistics of liquidity and control variables. The mean of the Amihud illiquidity ratio indicates that the average price change per dollar of yearly trading volume is 38.932. The standard

Table 3 Measures of Earnings Management by Country

EM1 is a ratio of the country-level standard deviation of operating earnings over the country-level standard deviation of cash flow from operations. EM2 is the Spearman correlation between changes in accruals and changes in operating cash flow. EM3 is a country's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. Aggregate EM is the average of the country rankings for EM1-EM3. There are 432 cross-listed firms from 34 countries.

Country	Number of firms	EM1	EM2	EM3	Aggregate EM
Argentina	7	0.001	-0.637	0.650	18.333
Australia	22	0.005	-0.670	0.478	9.333
Bermuda	5	0.001	-0.833	0.503	17.667
Brazil	35	0.000	-0.895	0.686	29.667
Cayman Islands	5	0.021	-0.632	1.050	20.000
Chile	15	0.000	-0.913	0.542	30.000
China	12	0.000	-0.541	0.594	17.667
Denmark	3	0.000	-0.574	0.283	13.667
Finland	4	0.001	-0.746	0.731	24.667
France	31	0.001	-0.808	0.670	22.333
Germany	23	0.000	-0.902	0.707	31.000
Greece	3	0.001	-0.954	0.704	30.667
Hong Kong	9	0.000	-0.809	0.525	23.333
India	2	0.000	-0.907	0.577	32.333
Indonesia	8	0.000	-0.857	0.684	30.333
Ireland	7	0.055	-0.545	0.479	5.000
Israel	9	0.013	-0.522	0.779	16.000
Italy	7	0.000	-0.792	0.477	20.000
Japan	36	0.000	-0.789	0.674	30.667
Korea	7	0.000	-0.711	0.655	29.333
Luxembourg	6	0.003	-0.413	0.714	16.000
Mexico	18	0.000	-0.692	0.528	17.333
Netherlands	22	0.002	-0.642	0.622	17.000
New Zealand	4	0.004	-0.180	0.575	7.667
Norway	6	0.000	-0.626	0.550	20.333
Portugal	2	0.000	-0.995	0.592	30.667
Russia	7	0.000	-0.282	0.509	11.667
Singapore	2	0.003	-0.603	0.971	20.000
South Africa	10	0.001	-0.780	0.594	21.000
Spain	4	0.000	-0.696	0.618	26.333
Sweden	10	0.000	-0.751	0.609	23.667
Switzerland	11	0.000	-0.841	0.487	19.333
Taiwan	7	0.000	-0.546	0.681	24.667
United Kingdom	73	0.002	-0.616	0.520	11.333

deviation of the Amihud illiquidity ratio is 562.493. The mean of market-to-book is 51.157 and its median is 0.341. The logarithm of total assets has the mean of 11.589 which is equivalent to \$107,904 million of total assets. The mean of debt-to-equity ratio is 2.504, implying that cross-listed firms use more debt financing than equity financing. The correlation statistics are reported in Appendices D and E.⁸

4.3 Univariate Analysis

First, univariate analysis is conducted to examine the relationship between earnings management and investor protection, market monitoring, or liquidity. Multivariate regression analysis will be discussed in section 4.5. For univariate analyses, the sample is split based on the mean and median of each variable to examine any significant differences in earnings management.

⁸ Appendix D shows the correlations of the aggregate earnings management score, investor protection, and market monitoring. Consistent with the first hypothesis, the aggregate earnings management is significantly negatively associated with legal origin, legal enforcement, and outside investor rights. It suggests that cross-listed firms in countries with strong investor protection and legal system have less degree of earnings management. The correlation between the aggregate earnings management and each market monitoring variable is consistent with the first hypothesis as well, suggesting that earnings management is more pervasive in countries with less developed equity market, less institutional monitoring, poor accounting disclosure quality, less analysts followed, and low portion of firms audited by the largest five accounting firms. Among the market monitoring proxies, institutional ownership has the largest and significantly negative correlation (-0.191) with the aggregate earnings management score. The presence of institutional stockholders restrains earnings manipulation by managers who have incentives to report more losses or deter profits. However, the importance of equity market and disclosure are significantly associated with the aggregate earnings management but are highly correlated (approximately 0.5) with legal origin and legal enforcement. Appendix E reports the correlations of earnings management and control variables. The aggregate earnings management index is positively correlated with the Amihud illiquidity ratio, inferring that more liquid cross-listed firms are associated with less earnings management. Market-to-book is positively related to the aggregate earnings management score, indicating that growth firms are inclined to manage earnings. A significant positive correlation between total assets and the aggregate earnings management suggests that large firms are prone to conduct earnings manipulation. However, the correlation between the aggregate earnings management and debt-to-equity ratio is insignificant.

Table 4 Summary Statistics of Investor Protection, Market Monitoring, and Control Variables

Panel A represents descriptive statistics for the investor protection variables. Legal enforcement is an index constructed by La Porta et al. (1998) and is measured by three ways: the efficiency of the judicial system, rule of law, and the corruption index. Outside investor rights is an anti-director index developed by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), ranges from 0 to 5. Panel B represents descriptive statistics for the market monitoring variables. Indexes of the importance of equity market, ownership concentration, and disclosure are from La Porta et al. (1998). Importance of equity market is composed by three variables: 1) the ratio of the aggregate stock market capitalization held by minority shareholders to gross national product, 2) the ratio of listed domestic firms to the population, and 3) the ratio of IPOs to the population. Institutional ownership is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization and is from Ferreira and Matos (2008). Disclosure is evaluated by seven categories, consisting of general information, income statement, balance sheets, cash flow statement, accounting standards, stock data, and special item. Number of analysts is the number of financial analysts following companies in the country. Audit measures the degree of audit quality. Analysts and audit are based upon Bushman, Piotroski, and Smith (2003). There are total 432 cross-listed firms across 34 countries. Panel C reports descriptive statistics for control variables. Amihud illiquidity ratio is defined as $\overline{|ret_d|} \times \overline{\$vol_d} \times 10^6$, where the bar on top of the ratio is the notation for the average. The Amihud illiquidity ratio is the average of daily price impact ratios, and then scaled by 1 million. Market to book is the market value of equity over the book value of equity at the end of firm year. Total assets is the logarithm of total assets. Debt-to-equity ratio is a ratio of total liabilities over total stockholder's equity.

Variable	Number of countries	Mean	Median	Standard deviation	Skewness	Kurtosis
<i>Panel A. Investor protection</i>						
Legal enforcement	28	8.320	9.053	1.535	-0.941	-0.128
Outside investor right	32	3.979	4.000	1.020	-0.831	0.085
<i>Panel B. Market monitoring</i>						
Importance of equity market	33	44.256	35.179	29.395	1.853	5.120
Institutional ownership	22	19.459	20.100	7.002	0.359	-0.476
Disclosure	26	66.378	65.000	9.195	-0.376	-0.149
Number of analysts	29	17.664	18.530	7.400	0.030	-0.304
Audit	29	3.560	4.000	0.706	-1.758	3.015
<i>Panel C. Control variables</i>						
Amihud illiquidity ratio	34	38.932	0.001	562.493	17.232	298.655
Market to book	34	51.157	0.341	1016.179	23.231	543.123
Total assets	34	11.589	10.286	4.692	0.900	0.413
Debt-to-equity ratio	34	2.504	1.394	7.146	14.999	273.698

The first hypothesis is that cross-listed companies from the countries with strong legal protection have less degree of earnings management. The results of the analysis on this

hypothesis are illustrated in Table 5. Panel A of Table 5 compares aggregate earnings management measures in four legal origins, including Common Law, Scandinavian Civil Law, French Civil Law, and German Civil Law. Because the composite earnings index is based on ranks, the difference in the means is tested by the nonparametric Mann-Whitney-Wilcoxon test while the difference in the medians is tested by the nonparametric Median Score test. The means of earnings management for cross-listed firms in countries following German Civil Law (199.291), French Civil Law (181.469), Scandinavian Civil Law (173.886), and Common Law (158.156) jointly are significantly different at the 1% level using the F-test. The medians of earnings management for cross-listed firms in countries with Common Law, Scandinavian Civil Law, French Civil Law, and German Civil Law are 154, 179, 182, and 198.333, respectively. In particular, the aggregate earnings management scores show a descending order from Civil Law to Common Law. This suggests that Common Law offers stronger legal investors' rights and protections than Civil Law does. Panel B of Table 5 presents the means and medians differences based on legal enforcement and outside investor rights. The result shows significant negative differences of earnings management scores between the above- and below-mean and median of legal enforcement; the differences are -8.030 and -14.833, respectively. These results imply that managers' incentives of misreporting earnings are weakened in more efficient judicial system. As for outside investor rights, either the mean (-2.022) or median (-3.667) difference of the earnings management score is negative but only the difference in medians is significant. Therefore, there is some evidence, albeit not strongly, that better investor rights are associated with less earnings management. The univariate analysis of the role of market monitoring on earnings management is reported in Table 6. The difference in means is -25.363, significant at the 1% significance level. The mean differences of the aggregate earnings management scores

for institutional ownership, disclosure, number of analysts, and audit quality are -33.983, -24.551, -30.124, and -8.500, respectively, and significant at the 10% significance level. Consistent with the mean comparisons, the differences in medians of market monitoring variables are also significant at the 1% level and the signs are consistent with the predictions. The results suggest that institutional holding has the highest impact on earnings management. A high level of institutional ownership can effectively reduce the use of discretionary accruals and thereby discourage earnings management. Overall evidence implies that cross-listed firms in countries with highly developed equity market, large portion of institutional ownership, more financial analysts following, and higher percentage of audited firms discourage opportunistic earnings management.

4.4 Market Comparisons and Comparison of Pre and Post Listing Earnings Management

The third hypothesis is that cross-listed firms adopting IFRS accounting standards have lower level of earnings management than those following U.S. GAAP. Univariate results are presented in Table 7. It should be noted that some cross-listed firms follow neither IFRS nor U.S. GAAP but rather their own domestic standards; these firms are excluded in this analysis. The mean and median differences of the aggregate earnings management scores are significant and consistent with the third hypothesis that cross-listed firms adopting the IFRS are less likely to engage in earnings management.

The fourth hypothesis is that, on average, the degree of earnings management for cross-listed firms is expected to be greater in the home country than in the U.S. market because U.S.'s stricter regulation and market monitoring limit the manipulation of accounting information

Table 5 Univariate Analysis of Investor Protection and Earnings Management

The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Panel A is the univariate analysis of Legal origin. Legal origin is created by La Porta et al. (1998) and classifies countries into Common law, Scandinavian civil law, French civil law, and German civil law. The F test is used to test the significance of the joint difference. P-value indicates the significance of the difference.

Panel A. Legal origin

	(1)	(2)	(3)	(4)		
	German civil law	French civil law	Scandinavian civil law	Common law	F-test	P-value
Mean comparison	199.291	181.469	173.886	158.156	66.887	[0.000]
Median comparison	198.333	182.000	179.000	154.000	68.145	[0.000]

Panel B is the univariate analysis of Legal enforcement and Outsider investor rights. The sample is separated by the mean and median values of each investor protection variable to examine the difference of the aggregate earnings management score. Legal enforcement is an index constructed by La Porta et al. (1998) and is measured by three measures: (1) the efficiency of the judicial system, (2) rule of law, and (3) the corruption index. Outside investor rights, an anti-director rights index developed by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008), ranges from 0 to 5. The difference in the means is tested by the nonparametric Mann-Whitney-Wilcoxon test. The difference in the medians is tested by the nonparametric Median Score test. P-value indicates the significance of the difference.

Panel B. Investor Protection

Variable	Above mean (1)	Below mean (2)	Difference (1)-(2)	P-value
<i>Part A. Mean comparison</i>				
Legal Enforcement	173.399	181.430	-8.030	[0.001]
Outsider investor rights	176.346	178.369	-2.022	[0.682]
<i>Part B. Median comparison</i>				
Legal Enforcement	166.667	181.500	-14.833	[0.019]
Outsider investor rights	174.333	178.000	-3.667	[0.066]

Table 6 Univariate Analysis of Market Monitoring and Earnings Management

The sample is separated by the mean and median values of each market monitoring variable to examine the difference of the aggregate earnings management scores. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Importance of equity market is an index which is constructed by La Porta et al. (1998). It is composed by three variables: 1) the ratio of the aggregate stock market capitalization held by minority shareholders to gross national product, 2) the ratio of listed domestic firms to the population, and 3) the ratio of IPOs to the population. Institutional ownership is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization and is from Ferreira and Matos (2008). Number of analysts is the number of financial analysts following the companies in a country. Audit measures the degree of audit quality. Analysts and audit are based upon Bushman, Piotroski, and Smith (2003). The difference in the means is tested by the nonparametric Mann-Whitney-Wilcoxon test. The difference in the medians is tested by the nonparametric Median Score test. P-value indicates the significance of the difference.

Variable	Above mean (1)	Below mean (2)	Difference (1)-(2)	P-value
<i>Part A. Mean comparison</i>				
Importance of Equity Market	161.732	187.096	-25.363	[0.000]
Institutional Ownership	165.785	199.769	-33.983	[0.000]
Disclosure	162.135	186.686	-24.551	[0.000]
Number of Analysts	162.419	192.543	-30.124	[0.000]
Audit	174.823	183.323	-8.500	[0.065]
<i>Part B. Median comparison</i>				
Importance of Equity Market	163.000	188.000	-25.000	[0.000]
Institutional Ownership	164.667	198.333	-33.667	[0.000]
Disclosure	161.333	189.000	-27.667	[0.000]
Number of Analysts	161.333	189.000	-27.667	[0.000]
Audit	174.000	181.667	-7.667	[0.001]

reported to outside investors. This hypothesis is tested by employing three earnings management measures. The result is reported in Table 8.⁹ All the mean and median differences under the four EM measures have the signs as predicted. Recall that the higher the EM1/EM2, the lesser the earnings smoothing; the higher the EM3, the higher the earnings discretion; the higher the aggregate EM, the higher the earnings management. Hence that evidence shows, on average, ADRs are associated with a lower tendency to adopt earnings smoothing and earnings discretion.

⁹ The univariate analysis of Home country and the U.S. market by country is also reported on Appendix F. Cross-listed firms from 28 out of 34 countries have consistent results that the degree of earnings management in ADR is significantly less than that in the Home countries.

Table 7 Effects of Accounting Standards

This table presents the mean and median values of the aggregate earnings management scores between the choice of accounting standards, U.S. GAAP and IFRS. Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Part A is the mean earnings management measure comparison between IFRS and U.S. GAAP. Part B is the median earnings management measure comparison between IFRS and U.S. GAAP. Difference is the aggregate earnings management score of IFRS minus that of U.S. GAAP. T-statistics to test the difference in the means and medians for EM1-EM3 are reported. The nonparametric Mann-Whitney-Wilcoxon test and Median Score test are conducted to test the difference in means and medians of aggregate EM, respectively. P-values are in brackets. The number of firms following IFRS is 189 while the number of firms following U.S. GAAP is 45. The sample period is from 2000 to 2009.

EM measure	IFRS (1)	U.S. GAAP (2)	Difference (1)-(2)	P-value
<i>Part A. Mean comparison</i>				
EM1	0.422	-0.012	0.434	[0.000]
EM2	-0.733	-0.659	-0.075	[0.980]
EM3	0.621	0.768	-0.147	[0.000]
Aggregate EM	165.168	173.024	-7.855	[0.012]
<i>Part B. Median comparison</i>				
EM1	0.000	0.001	0.000	[0.001]
EM2	-0.833	-0.867	0.033	[0.060]
EM3	0.562	0.681	-0.119	[0.000]
Aggregate EM	164.667	169.000	-4.333	[0.010]

The possible explanations are as follows: 1) ADR firms on the U.S. major stock markets must follow the SEC regulations so making earnings management difficult. 2) ADR firms in the U.S. market are protected by strong legal enforcement, investor protection, and market monitoring. The fifth hypothesis provides further support of that the U.S. market does provide powerful legal system and investor protection. If so, then foreign firms should limit the manipulation of earnings after cross-listing shares in the U.S. market. The results comparing pre

Table 8 Comparison of Home Country and the U.S. Market

Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. Part A reports the mean comparison of earnings management measure for Home and ADR. Part B shows median comparison of earnings management measure for Home and ADR. Difference is the earnings management of the ADR market minus the earnings management of the Home market. T-statistics to test the difference in the means and medians between ADR and Home for EM1-EM3 are reported. The nonparametric Mann-Whitney-Wilcoxon test and Median Score test are conducted to test the difference in means and medians of aggregate EM between ADR and Home, respectively. P-values are in brackets. The sample includes 432 firms across 34 countries over the period from 2000 to 2009.

EM measure	ADR (1)	Home (2)	Difference (1)-(2)	P-value
<i>Part A. Mean comparison</i>				
EM1	0.720	0.163	0.557	[0.000]
EM2	-0.505	-0.721	0.216	[0.000]
EM3	1.199	1.879	-0.680	[0.000]
Aggregate EM	176.961	216.884	-39.923	[0.000]
<i>Part B. Median comparison</i>				
EM1	0.886	0.000	0.885	[0.000]
EM2	-0.667	-0.833	0.167	[0.000]
EM3	0.762	0.796	-0.033	[0.001]
Aggregate EM	175.000	217.667	-42.667	[0.000]

and post-listing periods are reported in Table 9¹⁰. This finding implies that the degree of earnings management is higher before cross-listing on the U.S. market.

The sixth hypothesis is that firms listed in U.S. major stock markets have lower propensity to involve in earnings management than those listed in the OTC market because OTC is subject to a lesser degree of regulation. For instance, after the implementation of the Sarbanes-Oxley Act in 2002, several foreign companies, especially for small firms, have switched to OTC

¹⁰ Appendix G displays the degree of earnings management in the pre-listing and post-listing periods by country. The results indicate that the level of earnings management in the pre-listing period is higher than that in the post-listing period for all countries, except Chile and South Africa. Because Chile and South Africa have small number of observations in the pre-listing period, the results are insignificant or inconsistent.

Table 9 Comparison of Pre-listing Period and Post-listing Period

Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Part A is the mean earnings management measure comparison between Pre-listing and Post-listing. Part B is the median earnings management measure comparison between Pre-listing and Post-listing. Difference is the earnings management measure of the Post-listing minus the earnings management measure of the Pre-listing. T-statistics to test the difference in the means and medians for EM1-EM3 are reported. The nonparametric Mann-Whitney-Wilcoxon test and Median Score test are conducted to test the difference in means and medians of aggregate EM, respectively. P-values are in brackets. The sample includes 432 firms across 34 countries over the period from 2000 to 2009.

EM measure	Post-listing (1)	Pre-listing (2)	Difference (1)-(2)	P-value
<i>Part A. Mean comparison</i>				
EM1	0.166	-0.088	0.254	[0.000]
EM2	-0.720	-0.853	0.134	[0.000]
EM3	0.684	1.360	-0.676	[0.000]
Aggregate EM	275.047	298.923	-23.875	[0.000]
<i>Part B. Median comparison</i>				
EM1	0.000	0.000	0.000	[0.000]
EM2	-0.829	-0.967	0.138	[0.000]
EM3	0.601	0.749	-0.147	[0.001]
Aggregate EM	266.667	286.333	-19.667	[0.001]

markets from the NASDAQ to avoid the compliance of tighten regulation, the administrative burden, and costly fees (Kamar, Karaca-Mandic, Talley, 2006; McLean, 2005). This hypothesis is tested using the ADR shares' earnings. The results are reported in Table 10. Both the mean and median differences of the earnings management measure suggest that on average, foreign firms cross-listed in the U.S. major stock market have lower tendency to engage in earnings smoothing and earnings discretion, consistent with my hypothesis.

Table 10 Comparison of Stocks Listed in U.S Major Stock Markets and OTC

This table presents the mean and median values of the aggregate earnings management scores between the choice of the cross-listing exchange markets, the U.S. major stock market and the U.S. over-the-counter (OTC). The method of computing earnings management measures is based on Leuz, Nanda, and Wysocki (2003). Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Part A is the mean earnings management measure comparison between Major Exchanges and OTC. Part B is the median earnings management measure comparison between Major Exchanges and OTC. Difference is the aggregate earnings management score of firms cross-listing on the U.S. major stock market minus that of those firms cross-listing on the U.S. OTC. T-statistics to test the difference in the means and medians for EM1-EM3 are reported. The nonparametric Mann-Whitney-Wilcoxon test and Median Score test are conducted to test the difference in means and medians of aggregate EM, respectively. P-values are in brackets. The number of cross-listed firms in the US major exchanges is 373 while the number of cross-listed firms in the U.S. OTC is 174. The sample period is from 2000 to 2009.

EM measure	Major stock market (1)	OTC (2)	Difference (1)-(2)	P-value
<i>Part A. Mean comparison</i>				
EM1	0.761	0.702	0.059	[0.000]
EM2	-0.449	-0.530	0.081	[0.000]
EM3	0.540	0.577	-0.036	[0.003]
Aggregate EM	176.353	178.432	-2.079	[0.365]
<i>Part B. Median comparison</i>				
EM1	0.925	0.858	0.067	[0.000]
EM2	-0.571	-0.700	0.129	[0.000]
EM3	0.608	0.651	-0.043	[0.075]
Aggregate EM	174.333	175.667	-1.333	[0.574]

4.5 The Roles of Investor Protection, Market Monitoring, and Liquidity in Earnings Management: Regression Analyses

In the previous section, I use the univariate analysis to test the hypotheses and the results are consistent with my predictions. This section discusses results of multivariate regression analyses that investigate the relations between earnings management and investor protection, market monitoring, liquidity, and accounting standards. The dependent variable in the regression

equation is the aggregate earnings management score. The explanatory variables include three categories, investor protection (legal origin and outside investor rights), market monitoring (institutional ownership, number of analysts, and audit quality), and liquidity (Amihud liquidity ratio). To avoid the multi-collinearity problem, variables with similar meaning and high correlations are not included in the same regression. Specifically, the correlation between legal origin and outside investor rights is 53.1%; these variables are not used in the same regression. To account for potential heteroskedasticity, the t values are adjusted based on White (1980).

The regression results are shown in Table 11. In Model 1, legal origin is significantly negatively associated with earnings management, indicating that the degree of earnings management from high to low is German Civil Law, French Civil Law, Scandinavian Civil Law, and Common Law. Institutional ownership, number of analysts, and audit are significantly negatively related with earnings management, suggesting that market monitoring restrains earnings management in an effective manner. Liquidity is significantly negatively associated with earnings management, meaning that liquid cross-listed firms have less earnings management than illiquid firms. Consistent with previous results, large firms are more likely to manipulate earnings than small firms.

To examine the effect of IFRS on earnings management, Model 2 and Model 4 in Table 11 include a dummy variable of accounting standards, IFRS/GAAP. Since not all firms follow either IFRS or U.S. GAAP, the total sample firms drop to 234 after the inclusion of the dummy variable of IFRS/GAAP. The result is consistent with that of Model 1. The negative relation between IFRS/GAAP and the aggregate earnings management index suggests that IFRS reduces the occurrence of earnings management. Both Model 3 and Model 4 use the outside investor rights index as a proxy for investor protection. The results are consistent with those of Models 1

Table 11 Regression Analysis of Earnings Management

The dependent variable is the aggregate earnings management (*AggEM*). Legal origin (*origin*) is based upon La Porta et al. (1998). Outside investor rights (*outsider*) is an anti-director rights index. Institutional ownership (*inst*) is the sum of all institutional holdings in a firm's stock divided by market capitalization. Number of analysts (*ana*) is the average number of financial analysts following companies in a country. Audit (*aud*) measures the degree of audit quality. The Amihud liquidity ratio (*liq*) is defined as the inverse of $|ret_d| \times \$vol_d \times 10^6$. Market to book (*mb*) is the market value of equity over the book value of equity. Total assets (*at*) is the logarithm of total assets. Debt-to-equity ratio (*dr*) is a ratio of total liabilities over total stockholder's equity. Control variables are adjusted by the country's average. There are 432 cross-listed firms across 34 countries. IFRS/GAAP is a dummy variable that equal to one for IFRS and zero for U.S. GAAP. After including the dummy of IFRS/GAAP, the number of firms drops to 234. The subscript *i* and *c* represent the *i*th firm in the *c*th country. *e* is the error term.

$$AggEM_i = \alpha_{i,c} + \beta_1 origin_{i,c} + \beta_2 outsider_{i,c} + \beta_3 inst_{i,c} + \beta_4 ana_{i,c} + \beta_5 aud_{i,c} + \beta_6 liq_i + \beta_7 IFRS/GAAP_i + \beta_8 mb_i + \beta_9 at_i + \beta_{10} dr_i + e_{i,c}$$

Variable	Predicted sign	Model 1		Model 2		Model 3		Model 4	
		Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Constant		211.877	[0.000]	212.516	[0.000]	287.047	[0.000]	291.839	[0.000]
Legal Origin	-	-11.285	[0.000]	-11.713	[0.000]				
Outside investor rights	-					-12.804	[0.000]	-13.610	[0.000]
Institutional ownership	-	-2.030	[0.000]	-1.926	[0.000]	-2.115	[0.000]	-2.028	[0.000]
Number of analysts	-	-0.729	[0.000]	-0.632	[0.001]	-0.579	[0.003]	-0.479	[0.012]
Audit	-	-4.542	[0.016]	-4.990	[0.008]	-4.615	[0.017]	-4.952	[0.010]
Amihud liquidity ratio	-	-1.459	[0.000]	-1.468	[0.000]	-1.392	[0.000]	-1.400	[0.000]
IFRS/GAAP	-			-10.730	[0.000]			-10.991	[0.000]
Market-to-book		1.308	[0.001]	1.276	[0.001]	1.253	[0.001]	1.217	[0.002]
Total assets		6.813	[0.000]	6.990	[0.000]	6.979	[0.000]	7.169	[0.000]
Debt-to-equity ratio		1.682	[0.014]	1.515	[0.026]	1.791	[0.009]	1.625	[0.017]
Adjusted-R ²		0.139		0.145		0.126		0.133	

and 2 that cross-listed firms in countries with strong investor rights, high institutional ownership, and more financial analysts following are less inclined to manage earnings and that cross-listed firms adopting IFRS are less prone to manipulate earnings than cross-listed firms following U.S. GAAP.

To control for potential industry effects, I incorporate a fixed industry effect model to assess the relationship between earnings management and investor protection, market monitoring, and liquidity, reported in Table 12. Overall, cross-listed firms in countries with strong legal system, concentrated institutional ownership, more financial analysts following, high quality of audit, and the adoption of IFRS have lower propensity in managing earnings. Highly liquid cross-listed firms are less opportunistic than illiquid ones in earnings report. In addition, market-to-book, total assets, and debt-to-equity ratio are significantly positively related with earnings management, indicating that firms with high growth opportunity, large size, or high debt financing are more likely to manipulate earnings. In sum, after controlling for industry effects, the relationships between earnings management and investor protection, market monitoring, and liquidity remain evident. As an alternative specification, Table 13 presents GMM estimations. The results remain consistent with the hypotheses.

As another alternative specification, Table 14 transforms investor protection and market monitoring variables into dummies and includes interaction terms with liquidity. The dummy variables are equal to 1 for high investor protection or monitoring and 0 otherwise. The dummy variable of *D_Legal origin* is equal to 1 for common law and 0 for civil law. The evidence shows significantly negative relations between earnings management and legal origin, outside investor rights, institutional ownership, and IFRS/GAAP. Again, this is consistent with the above findings

Table 12 Regression Analysis of Earnings Management with Fixed Effect

The dependent variable is the aggregate earnings management (*AggEM*). Legal origin (*origin*) is based upon La Porta et al. (1998). Outside investor rights (*outsider*) is an anti-director rights index. Institutional ownership (*inst*) is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization. Number of analysts (*ana*) is the average number of financial analysts following companies in a country. Audit (*aud*) measures the degree of audit quality. The Amihud liquidity ratio (*liq*) is defined as the inverse of $|ret_d| \times \$vol_d \times 10^6$. Market to book (*mb*) is the market value of equity over the book value of equity at the end of firm year. Total assets (*at*) is the logarithm of total assets. Debt-to-equity ratio (*dr*) is a ratio of total liabilities over total stockholder's equity. Control variables are adjusted by the country's average. IFRS/GAAP is a dummy variable that equal to one for IFRS and zero for U.S. GAAP. There are 432 cross-listed firms across 34 countries. The subscript *i* and *c* represent the *i*th firm in the *c*th country. *e* is the error term. The industry effect is tested by F test.

$$AggEM_i = \beta_1 origin_{i,c} + \beta_2 outsider_{i,c} + \beta_3 inst_{i,c} + \beta_4 ana_{i,c} + \beta_5 aud_{i,c} + \beta_6 liq_i + \beta_7 IFRS/GAAP_i + \beta_8 mb_i + \beta_9 at_i + \beta_{10} dr_i + e_{i,c}$$

Variable	Predicted sign	Model 1		Model 2		Model 3		Model 4	
		Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Legal origin	-	-6.620	[0.000]	-6.287	[0.000]				
Outside investor rights	-					-0.128	[0.000]	-0.776	[0.000]
Institutional ownership	-	-0.227	[0.000]	-0.100	[0.000]	-0.434	[0.000]	-0.291	[0.000]
Number of analysts	-	-0.969	[0.000]	-0.867	[0.000]	-0.533	[0.000]	-0.438	[0.000]
Audit	-	-5.015	[0.000]	-3.964	[0.000]	-4.346	[0.000]	-3.685	[0.000]
Amihud liquidity ratio	-	-1.372	[0.000]	-1.390	[0.000]	-1.358	[0.000]	-1.381	[0.000]
IFRS/GAAP	-			-6.807	[0.000]			-8.085	[0.000]
Market-to-book		0.765	[0.000]	0.826	[0.000]	0.765	[0.000]	0.839	[0.000]
Total assets		4.416	[0.000]	4.394	[0.000]	4.421	[0.000]	4.389	[0.000]
Debt-to-equity ratio		2.288	[0.000]	2.115	[0.000]	2.238	[0.000]	2.037	[0.000]
Adjusted-R ²		0.057		0.063		0.036		0.044	
F-test		15.889	[0.000]	15.340	[0.000]	15.837	[0.000]	6.075	[0.000]

Table 13 Regression Analysis of Earnings Management with GMM Estimation

The dependent variable is the aggregate earnings management (*AggEM*). Legal origin (*origin*) is based upon La Porta et al. (1998). Outside investor rights (*outsider*) is an anti-director rights index. Institutional ownership (*inst*) is the sum of all institutional holdings in a firm's stock divided by market capitalization. Number of analysts (*ana*) is the average number of financial analysts following companies in a country. Audit (*aud*) measures the degree of audit quality. The Amihud liquidity ratio (*liq*) is defined as the inverse of $|ret_d| \times \$vol_d \times 10^6$. Market to book (*mb*) is the market value of equity over the book value of equity. Total assets (*at*) is the logarithm of total assets. Debt-to-equity ratio (*dr*) is a ratio of total liabilities over total stockholder's equity. Control variables are adjusted by the country's average. There are 432 cross-listed firms across 34 countries. IFRS/GAAP is a dummy variable that equal to one for IFRS and zero for U.S. GAAP. After including the dummy of IFRS/GAAP, the number of firms drops to 234. The subscript *i* and *c* represent the *i*th firm in the *c*th country. *e* is the error term.

$$AggEM_i = \alpha_{i,c} + \beta_1 origin_{i,c} + \beta_2 outsider_{i,c} + \beta_3 inst_{i,c} + \beta_4 ana_{i,c} + \beta_5 aud_{i,c} + \beta_6 liq_i + \beta_7 IFRS/GAAP_i + \beta_8 mb_i + \beta_9 at_i + \beta_{10} dr_i + e_{i,c}$$

Variable	Predicted sign	Model 1		Model 2		Model 3		Model 4	
		Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Constant		175.515	[0.000]	151.276	[0.000]	231.635	[0.000]	258.102	[0.000]
Legal origin	-	-4.272	[0.067]	-7.568	[0.001]				
Outside investor rights	-					-9.588	[0.000]	-13.784	[0.000]
Institutional ownership	-	-0.264	[0.031]	-0.085	[0.025]	-0.619	[0.000]	-0.332	[0.011]
Number of analysts	-	-1.010	[0.000]	-1.004	[0.000]	-0.940	[0.000]	-0.879	[0.000]
Audit	-	-2.120	[0.051]	-5.635	[0.065]	-1.813	[0.029]	-3.043	[0.035]
Amihud liquidity ratio	-	-1.252	[0.000]	-1.420	[0.000]	-1.006	[0.000]	-1.072	[0.000]
IFRS/GAAP	-			-6.037	[0.023]			-9.557	[0.000]
Market-to-book		0.568	[0.003]	1.030	[0.009]	0.031	[0.046]	0.076	[0.072]
Total assets		3.111	[0.011]	4.844	[0.000]	0.148	[0.077]	0.030	[0.076]
Debt-to-equity ratio		1.545	[0.094]	2.796	[0.005]	0.567	[0.012]	1.552	[0.042]
Adjusted-R ²		0.130		0.142		0.112		0.131	

Table 14 Regression Analysis of Earnings Management with Interaction Terms

The dependent variable is the aggregate earnings management score (*AggEM*). *D_origin* is equal to 1 for common law and 0 for civil law. *D_outsider*, *D_inst*, *D_ana*, and *D_aud* are dummy variables that equal to 1 if above its mean and zero otherwise. The Amihud liquidity ratio (*liq*) is defined as the inverse of $\frac{|ret_d| \times \$vol_d}{10^6}$. Control variables are adjusted by the country's average. IFRS/GAAP is a dummy variable that equal to one for IFRS and zero for U.S. GAAP. There are 432 cross-listed firms across 34 countries. The subscript *i* and *c* represent the *i*th firm in the *c*th country. *e* is the error term.

$$AggEM_i = \alpha_{i,c} + \beta_1 D_origin_{i,c} + \beta_2 D_outsider_{i,c} + \beta_3 D_inst_{i,c} + \beta_4 D_ana_{i,c} + \beta_5 D_aud_{i,c} + \beta_6 liq_i + \beta_7 D_origin_{i,c} \times liq_i + \beta_8 D_outsider_{i,c} \times liq_i + \beta_9 D_inst_{i,c} \times liq_i + \beta_{10} D_ana_{i,c} \times liq_i + \beta_{11} D_aud_{i,c} \times liq_i + \beta_{12} IFRS/GAAP_i + \beta_{13} mb_i + \beta_{14} at_i + \beta_{15} dr_i + e_{i,c}$$

Variable	Predicted sign	Model 1		Model 2		Model 3		Model 4	
		Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Constant		212.885	[0.000]	198.005	[0.000]	221.007	[0.000]	200.288	[0.000]
D_Legal origin	-	-27.552	[0.000]	-29.913	[0.000]				
D_Outside investor rights	-					-24.126	[0.000]	-33.471	[0.000]
D_Institutional ownership	-	-34.371	[0.000]	-23.058	[0.003]	-39.544	[0.000]	-24.754	[0.001]
D_Number of analysts	-	-2.988	[0.014]	-1.029	[0.079]	-9.880	[0.007]	-3.183	[0.032]
D_Audit	-	-10.905	[0.001]	-5.677	[0.059]	-7.835	[0.020]	-5.637	[0.061]
Amihud liquidity ratio	-	-0.106	[0.079]	-0.142	[0.027]	-0.267	[0.028]	-0.163	[0.014]
D_origin × liq	-	0.000	[0.389]	-0.001	[0.104]				
D_out × liq	-					-13.935	[0.068]	-15.371	[0.034]
D_inst × liq	-	0.000	[0.457]	-0.002	[0.108]	0.000	[0.393]	-0.001	[0.291]
D_ana × liq	-	-0.001	[0.000]	-0.001	[0.020]	-0.001	[0.006]	-0.001	[0.007]
D_aud × liq	-	-1.289	[0.002]	-0.033	[0.042]	2.294	[0.395]	-0.035	[0.048]
IFRS/GAAP	-			-5.056	[0.009]			-3.601	[0.074]
Market-to-book		-6.506	[0.143]	0.553	[0.501]	0.983	[0.017]	0.530	[0.517]
Total assets		7.432	[0.000]	12.380	[0.000]	7.090	[0.000]	11.082	[0.000]
Debt-to-equity ratio		1.865	[0.005]	1.937	[0.201]	1.914	[0.004]	1.991	[0.187]
Adjusted-R ²		0.186		0.135		0.162		0.141	

that cross-listed firms in a country with strong legal system, large institutional ownership, and the adoption of IFRS are less prone to involve in opportunistic earnings. The results of interaction terms are consistent with the second hypothesis: in a country with strong outside investor rights, more analysts following, or high audit quality, liquid firms are less likely to misreport earnings than those with low liquidity. This finding further supports the hypotheses that in addition to investor protection and market monitoring, liquidity is also important and can reduce the incident of opportunistic earnings management.

4.6 Country-Level Regression

The analyses in the above sections use firm-level earnings management as the dependent variable. In this subsection, a country-level analysis is presented. In this analysis, investor protection, market monitoring as well as liquidity are country average data. The results are displayed in Table 15. The evidence shows a negative association between legal investor protection and the country aggregate earnings management score, a negative relation between earnings management and market monitoring, a negative association between liquidity and earnings management at the 1% significance level. Model 1 and Model 3 explain the variation of the country earnings management by 68.9% and 68.4%, respectively. Again, the results support the hypothesis that a country with strong legal system, large institutional ownership, more financial analysts following, more firms audited by the largest five accounting firms, and high liquidity has less degree of earnings management. Model 2 and Model 4 examine the effect of IFRS on earnings management. The results are consistent with those in Models 1 and 3. Countries following the IFRS accounting standards effectively limit the manipulation of accounting information as compared to those following U.S. GAAP. In addition, the GMM

Table 15 Country Level Regression Analysis of Earnings Management

The dependent variable is the aggregate earnings management (*AggEM*). The aggregate earnings management score is calculated by taking the average of the country rankings for three earnings management measures, EM1-EM3. Legal origin (*origin*) classifies countries into Common law, Scandinavian civil law, French civil law, and German civil law and is based on La Porta et al. (1998). Outside investor rights (*outsider*) is an anti-director rights index developed by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008). Institutional ownership (*inst*) is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization and is from Ferreira and Matos (2008). Number of analysts (*ana*) is the average number of financial analysts following the companies in a country. Audit (*aud*) measures the degree of audit quality. Both number of analysts and audit are based upon Bushman, Piotroski, and Smith (2003). The Amihud liquidity ratio (*liq*) is defined as the inverse of $\frac{|ret_d| \times \$vol_d \times 10^6}{}$. IFRS/GAAP is a dummy variable that equal to one for IFRS and zero for U.S. GAAP. There are total 34 country-level observations. The subscript *c* represents the c^{th} country and *e* is the error term.

$$AggEM_c = \alpha_c + \beta_1 origin_c + \beta_2 outsider_c + \beta_3 inst_c + \beta_4 ana_c + \beta_5 aud_c + \beta_6 liq_c + \beta_7 IFRS/GAAP_c + e_c$$

Variable	Predicted sign	Model 1		Model 2		Model 3		Model 4	
		Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Intercept		34.349	[0.000]	34.177	[0.000]	27.838	[0.000]	29.092	[0.000]
Legal origin	-	-1.246	[0.000]	-0.429	[0.000]				
Outside investor rights	-					-0.655	[0.000]	-1.013	[0.000]
Institutional ownership	-	-0.393	[0.000]	-0.400	[0.000]	-0.362	[0.000]	-0.368	[0.000]
Number of analysts	-	-0.307	[0.000]	-0.280	[0.000]	-0.306	[0.000]	-0.280	[0.000]
Audit	-	-1.909	[0.000]	-2.092	[0.000]	-2.034	[0.000]	-2.228	[0.000]
Amihud liquidity ratio	-	-0.087	[0.000]	-0.081	[0.000]	-0.089	[0.000]	-0.084	[0.000]
IFRS/GAAP	-			-1.159	[0.000]			-1.236	[0.000]
Adjusted-R ²		0.689		0.699		0.684		0.694	

Table 16 Country Level Regression Analysis of Earnings Management with GMM Estimation

The dependent variable is the aggregate earnings management (*AggEM*). The aggregate earnings management score is calculated by taking the average of the country rankings for three earnings management measures, EM1-EM3. Legal origin (*origin*) classifies countries into Common law, Scandinavian civil law, French civil law, and German civil law and is based on La Porta et al. (1998). Outside investor rights (*outsider*) is an anti-director rights index developed by Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2008). Institutional ownership (*inst*) is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization and is from Ferreira and Matos (2008). Number of analysts (*ana*) is the average number of financial analysts following the companies in a country. Audit (*aud*) measures the degree of audit quality. Both number of analysts and audit are based upon Bushman, Piotroski, and Smith (2003). The Amihud liquidity ratio (*liq*) is defined as the inverse of $\frac{|ret_d| \times \$vol_d}{10^6}$. IFRS/GAAP is a dummy variable that equal to one for IFRS and zero for U.S. GAAP. There are total 34 country-level observations. The subscript *c* represents the c^{th} country and *e* is the error term.

$$AggEM_c = \alpha_c + \beta_1 origin_c + \beta_2 outsider_c + \beta_3 inst_c + \beta_4 ana_c + \beta_5 aud_c + \beta_6 liq_c + \beta_7 IFRS/GAAP_c + e_c$$

Variable	Predicted sign	Model 1		Model 2		Model 3		Model 4	
		Estimate	P-value	Estimate	P-value	Estimate	P-value	Estimate	P-value
Constant		30.206	[0.000]	36.320	[0.000]	54.831	[0.000]	57.235	[0.000]
Legal origin	-	-3.100	[0.001]	-2.916	[0.020]				
Outside investor rights	-					-3.753	[0.011]	-4.111	[0.009]
Institutional ownership	-	-0.440	[0.004]	-0.420	[0.000]	-0.613	[0.000]	-0.574	[0.000]
Number of analysts	-	-0.545	[0.000]	-0.352	[0.000]	-0.455	[0.000]	-0.437	[0.000]
Audit	-	-4.294	[0.005]	-5.301	[0.000]	-3.682	[0.000]	-4.107	[0.000]
Amihud liquidity ratio	-	-0.043	[0.000]	-0.033	[0.000]	-0.043	[0.000]	-0.039	[0.000]
IFRS/GAAP	-			-0.430	[0.000]			-0.394	[0.001]
Adjusted-R ²		0.590		0.603		0.585		0.596	

estimations confirm the above conclusions, as displayed in Table 16. The interaction term analysis is not performed for the country-level analysis due to small (country-level) data points.

5. Conclusions

This study investigates the relationship between earnings management and investor protection, market monitoring, and liquidity using the sample of the 432 cross-listed firms across 34 countries over the period of 2000-2009. The method of constructing the aggregate earnings management index is based upon Leuz, Nanda, and Wysocki (2003).

Main findings are described as follows. First, cross-listed firms in countries with strong legal system, strong outside investor rights, more institutional shareholders, more financial analysts following, and more firms audited by the largest five accounting firms are less likely to engage in earnings management. This finding is largely consistent using both firm-level and country-level aggregate earnings management and also evident either after controlling for a potential industry effect. Second, cross-listed firms with low stock liquidity tend to manipulate earnings than those with high liquidity. Third, cross-listed firms adopting IFRS have lower propensity in earnings management than those following U.S. GAAP.

Other results indicate that the degree of earnings management is less for statements reported in the U.S. than those reported in the home countries and that cross-listed firms have higher earnings management in the pre-listing period than in the post-listing period. These two results can be explained by U.S. being the country where the combined level of investor protection, market development, and institutional holdings is the strongest. In addition, foreign firms cross-list shares on the U.S. major stock market have lower propensity to engage in

earnings management than those listed in the OTC market, which is consistent with regulatory requirements on major exchanges being stricter.

This paper contributes to the literature that in addition to legal enforcement and outside investor rights, market monitoring (institutional holdings, number of analysts, and audit quality) and liquidity are also important in explaining the variation in earnings management. Particularly, liquidity plays a influential role in reducing earnings management after controlling for legal protection and market monitoring. The differences in earnings management between home shares and ADR shares and between pre and post listing periods further reinforce the importance of market monitoring and liquidity in earnings management.

6. Appendix A The Progress of IFRS

Country	Status for listed companies as of April 2010
Argentina	Required for fiscal years beginning on or after 1 January 2011
Australia	Required for all private sector reporting entities and as the basis for public sector reporting since 2005
Brazil	Required for consolidated financial statements of banks and listed companies from 31 December 2010 and for individual company accounts progressively since January 2008
Canada	Required from 1 January 2011 for all listed entities and permitted for private sector entities including not-for-profit organizations
China	Substantially converged national standards
European Union	All member states of the EU are required to use IFRSs as adopted by the EU for listed companies since 2005
France	Required via EU adoption and implementation process since 2005
Germany	Required via EU adoption and implementation process since 2005
India	India is converging with IFRSs over a period beginning 1 April 2011
Indonesia	Convergence process ongoing; a decision about a target date for full compliance with IFRSs is expected to be made in 2012
Italy	Required via EU adoption and implementation process since 2005
Japan	Permitted from 2010 for a number of international companies; decision about mandatory adoption by 2016 expected around 2012
Mexico	Required from 2012
Republic of Korea	Required from 2011
Russia	Required for banking institutions and some other securities issuers; permitted for other companies
Saudi Arabia	Not permitted for listed companies
South Africa	Required for listed entities since 2005
Turkey	Required for listed entities since 2008
United Kingdom	Required via EU adoption and implementation process since 2005
United States	Allowed for foreign issuers in the US since 2007; target date for substantial convergence with IFRSs is 2011 and decision about possible adoption for US companies expected in 2011

Source: IFRS.org website

7. Appendix B Characteristics of Home Countries for Cross-listed Firms

Country	Region	Legal origin	Legal enforcement	Outside investor rights	Importance of equity market	Institutional holdings (%)	Disclosure	Analysts	Audit
Argentina	America Emerging	French	5.79	2.00	20.58	NA	45	12.73	NA
Australia	Asia Developed	Common	9.51	4.00	59.68	9.20	75	12.30	4
Bermuda	NA	Common	NA	NA	NA	NA	NA	NA	NA
Brazil	America Emerging	French	6.13	5.00	13.63	NA	54	16.10	3
Cayman Islands	NA	Common	NA	NA	NA	NA	NA	NA	NA
Chile	America Emerging	French	6.52	4.00	35.64	NA	52	5.53	4
China	Asia Emerging	German	NA	1.00	22.11	NA	NA	NA	NA
Denmark	Europe Developed	Scandinavian	10.00	4.00	33.05	20.50	62	12.87	4
Finland	Europe Developed	Scandinavian	10.00	3.50	69.83	33.80	77	14.90	4
France	Europe Developed	French	8.68	3.50	35.18	21.10	69	23.20	3

Appendix B continued

Country	Region	Legal origin	Legal enforcement	Outside investor rights	Importance of equity market	Institutional holdings (%)	Disclosure	Analysts	Audit
Germany	Europe Developed	German	9.05	3.50	22.67	21.00	62	32.40	4
Greece	Europe Developed	French	6.82	2.00	43.29	10.20	55	6.10	1
Hong Kong	Asia Developed	Common	8.91	5.00	166.43	10.90	69	25.00	4
India	Asia Emerging	Common	5.58	5.00	13.33	15.90	57	11.90	1
Indonesia	Asia Emerging	French	2.88	4.00	9.28	NA	NA	NA	NA
Ireland	Europe Developed	Common	8.36	5.00	30.54	30.50	NA	5.43	4
Israel	Middle East Developed	Common	7.72	4.00	50.38	NA	64	3.19	2
Italy	Europe Developed	French	7.07	2.00	21.21	13.60	62	21.57	4

Appendix B continued

Country	Region	Legal origin	Legal enforcement	Outside investor rights	Importance of equity market	Institutional holdings (%)	Disclosure	Analysts	Audit
Japan	Asia Developed	German	9.17	4.50	31.02	10.80	65	14.87	4
Korea	Asia Emerging	German	NA	4.50	29.62	NA	NA	9.90	3
Luxembourg	NA	French	NA	2.00	128.98	20.40	NA	0.00	4
Mexico	America Emerging	French	5.37	3.00	7.94	NA	60	18.53	3
Netherlands	Europe Developed	French	10.00	2.50	48.90	32.40	64	29.53	4
New Zealand	Asia Developed	Common	10.00	4.00	25.68	NA	70	8.87	4
Norway	Europe Developed	Scandinavian	10.00	3.50	27.37	21.10	74	12.83	4
Portugal	Europe Developed	French	7.19	2.50	19.11	9.00	36	5.33	3
Russia	Europe, Emerging	German	NA	4.00	17.34	NA	NA	NA	NA

Appendix B continued

Country	Region	Legal origin	Legal enforcement	Outside investor rights	Importance of equity market	Institutional holdings (%)	Disclosure	Analysts	Audit
Singapore	Asia Developed	Common	8.93	5.00	90.41	10.80	78	20.90	4
South Africa	Africa Emerging	Common	6.45	5.00	56.15	11.20	70	7.40	4
Spain	Europe Developed	French	7.14	5.00	42.75	16.60	64	22.73	4
Sweden	Europe Developed	Scandinavian	10.00	3.50	49.99	33.80	83	20.60	4
Switzerland	Europe Developed	German	10.00	3.00	97.34	22.90	68	19.97	3
Taiwan	Asia Emerging	German	7.37	3.00	45.92	28.20	65	6.80	2
United Kingdom	Europe Developed	Common	9.22	5.00	67.37	20.10	78	20.10	4

Note: NA represents that the data is not available.

8. Appendix C Measures of Earnings Management by Region

The method of computing earnings management measures is based on Leuz, Nanda, and Wysocki (2003). Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for these three earnings management measures. According to the Morgan Stanley Capital International (MSCI), countries are classified into five regions, American Emerging, Asia Developed, Asia Emerging, Europe Developed, and Europe Emerging, Israel, and South Africa. Since Bermuda, Cayman Islands, and Luxembourg are excluded from the region classification of the Morgan Stanley Capital International (MSCI), the number of firms in the analysis is 416 across 31 countries over the period of 2000 to 2009.

Region by MSCI	Number of firms	EM1	EM2	EM3	Aggregate EM
America Emerging	75	0.000	-0.900	0.559	182.333
Asia Developed	73	0.000	-0.800	0.550	197.333
Asia Emerging	36	0.000	-0.717	0.679	212.667
Europe Developed	215	0.001	-0.850	0.612	163.667
Europe Emerging, Israel, and South Africa	17	0.000	-0.738	0.549	163.000

9. Appendix D Correlation of Earnings Management, Investor Protection, and Market Monitoring

Variables are from 432 cross-listed firms across 34 countries over the period of 2000 to 2009. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Legal origin is based upon La Porta et al. (1998). Legal enforcement is measured by three measures: (1) the efficiency of the judicial system, (2) rule of law, and (3) the corruption index. Outside investor rights is an anti-director rights index. Importance of equity market is composed by three variables: 1) the ratio of the aggregate stock market capitalization held by minority shareholders to gross national product, 2) the ratio of listed domestic firms to the population, and 3) the ratio of IPOs to the population. Institutional ownership is defined as the sum of all institutional holdings in a firm's stock divided by market capitalization. Ownership concentration is the average percentage of common shares owned by the three largest shareholders in the ten largest nonfinancial and privately owned domestic firms. Disclosure is an index and evaluated by seven categories, including general information, income statement, balance sheets, cash flow statement, accounting standards, stock data, and special item. Number of analysts is the number of financial analysts following the companies in a country. Audit measures the degree of audit quality.

Variable	Aggregate EM	Legal origin	Legal enforcement	Outside investor rights	Importance of equity market	Institutional ownership	Disclosure	Number of analysts	Audit
Legal origin	-0.122 [0.000]								
Legal enforcement	-0.092 [0.000]	0.412 [0.000]							
Outside investor rights	-0.033 [0.089]	0.531 [0.000]	0.005 [0.819]						
Importance of equity market	-0.155 [0.000]	0.488 [0.000]	0.489 [0.000]	0.219 [0.000]					
Institutional ownership	-0.191 [0.000]	-0.378 [0.000]	0.336 [0.000]	-0.444 [0.000]	-0.026 [0.250]				
Disclosure	-0.142 [0.000]	0.617 [0.000]	0.675 [0.000]	0.376 [0.000]	0.571 [0.000]	0.199 [0.000]			
Number of analysts	-0.112 [0.000]	-0.073 [0.000]	0.447 [0.000]	-0.135 [0.000]	0.109 [0.000]	0.381 [0.000]	0.266 [0.000]		
Audit	-0.079 [0.000]	0.249 [0.000]	0.557 [0.000]	0.208 [0.000]	0.291 [0.000]	-0.029 [0.202]	0.411 [0.000]	0.296 [0.000]	

10. Appendix E Correlation of Earnings Management and Control Variables

Variables of control variables are computed from 432 cross-listed firms across 34 countries over the period of 2000 to 2009. The aggregate earnings management score (aggregate EM) is calculated by taking the average of the firm rankings for three earnings management measures, EM1-EM3. Earnings management 1 (EM1) is calculated as a ratio of the firm-level standard deviation of operating earnings over the firm-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each firm. Earnings management 3 (EM3) is a firm's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. Amihud illiquidity ratio is defined as $\overline{|ret_d|} \times \$vol_d \times 10^6$, where the bar on top of the ratio is the notation for the average. The Amihud illiquidity ratio is the average of daily price impact ratios, and then scaled by 1 million. Market to book is the market value of equity over the book value of equity at the end of firm year. Total assets is the logarithm of total assets. Debt-to-equity ratio is a ratio of total liabilities over total stockholder's equity.

Variable	Aggregate EM	Amihud illiquidity ratio	Market to book	Total assets	Debt-to-equity ratio
Amihud illiquidity ratio	0.140 [0.000]				
Market to book	0.035 [0.065]	-0.003 [0.867]			
Total assets	0.318 [0.000]	-0.097 [0.000]	-0.073 [0.000]		
Debt-to-equity ratio	-0.015 [0.423]	0.065 [0.001]	-0.016 [0.396]	-0.026 [0.169]	

11. Appendix F Univariate Analysis of Home country (Home) and the U.S. Market (ADR): By country

Each earnings management measure is computed from 432 cross-listed firms across 34 countries over the period of 2000 to 2009. The method of computing earnings management measures is based on Leuz, Nanda, and Wysocki (2003). Earnings management 1 (EM1) is calculated as a ratio of the country-level standard deviation of operating earnings over the country-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each country. Earnings management 3 (EM3) is a country's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. The difference is tested by the t-test. P-value indicates the significance of the difference.

Country	EM measures	ADR (1)	Home (2)	Difference (1)-(2)	P-value
Argentina	EM1	0.713	0.002	0.711	[0.000]
	EM2	-0.578	-0.605	0.027	[0.165]
	EM3	0.586	0.638	-0.052	[0.016]
Australia	EM1	0.705	-0.018	0.723	[0.000]
	EM2	-0.535	-0.676	0.141	[0.106]
	EM3	0.524	0.535	-0.011	[0.092]
Bermuda	EM1	0.584	0.001	0.583	[0.000]
	EM2	-0.607	-0.910	0.303	[0.081]
	EM3	0.821	2.052	-1.231	[0.012]
Brazil	EM1	0.733	0.001	0.732	[0.000]
	EM2	-0.476	-0.900	0.424	[0.000]
	EM3	0.510	0.702	-0.193	[0.000]
Cayman Islands	EM1	0.327	0.001	0.326	[0.000]
	EM2	-0.852	-0.603	-0.249	[0.003]
	EM3	0.896	1.141	-0.246	[0.000]
Chile	EM1	0.797	0.001	0.796	[0.000]
	EM2	-0.429	-0.925	0.495	[0.000]
	EM3	0.579	0.512	0.067	[0.771]
China	EM1	0.636	0.000	0.636	[0.000]
	EM2	-0.706	-0.539	-0.167	[0.000]
	EM3	0.682	0.637	0.045	[0.201]
Denmark	EM1	0.960	0.001	0.959	[0.000]
	EM2	-0.295	-0.570	0.275	[0.008]
	EM3	0.748	0.351	0.397	[0.006]
Finland	EM1	0.880	0.001	0.879	[0.000]
	EM2	-0.468	-0.860	0.391	[0.000]
	EM3	0.510	0.749	-0.239	[0.005]
France	EM1	0.778	-0.008	0.786	[0.000]
	EM2	-0.434	-0.839	0.405	[0.000]
	EM3	0.500	0.760	-0.261	[0.000]

Appendix F continued

Country	EM measures	ADR (1)	Home (2)	Difference (1)-(2)	P-value
Germany	EM1	0.782	0.005	0.777	[0.000]
	EM2	-0.465	-0.731	0.267	[0.000]
	EM3	0.520	0.723	-0.203	[0.000]
Greece	EM1	0.853	0.000	0.853	[0.000]
	EM2	-0.472	-0.874	0.401	[0.002]
	EM3	0.343	0.661	-0.318	[0.007]
Hong Kong	EM1	0.801	0.000	0.800	[0.000]
	EM2	-0.506	-0.759	0.253	[0.003]
	EM3	0.628	0.508	0.119	[0.687]
India	EM1	0.910	0.000	0.910	[0.000]
	EM2	-0.399	-0.933	0.534	[0.002]
	EM3	0.636	0.643	-0.008	[0.000]
Indonesia	EM1	0.690	0.000	0.690	[0.000]
	EM2	-0.569	-0.852	0.283	[0.036]
	EM3	0.601	1.465	-0.863	[0.000]
Ireland	EM1	0.731	0.039	0.692	[0.000]
	EM2	-0.550	-0.502	-0.048	[0.126]
	EM3	0.743	2.697	-1.955	[0.000]
Israel	EM1	0.798	0.008	0.790	[0.000]
	EM2	-0.466	-0.615	0.149	[0.012]
	EM3	0.519	0.774	-0.255	[0.000]
Italy	EM1	0.652	0.000	0.652	[0.000]
	EM2	-0.550	-0.868	0.317	[0.000]
	EM3	0.542	0.569	-0.026	[0.000]
Japan	EM1	0.800	0.000	0.800	[0.000]
	EM2	-0.388	-0.755	0.366	[0.000]
	EM3	0.449	0.638	-0.189	[0.000]
Korea	EM1	0.728	0.000	0.728	[0.000]
	EM2	-0.472	-0.723	0.251	[0.000]
	EM3	0.597	0.675	-0.078	[0.000]
Luxembourg	EM1	0.560	-0.001	0.561	[0.000]
	EM2	-0.745	-0.569	-0.176	[0.000]
	EM3	0.789	0.981	-0.193	[0.000]
Mexico	EM1	0.678	0.001	0.677	[0.000]
	EM2	-0.604	-0.712	0.108	[0.000]
	EM3	0.640	0.756	-0.116	[0.000]

Appendix F continued

Country	EM measures	ADR (1)	Home (2)	Difference (1)-(2)	P-value
Netherlands	EM1	0.861	-0.052	0.913	[0.000]
	EM2	-0.415	-0.654	0.239	[0.000]
	EM3	0.423	0.757	-0.334	[0.000]
New Zealand	EM1	0.575	0.001	0.574	[0.000]
	EM2	-0.565	-0.358	-0.208	[0.443]
	EM3	0.749	0.473	0.276	[0.056]
Norway	EM1	0.724	0.002	0.722	[0.000]
	EM2	-0.332	-0.470	0.138	[0.000]
	EM3	0.450	0.632	-0.182	[0.000]
Portugal	EM1	0.773	0.000	0.773	[0.000]
	EM2	-0.643	-0.995	0.352	[0.000]
	EM3	0.519	0.592	-0.073	[0.000]
Russia	EM1	0.748	0.000	0.747	[0.000]
	EM2	-0.520	-0.543	0.023	[0.010]
	EM3	0.662	0.520	0.142	[0.567]
Singapore	EM1	0.652	0.012	0.640	[0.000]
	EM2	-0.639	-0.396	-0.243	[1.000]
	EM3	0.806	0.945	-0.138	[0.005]
South Africa	EM1	0.678	0.000	0.678	[0.000]
	EM2	-0.575	-0.735	0.160	[0.000]
	EM3	0.759	0.815	-0.055	[0.000]
Spain	EM1	0.942	0.000	0.941	[0.000]
	EM2	-0.134	-0.751	0.617	[0.000]
	EM3	0.236	0.515	-0.279	[0.000]
Sweden	EM1	0.720	0.002	0.719	[0.000]
	EM2	-0.561	-0.714	0.153	[0.000]
	EM3	0.618	0.693	-0.076	[0.000]
Switzerland	EM1	0.816	0.003	0.813	[0.000]
	EM2	-0.368	-0.877	0.509	[0.000]
	EM3	0.416	0.519	-0.103	[0.000]
Taiwan	EM1	0.770	0.000	0.770	[0.000]
	EM2	-0.353	-0.482	0.129	[0.000]
	EM3	0.687	0.722	-0.035	[0.000]
United Kingdom	EM1	0.769	1.015	-0.246	[0.000]
	EM2	-0.388	-0.606	0.219	[0.000]
	EM3	0.504	0.717	-0.213	[0.000]

12. Appendix G Comparison of Pre-listing Period and Post-listing Period by Country

The method of computing earnings management measures is based on Leuz, Nanda, and Wysocki (2003). Earnings management 1 (EM1) is calculated as a ratio of the country-level standard deviation of operating earnings over the country-level standard deviation of cash flow from operations in the sample period. Earnings management 2 (EM2) is the Spearman correlation between changes in accruals and changes in operating cash flow for each country. Earnings management 3 (EM3) is a country's median of the absolute value of accruals scaled by the absolute value of cash flow from operations. Difference is the earnings management measure of the Post-listing minus the earnings management measure of the Pre-listing. The difference is tested by the t-test. P-value indicates the significance of the difference.

Country	EM measures	Post-listing (1)	Pre-listing (2)	Difference (1)-(2)	P-value
Argentina	EM1	0.0009	0.0000	0.0009	[0.0000]
	EM2	-0.6367	-0.7831	0.1464	[0.0000]
	EM3	0.6498	0.7452	-0.0954	[0.0000]
Australia	EM1	0.0054	0.0023	0.0031	[0.0000]
	EM2	-0.6697	-0.9014	0.2317	[0.0000]
	EM3	0.4779	0.5352	-0.0573	[0.0000]
Bermuda	EM1	0.0008	0.0020	-0.0012	[0.1637]
	EM2	-0.8334	-0.8792	0.0458	[0.0000]
	EM3	0.5027	0.6653	-0.1626	[0.0000]
Brazil	EM1	0.0003	0.0000	0.0003	[0.0000]
	EM2	-0.8953	-0.9553	0.0600	[0.0000]
	EM3	0.6855	0.9485	-0.2630	[0.0000]
Cayman Islands	EM1	0.0212	-0.0387	0.0599	[0.0150]
	EM2	-0.6318	-1.0000	0.3682	[0.0000]
	EM3	1.0495	1.2921	-0.2426	[0.0000]
Chile	EM1	0.0012	0.0062	-0.0050	[0.6599]
	EM2	-0.9245	-0.8180	-0.1065	[0.9887]
	EM3	0.8575	0.8648	-0.0073	[0.7709]
China	EM1	0.0002	0.0001	0.0001	[0.0000]
	EM2	-0.5392	-1.0000	0.4608	[0.0000]
	EM3	0.9125	1.8435	-0.9311	[0.0000]
Denmark	EM1	0.0006	0.0000	0.0006	[0.0000]
	EM2	-0.5704	-1.0000	0.4296	[0.0000]
	EM3	0.3512	0.2989	0.0523	[0.1914]
Finland	EM1	0.0007	0.0003	0.0004	[0.0000]
	EM2	-0.7457	-0.9985	0.2528	[0.0000]
	EM3	0.7311	0.7861	-0.0551	[0.0000]
France	EM1	0.0010	0.0001	0.0009	[0.0000]
	EM2	-0.8080	-0.8408	0.0328	[0.0000]
	EM3	0.6695	0.7021	-0.0326	[0.0000]

Appendix G continued

Country	EM measures	Post-listing (1)	Pre-listing (2)	Difference (1)-(2)	P-value
Germany	EM1	0.0047	-0.0401	0.0449	[0.0000]
	EM2	-0.7315	-0.9663	0.2348	[0.0000]
	EM3	1.3134	1.0520	0.2614	[0.0440]
Greece	EM1	0.0002	0.0000	0.0002	[0.0000]
	EM2	-0.8736	-1.0000	0.1264	[0.0000]
	EM3	0.6908	1.0649	-0.3741	[0.0000]
Hong Kong	EM1	0.0005	0.0000	0.0005	[0.0000]
	EM2	-0.7590	-0.9667	0.2077	[0.0000]
	EM3	0.6696	1.8240	-1.1543	[0.0000]
India	EM1	0.0000	0.0000	0.0000	[0.0000]
	EM2	-0.9333	-1.0000	0.0667	[0.0000]
	EM3	0.5701	2.8721	-2.3021	[0.0770]
Indonesia	EM1	0.0002	0.0001	0.0001	[0.3640]
	EM2	-0.8566	-0.9643	0.1077	[0.0000]
	EM3	1.5108	0.3997	1.1111	[0.3253]
Ireland	EM1	0.0551	0.0237	0.0314	[0.0000]
	EM2	-0.5450	-0.5565	0.0115	[0.0000]
	EM3	0.4794	0.4839	-0.0045	[0.0000]
Israel	EM1	0.0126	0.0077	0.0048	[0.0000]
	EM2	-0.5224	-0.9152	0.3928	[0.0390]
	EM3	1.2675	3.1810	-1.9135	[0.0000]
Italy	EM1	0.0001	0.0000	0.0001	[0.0000]
	EM2	-0.8675	-0.9792	0.1117	[0.0341]
	EM3	0.6689	1.0005	-0.3316	[0.0000]
Japan	EM1	0.0000	0.0000	0.0000	[0.0000]
	EM2	-0.7548	-0.9587	0.2039	[0.0000]
	EM3	0.6380	0.6970	-0.0589	[0.0000]
Korea	EM1	0.0002	0.0000	0.0002	[0.0000]
	EM2	-0.7233	-0.8125	0.0892	[0.0000]
	EM3	0.6749	0.6759	-0.0011	[0.0000]
Luxembourg	EM1	0.0025	0.0023	0.0002	[0.0000]
	EM2	-0.4133	-0.7294	0.3161	[0.0000]
	EM3	0.7136	0.8136	-0.0999	[0.0000]
Mexico	EM1	0.0003	0.0000	0.0003	[0.0000]
	EM2	-0.6921	-0.9444	0.2523	[0.0000]
	EM3	0.5282	0.6199	-0.0917	[0.0000]
Netherlands	EM1	0.0020	0.0009	0.0012	[0.0010]
	EM2	-0.6418	-0.8499	0.2081	[0.0000]
	EM3	0.6220	0.6793	-0.0573	[0.0000]

Appendix G continued

Country	EM measures	Post-listing (1)	Pre-listing (2)	Difference (1)-(2)	P-value
New Zealand	EM1	0.0009	-0.0017	0.0026	[0.0021]
	EM2	-0.3576	-0.3766	0.0190	[0.9635]
	EM3	0.5795	0.3829	0.1966	[0.1458]
Norway	EM1	0.0018	-0.0008	0.0027	[0.0000]
	EM2	-0.4701	-0.6571	0.1871	[0.0027]
	EM3	0.7084	2.1549	-1.4465	[0.0000]
Portugal	EM1	0.0001	0.0000	0.0001	[0.0000]
	EM2	-0.9947	-1.0000	0.0053	[0.0000]
	EM3	0.5924	0.9644	-0.3720	[0.0000]
Russia	EM1	0.0002	0.0000	0.0002	[0.0000]
	EM2	-0.5432	-0.9167	0.3735	[0.0000]
	EM3	0.5202	0.8992	-0.3790	[0.0570]
South Africa	EM1	0.0001	-0.0062	0.0063	[0.2611]
	EM2	-0.7349	-0.3418	-0.3932	[0.2230]
	EM3	0.8146	0.5891	0.2255	[0.3634]
Spain	EM1	0.0000	0.0000	0.0000	[0.0050]
	EM2	-0.7511	-0.8659	0.1148	[0.0750]
	EM3	0.6796	0.7809	-0.1013	[0.0000]
Sweden	EM1	0.0016	0.0012	0.0004	[0.0000]
	EM2	-0.7137	-0.8846	0.1710	[0.0000]
	EM3	2.8474	2.4689	0.3785	[0.0000]
Switzerland	EM1	0.0034	0.0031	0.0003	[0.0000]
	EM2	-0.8770	-0.8896	0.0126	[0.0000]
	EM3	1.1296	0.8201	0.3095	[0.3095]
Taiwan	EM1	0.0001	0.0000	0.0000	[0.0000]
	EM2	-0.4821	-1.0000	0.5179	[0.0009]
	EM3	0.9586	1.1114	-0.1529	[0.0000]
United Kingdom	EM1	1.0155	-0.3856	1.4011	[0.0000]
	EM2	-0.6064	-0.7644	0.1580	[0.0000]
	EM3	3.2046	1.5357	1.6690	[0.6576]

13. References

- Abdallah, W., Goergen, M., 2008. Does corporate control determine the cross-listing location? *Journal of Corporate Finance* 14(3), 183-199.
- Abdallah, A., Ioannidis, C., 2010. Why do firms cross-list? International evidence from the US market. *Quarterly Review of Economics & Finance* 50, 202-213.
- Amihud, Y., 2002. Illiquidity and equity returns: Cross-section and time-series effects. *Journal of Financial Markets* 5, 31-56.
- Baker, T., Collins, D., Reitenga, A., 2003. Stock option and compensation earnings management incentives. *Journal of Accounting, Auditing & Finance* 18, 557-582.
- Ball, R., Robin, A., Wu, J., 2003. Incentives versus standards: properties of accounting income in four East Asian countries, and implications for acceptance of IAS. *Journal of Accounting and Economics* 36, 235–270.
- Barth, M., Landsman, W., Lang, M., 2008. International accounting standards and accounting quality. *Journal of Accounting Research* 46(3), 467-498.
- Beatty, A., Chamberlain, S., Magliolo, J., 1995. Managing financial reports of commercial banks: The influence of taxes, regulatory capital and earnings. *Journal of Accounting Research* 33, 231-261.
- Bergstresser, D., Philippon, T., 2006. CEO incentives and earnings management. *Journal of Financial Economics* 80, 511-529.
- Bhattacharya, U., Daouk, H., 2002. The world price of insider trading. *Journal of Finance* 57, 75-108.
- Black, B., 2001. The legal and industrial preconditions for strong securities markets. *UCLA Law Review* 48, 781–858.
- Burgstahler, D., Dichev, I., 1997. Earnings management to avoid earnings decreases and losses. *Journal of Accounting and Economics* 24, 99–129.
- Burns, N., Francis, B., Hasan, I., 2007. Cross-listing and legal bonding: Evidence from mergers and acquisitions. *Journal of Banking and Finance* 31(4), 1003-1031.
- Bushman, R., Piotroski, J., Smith, A., 2004. What determines corporate transparency? *Journal of Accounting Research* 42, 207-252.
- Cahan, S., Liu, G., Sun, J., 2008. Investor protection, income smoothing, and earnings informativeness. *Journal of International Accounting Research* 7(1), 1-24.

- Chen, H., Tang, Q., Jiang, Y., Lin, Z., 2010. The role of international financial reporting standards in accounting quality: evidence from the European Union. *Journal of International Financial Management & Accounting Autumn* 21(3). 220-278.
- Cheng, Q., Warfield, T., 2005. Equity incentives and earnings management. *Accounting Review* 80, 441-476.
- Chin, C., Chen, Y.J., Hsieh, T.J., 2009. International diversification, ownership structure, legal origin, and earnings management: Evidence from Taiwan. *Journal of Accounting, Auditing & Finance* 24(2), 233-362.
- Coffee, J., 1999. The future as history: the prospects for global convergence in corporate governance and its implications. *Northwestern University Law Review* 93, 641–708.
- Collins, J., Shackelford, D., Wahlen, J., 1995. Bank differences in the coordination of regulatory capital, earnings and taxes. *Journal of Accounting Research* 33, 263-291.
- Cornett, M., Marcus, A., Tehranian, H., 2008. Corporate governance and pay-for-performance: The impact of earnings management. *Journal of Financial Economics* 87, 357-373.
- Cotten, B., 2008. Earnings management prior to initial public offerings: Evidence from secondary share. *Quarterly Journal of Finance & Accounting* 47, 87-107.
- DeAngelo, L., 1988. Managerial competition, information costs, and corporate governance: The use of accounting performance measures in proxy contests. *Journal of Accounting and Economics* 10, 3-36.
- Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2008. The law and economics of self-dealing. *Journal of Financial Economics* 88(3), 430-465.
- Doidge, C., Karolyi, A., Stulz, R., 2004. Why are firms listed in the U.S. worth more? *Journal of Financial Economics* 71, 205-238.
- Dyck, A., Zingales, L., 2004. Private benefits of control: an international comparison. *Journal of Finance* 59(2), 537-600.
- Ferreira, M., Matos, P., 2008. The colors of investors' money: Which firms attract institutional investors from around the world. *Journal of Financial Economics* 88, 499-533.
- Healy, P., Wahlen, J., 1999. A review of the earnings management literature and its implications for standard setting. *Accounting Horizons* 13(4), 365-383.
- Holthausen, R., 2009. Accounting standards, financial reporting outcomes, and enforcement. *Journal of Accounting Research* 47, 447-458.

- Iatridis, G., 2010. International financial reporting standards and the quality of financial statement information. *International Review of Financial Analysis* 19(3), 193-204.
- Jeanjean, T.; Stolowy, H., 2008. Do accounting standards matter? An exploratory analysis of earnings management before and after IFRS adoption. *Journal of Accounting & Public Policy* 27(6), 480-494.
- Jin, L., Myers, S.C., 2006. R² around the world: new theory and new tests. *Journal of Financial Economics* 79(2), 257-292.
- Kamar, E., Karaca-Mandic, P., Talley, E., 2006. Going-private decisions and the Sarbanes-Oxley Act of 2002: a cross-country analysis. *American Law & Economics Association Papers* 39, 1-85.
- La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1998. Law and finance. *Journal of Political Economy* 106, 1113-1155.
- Lang, M., Raedy, S., Wilson, W., 2006. Earnings management and cross listing: are reconciled earnings comparable to US earnings? *Journal of Accounting & Economics* 42, 255-283.
- Lesmond, D., 2005. Liquidity of emerging markets. *Journal of Financial Economics* 77, 411-452.
- Leuz, C., Nanda, D., Wysocki, P., 2003. Earnings management and investor protection: an international comparison. *Journal of Financial Economics* 69, 505-527.
- Levine, R., 1999. Law, finance, and economic growth. *Journal of Financial Intermediation* 8, 8-35.
- Levine, R., Zervos, S., 1998. Stock markets, banks, and economic growth. *The American Economic Review* 88 (3), 537-558.
- McLean, W.C., 2005. The Sarbanes-Oxley Act: A detriment to market globalization & international securities regulation. *Syracuse Journal of International Law & Commerce* 33, 319-346.
- Nabar, S., Boonlert-U-Thai, K., 2007. Earnings management, investor protection, and national culture. *Journal of International Accounting Research* 6, 35-54.
- O'Connor, T., 2006. Cross-listing in the U.S. and domestic investor protection. *Quarterly Review of Economics & Finance* 46(3), 413-436.
- Pagano, M., Randl, O., Röell, A., Zechner, J., 2001. What makes stock exchanges succeed? Evidence from cross-listing decisions. *European Economic Review* 45, 770-782.
- Perry, S., Williams, T., 1994. Earnings management preceding management buyout offers. *Journal of Accounting and Economics* 18, 157-179.

- Roosenboom, P., van Dijk, M.A., 2009. The market reaction to cross-listings: does the destination market matter? *Journal of Banking and Finance* 33, 1898-1908.
- Shen, C.H., Chih, H.L., 2007. Earnings management and corporate governance in Asia's emerging markets. *Corporate Governance: An International Review* 15(5), 999-1021.
- Siegel, J., 2005. Can foreign firms bond themselves effectively by renting U.S. securities laws? *Journal of Financial Economics* 75(2), 319-359.
- Speidell, L.S., Bavishi, V.B., 1992. GAAP arbitrage: Valuation opportunities in international accounting standards. *Financial Analysts Journal* 48, 58-66.
- Stulz, R.M., 1999. Globalization, corporate finance, and the cost of capital. *Journal of Applied Corporate Finance* 12, 8-25.
- Van tendeloo, B., Vanstraelen, A., 2005. Earnings management under German GAAP versus IFRS. *European Accounting Review* 14, 155-180.
- Watts, R., Zimmerman, J., 1978. Towards a positive theory of the determination of accounting standards. *The Accounting Review* 53, 112-134.
- White, H., 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* 48, 817-838.
- Zhou, H., Xiong, Y., Ganguli, G., 2009. Does the adoptions of international financial reporting standards restrain earnings management? Evidence from an emerging market. *Academy of Accounting and Financial Studies Journal* 13, 43-56.

Essay Two

Does A More Liquid Currency Futures Market Tend to Be More Informative?

1. Introduction

In this paper, we examine the relative contribution by Chicago Mercantile Exchange (CME) and Intercontinental Exchange (ICE) to the price discovery process of EURO/USD futures contracts. Moreover, this paper tests whether the information share can be explained by trading characteristics, including volume, quoted bid-ask spread, and price volatility. The hypothesis is that a liquid market is also more informative.¹¹ The underlying rationale is that, if most of the liquidity and trading is generated by informed traders, then greater liquidity means greater information production. Chowdhry and Nanda (1991) theorize that informed traders tend to trade in more liquid markets. However, if liquidity is mostly generated by noise traders, then greater liquidity does not necessarily translate into more or better information, thus our hypothesis might not hold.¹² The EURO/USD currency futures accounted for one third of all currency futures contracts traded on CME and ICE in 2009, and the two markets trade identical contracts and employ similar trading mechanisms. However, liquidity varies substantially between these two markets. Hence, any differences in information production arguably could be largely attributed to differences in liquidity.

¹¹ Easley and O'Hara (1987) argue that the speed of price adjustment is determined by market size, depth, volume, and variance. Higher trading volume or greater depth may slow the speed of price adjustment. In turn, market liquidity does affect price discovery. Lyons (1997) argues the "hot potato" effect increases inventory. From the market microstructure point of view, inventory is one of components to determine bid-ask spread. Therefore, liquidity is a factor of price determination.

¹² Noise traders enhance the market liquidity, but make the information discovery process longer. See, for example, Kyle (1985). French and Roll (1986) present evidence that suggests the influence of noise trading is non-trivial.

Rather than comparing two futures markets, prior related studies focus on the interaction between spot and futures markets. The linkage between liquidity and information share has been documented by Eun and Sabherwal (2003) and Kehrie and Peter (2010) using the sample of the US-listed Canadian stocks and US Treasury futures, respectively. Poskitt (2009) examines price discovery in the electronic Sterling/ US currency futures and spot markets; the evidence shows that time-varying liquidity can explain the time-varying information shares in the Globex market. Using Hasbrouck's (1995) information share approach and Gonzalo and Granger's (1995) common factor weight approach, Chen and Gau (2010) analyze the macroeconomics news effect on price discovery in EURO/USD and JPY/USD currency futures and on-line spot markets. Around the announcement of macroeconomic news, more informed traders are more likely to engage in futures market and thereby price discovery in futures market is higher than spot market. The findings in Poskitt (2009) and Chen and Gau (2010) imply that the futures market is the leader in price discovery and information share. However, futures involve higher leverage than spot transactions, hence comparison of liquidity of spot and futures markets is ambiguous. In contrast to Poskitt (2009) and Chen and Gau (2010), we compare two futures markets and we consider this a more direct test of the relation between liquidity and information discovery. Microstructure studies, such as Korajczyk and Sadka (2008), suggest that liquidity has multiple dimensions, so a single liquidity measure might not adequately capture liquidity. Therefore, we utilize two liquidity measures, which include volume and quoted spread, to explain the variation of relative information share.

In the present study, the contribution by CME and ICE to the price discovery process of EURO/USD is estimated by the information share approach of Hasbrouck (1995). The intraday data in 2010 from CME and ICE is utilized to generate continuous series of quote midpoints over

the one-minute sampling interval. The information share is then estimated by a vector error correction model through the series of midquotes. Empirical findings indicate that CME contributes substantially more to price discovery process than ICE. In addition, the information share of CME is greater in the mornings than in the afternoons. Variations in CME's information share are partially explained by variations in volume, quoted spread, and price volatility. The results support the liquidity hypothesis that a market with greater market depth and lower transaction cost contributes more to price discovery. The higher price volatility in the ICE market is another reason explaining the greater information share of CME.

The next section describes the related literature, which is followed by section 3 that describes data. Section 4 describes the methodologies, Section 5 discusses results, and Section 6 concludes the paper.

2. Literature Review

2.1 Liquidity and Information Discovery

Previous studies (Eun and Sabherwal, 2003; Foucault and Lescourret, 2003; Mizrach and Neely, 2008; Poskitt, 2009; Kehrie and Peter, 2010; Chen and Gau, 2010) indicate, both theoretically and empirically, a positive link between liquidity and information discovery. For instance, Foucault and Lescourret (2003) extend Kyle's (1985) model to distinguish traders into uninformed traders, informed traders with fundamental information, and liquidity traders with non-fundamental information. With this theoretical framework, information discovered through trading improves market quality in terms of price volatility, information efficiency, market liquidity, and trading costs.

Empirically, some studies show a linkage between liquidity and information discovery. For example, Eun and Sabherwal (2003) examine price discovery for Canadian stocks listed on both the Toronto Stock Exchange (TSE) and U.S. exchanges (NYSE, NASDAQ, and AMEX). Price discovery is positively associated with the number of shares traded in the U.S. but negatively with transaction costs. As another example, Mizrach and Neely (2008) examine price discovery of the U.S. Treasury futures and conclude that liquidity measures, such as relative bid-ask spread, number of trades, and realized volatility, explain roughly 21% of daily information share. In addition, comparing futures and options markets, Blasco, Corredor, and Santamaria (2007) document that the higher information spillover in futures market is attributed to higher liquidity and lower transaction costs.

Two studies most related to the present paper are Chen and Gau (2010) and Poskitt (2009). Taking Hasbrouck's (1995) information share and Gonzalo and Granger (1995) common factor weight approaches, Chen and Gau (2010) study how the spot and futures markets react to the US macroeconomics news in the JPY/USD and EURO/USD markets from 2004 to 2005. They find that information share is determined by market quality, including bid-ask spread, trading volume, and volatility. Around the announcement of macroeconomic news, more informed traders are more likely to engage in futures market and thereby price discovery in futures market is higher than spot market. When either spot market is volatile or futures market is liquid, futures market has higher contribution in price discovery. Poskitt (2009) investigates price discovery between the Globex futures and Reuters D3000 markets in the electronic Sterling/Dollar foreign currency trading system. The results show that Globex has a lower information share than Reuters D3000. Globex's information share is positively related to the relative volume but negatively related to the relative spread and volatility.

2.2 Return and Volatility Spillovers

Prior studies on information transmission and volatility and return spillovers are also related to the present study. Most of these investigate equity and commodity futures markets, and show that information influence returns from the most active to less active markets. For instance, studies document bi-directional transmissions between developed equity markets (e.g., Hamao, Masulis, and Ng, 1990; Koutmos and Booth, 1995; Wang and Firth, 2004), and uni-directional transmission from developed to emerging equity markets (Liu and Pan, 1997). In the wheat futures market, Booth, Brockman, and Tse (1998) examine whether the U.S. or the Canadian market is relatively informative. Yang, Zhang, and Leatham (2003) simultaneously examine wheat markets in the U.S., Canada, and London. Both studies conclude that the U.S. market is the dominant center of information production in the worldwide wheat market.

Other papers, studying cross-listed stocks, present evidence of information transfer across countries. Taking the approaches of information share suggested by Hasbrouck (1995) and Grammig et al. (2005), Frijns, Gilbert, and Tourani-Red (2010) and Binh, Chong, and Eom's (2010) document that price discovery is dominant in home country. Frjins, Gilbert, and Tourani-Red study cross-listed stocks between Australia and New Zealand stocks cross-listed in Australia. Binh, Chong, and Eom (2010) examine Korean stocks cross-listed on the Tokyo Stock Exchange (TSE) and find that Korean market contributes more to price discovery.

Evidence from other research indicates information transmission across countries and asset classes. Andersen, Bollerslev, Diebold, and Vega (2007) investigate the impact of U.S. macroeconomic news on U.S., German, and British stock, bond, and foreign exchange markets from July 1998 to December 2002, including the contraction and expansion periods. After controlling for news effect, Andersen et al. (2007) find a contemporaneous linkage cross markets

and countries. Examining non-financial firms in North America and Europe, Forte and Peña (2009) analyze the price discovery among the stock, bond, and credit default swap (CDS) markets using the vector error correction model. They show that the stock market leads the bond and CDS markets.

2.3 Currency Spot and Futures Markets

Empirical research documents mixed results with regard to information transfer between currency futures and spot markets. Because of futures market's attraction to informed traders, several studies argue that currency futures market is more informative than currency spot market [e.g., Garbade and Silber, 1983; Crain and Lee, 1995; Chartrath and Song, 1998; Martens and Kofman, 1998; Tse et al. 2006; Chen and Gau, 2010]. However, other studies indicate that the spot market is more informative than the futures market. For example, Rosenberg and Traub (2009) and Cabrera, Wang, and Yang (2009) find that spot market contributes more to the price discovery as the spot market become more transparent.

Blasco, Corredor, and Santamaria (2007), Kim, Szakmary, and Schwarz (1999), Ates and Wang (2005), and Tse, Xiang, and Fung (2006) study the impact of trading platform on price discovery. In general, their results indicate that electronic trading systems achieve operational efficiency and lower order processing or transaction costs. Thus electronic trading provides more efficiency in price discovery than the floor trading in either the futures or spot markets. Their findings support the trading cost hypothesis that futures markets with lower transaction costs have higher contribution to price discovery.

3. Data

The data set used in this study is from the best bid or offer (BBO) intraday data of the EURO/USD futures traded on Chicago Mercantile Exchange (CME) and the Intercontinental Exchange (ICE). The sample period covers from January 2010 to December 2010, with a total of 252 trading days. We extracted the data from electronic trading as the study sample.

Appendix A provides the specifications of EURO/USD futures contracts traded on CME and ICE. The EURO/USD futures contract traded on CME has a contract size of €125,000 with a minimum price fluctuation of \$0.00005 per euro increments (\$6.25/contract). The electronic trading is conducted on the CME Globex trading platform and runs from 1700 CST to 1600 CST (Central Standard Time) the next day, Sunday through Friday. The trading is closed at 1600 CST on Fridays and reopened on Sundays at 1700 CST. ICE trades the EURO/USD currency futures contracts in units of €125,000, with a minimum price fluctuation of \$0.00005 per euro increments (\$6.25/contract). The electronic trading hours are from 1700 CST to 1630 CST the next day. In sum, the contracts and trading mechanism are virtually identical.

We apply the following criteria to filter the data: In each month, the most actively traded nearest-to-maturity contract was extracted. Five days prior to its expiration, the next-maturity contract was selected in the sample. The quotes must be two-sided, with a positive value of bid-ask spread. The filtered data for CME include 285,701,517 quote observations, while that for ICE include 4,450,397 quote observations¹³.

To access market contribution to price discovery, the data selected are from the overlapped trading hours in both exchanges. More specifically, we form time series of the futures midquotes from 1700 CST to 1600 CST next day during the period of January 2010 to December

¹³ Because of the thinness of actual trading in ICE, only quote data will be used in this study.

2010. Midquote returns are calculated from the time series of the prevailing futures midquote sampled at either one-minute or five- minute intervals.

Table 1 provides summary statistics of the logarithm futures midquotes for CME and ICE at the one-minute interval. The price series in both markets show negative kurtosis, indicating a flat tail. The statistics of the Jarque-Bera (J-B) test indicate that the midquote series in two markets are not normally distributed. Table 2 reports the hourly average number of quotes on CME and ICE between 1700 CST and 1600 CST the following day over the sample period. The number of quotes rises steadily after opening hour, reaches the peak during 0800-1000 CST, and gradually declines before closing. On average, the level of quote activity is higher in the mornings (0000-1200 CST) than that in the afternoons (1200-2400 CST). This pattern suggests that more information comes into both markets in the mornings. On average, CME has a substantially large number of quotes as compared to ICE in the hourly interval.

Table 1 Summary Statistics of Prices

The table summarizes the one-minute logarithm futures midquotes of EURO/USD traded on CME and ICE. The notation *** denotes significance at 1% level.

	CME	ICE
Mean	0.282	0.283
Std. dev.	0.045	0.045
Skewness	-0.285	-0.619
Kurtosis	-0.362	-0.550
Jarque-Bera	6843.912***	7988.588***

Table 2 Average Number of Quotes per Hour on CME and ICE

This table reports the average number of quotes per hour of the EURO/USD futures contracts traded on CME and ICE. The sample period is from January 2010 to December 2010.

Hour Beginning (HHMM)	CME	ICE
2400 (CST)	1,440.8	977.5
0100	2,001.6	1,010.5
0200	2,770.2	1,050.3
0300	2,623.0	1,051.8
0400	2,366.4	1,052.8
0500	2,485.5	1,036.6
0600	2,821.5	1,010.5
0700	3,614.9	1,050.2
0800	3,965.6	1,098.5
0900	4,203.8	1,087.9
1000	3,813.1	1,060.4
1100	2,948.4	1,033.3
1200	2,738.1	990.3
1300	2,753.1	961.2
1400	1,709.8	714.9
1500	197.0	197.5
1700	253.6	260.5
1800	281.9	307.9
1900	750.4	573.5
2000	849.9	623.1
2100	847.9	641.7
2200	843.7	648.4
2300	971.4	707.8
Morning (2400-1200)	37,792.9	13,510.3
Afternoon (1200-2400)	9,205.1	5,376.0

4. Methodologies

4.1 Estimating Information Share

The present study takes the approach of Hasbrouck (1995)¹⁴ to estimate the information share. This measure is based on the vector error correction model (VECM) developed by Engle and Granger (1987). We formed time series of midquotes for EURO/USD futures traded on CME and ICE over the sample period in 2010. The unit root test for stationarity of midquote series is performed. Johansen's (1988) method is employed to check whether the CME and ICE midquote series are co-integrated.

The vector error correction model (VECM) is defined as:

$$\Delta P_{CME,t} = a_{CME,o} + \gamma_{CME}(P_{CME,t-1} + \beta_{ICE}P_{ICE,t-1}) + \sum_{q=1}^Q \delta_q \Delta P_{CME,t-q} + \sum_{q=1}^Q \eta_q \Delta P_{ICE,t-q} + \varepsilon_{CME,t} \quad (eq. 1)$$

$$\Delta P_{ICE,t} = a_{ICE,o} + \gamma_{ICE}(P_{CME,t-1} + \beta_{ICE}P_{ICE,t-1}) + \sum_{q=1}^Q \delta_q \Delta P_{ICE,t-q} + \sum_{q=1}^Q \eta_q \Delta P_{CME,t-q} + \varepsilon_{ICE,t} \quad (eq. 2)$$

where $\Delta P_{CME,t}$ and $\Delta P_{ICE,t}$ are the first log difference of the futures midquote for CME and ICE, respectively. β_{ICE} is the co-integrated vector between the two markets such that $\beta_{CME}P_{CME,t-1} + \beta_{ICE}P_{ICE,t-1}$ is co-integrated of order 1. Q is the number of lags in the model based on multivariate Schwarz Bayesian criterion (Schwarz, 1978). The coefficients of the error correction term γ_{CME} and γ_{ICE} (adjustment coefficients) indicate the responsiveness of the midquote series to any deviation from the equilibrium relationship. $\varepsilon_{CME,t}$ and $\varepsilon_{ICE,t}$ are the unautocorrelated residuals.

¹⁴ Hasbrouck's approach (1995) has been widely used to access information share: Mizrach and Neely (2008), Forte and Peña (2009), Poskitt (2009), Cabrera, Wang, and Yang (2009), Chen and Gau (2010), and Frjins, Gilbert, and Tourani-Red (2010).

Hasbrouck (1995) defines the information share of one market as the proportion of the variance of price innovation attributed to the variance of the innovation in the market of interest. The contribution of one market to the price discovery process (i.e., share in price discovery) is defined as:

- I. If the innovations are not correlated, the information share of the CME market is

$$IS = \frac{\gamma_{ICE}^2 \sigma_{CME}^2}{\gamma_{CME}^2 \sigma_{ICE}^2 + \gamma_{ICE}^2 \sigma_{CME}^2} \quad (eq. 3)$$

where σ_{CME} , σ_{ICE} , and σ_{CI} are estimated from the residual covariance matrix of the VECM.

- II. If the innovations are correlated, Hasbrouck (1995) derives the upper and lower information share bounds. According to Ballie et al. (2002), the mean of the upper and lower bounds is a reasonable estimate of a market's information share.

$$IS_{UB} = \frac{(\gamma_{ICE} \sigma_{CME} - \gamma_{CME} \frac{\sigma_{CI}}{\sigma_{CME}})^2}{\gamma_{CME}^2 \sigma_{ICE}^2 - 2\gamma_{CME} \gamma_{ICE} \sigma_{CI} + \gamma_{ICE}^2 \sigma_{CME}^2} \quad (eq. 4)$$

$$IS_{LB} = \frac{\gamma_{ICE}^2 (\sigma_{CME}^2 - \frac{\sigma_{CI}^2}{\sigma_{ICE}^2})}{\gamma_{CME}^2 \sigma_{ICE}^2 - 2\gamma_{CME} \gamma_{ICE} \sigma_{CI} + \gamma_{ICE}^2 \sigma_{CME}^2} \quad (eq. 5)$$

The subscripts UB and LB denote upper and lower bounds, respectively. A higher value of IS indicates a larger contribution from the CME market.¹⁵

¹⁵ A similar model is by Gonzalo and Granger (1995), so-called common factor component model. However, Baillie, Booth, Tse, and Zobotina (2002) and De Jong (2002) both show that the two models are closely related and complement each other.

4.2. Role of Trading Characteristics on Information Share

Chowdhry and Nanda's (1991) theory implies that informed traders tend to trade in more liquid markets. Liquid markets are often characterized as markets with high trading volume and lower transaction costs. Thus, we examine how trading characteristics, such as trading volume and transaction costs, influence a market's contribution to price discovery. In this study, we use volume of quotes as a proxy for trading activity as suggested by Poskitt (2009). Bid-ask spread, a common liquidity measure, is used as a proxy for transaction cost. Chen and Gau (2010) and Mizrach and Neely (2008), and Capelle-Blancard (2001) document that higher uncertainty inhibits price discovery. The level of uncertainty, proxied by price volatility, is therefore included in the analysis.

A regression model is used to analyze whether these trading characteristics influence a market's contribution to price discovery:

$$\ln[IS_k / (1 - IS_k)] = c + \beta_1 \Delta \ln(\text{Volume}_k) + \beta_2 \ln(\text{Spread}_k) + \beta_3 \ln(\text{Volatility}_k) + \beta_4 D_time_k + \varepsilon_k \quad (\text{eq. } 6)$$

where IS_k denotes the information share of the CME market during the k-hour interval and c is a constant. Volume is the relative volume of quotes computed as the ratio of volume on CME to the volume on ICE during the k-hour interval¹⁶. \ln denotes logarithm. Δ represents the difference between current and previous 12-hour intervals. Spread is the ratio of quoted spread on CME over the quoted spread on ICE at the end of the k-hour interval. Volatility is the standard deviation of prices (midquotes) on ICE to the standard deviation of prices (midquotes) on CME during the k-hour interval. k denotes the 12-hour interval. D_time is a time dummy variable; $D_time_k = 1$ if interval k is in the morning (0000– 1200 CST), otherwise $D_time_k = 0$ (1200– 2400 CST).

¹⁶ Because of the thinness of actual trading in ICE, volume of quotes is used as a proxy for trading activity.

The level of trading activity is a proxy for how active a market is. A positive association between volume and information share is expected. The trading cost hypothesis suggests that the market with lower bid-ask spread is more likely to attract more informed trading (Fleming, Ostdiek, and Whaley, 1996; De Jong and Donders, 1998; Kim, Szakmary, and Schwarz, 1999; Eun and Sabherwal, 2003; Hsieh, Lee, and Yuan, 2008). A negative association between spread and information share is expected. High uncertainty inhibits price discovery. The higher volatility of ICE likely leads to less contribution to price discovery, implying a relatively larger information share for CME.

5. Results

Table 3 reports the mean and median information shares for full sample, morning, and afternoon over the one- and five-minute sampling intervals. Panel A of Table 3 shows the statistics for one-minute sampling interval. CME accounts for 87% contribution to the price discovery (ICE contributes 13%). The implication is that CME reflects information more efficiently compared to ICE. Recall that (Table 2) trading is much more active in CME than in ICE, and therefore the initial result is consistent with the notion that a more liquid market is also a more informative one. The contribution level of 91% in the morning is greater than that of 82% in the afternoon. The statistics of t test for the difference in means and medians of contribution levels between morning and afternoon are significant at 1% level. According to Easley and O'Hara (1987), there is a higher fraction of informed trades in the pre-open due to overnight accumulation of information. Therefore, concentrated trading in the morning allows prices to reach the equilibrium quickly and efficiently. Also, recall the results from Table 2, activity tends to be more intense in the morning for either exchange, but note that CME's trading is even more

dominant in the morning (Table 2 shows that, in the morning sections, CME’s activity is more than twice of that of ICE; in the afternoon, activity in CME is less than twice of ICE). In sum, it is clear that CME has higher information share than ICE, especially in the mornings. Panel B of Table 3 presents the statistics of five-minute sampling interval. The findings are consistent with those shown in Panel A. Again, CME has a higher contribution to price discovery than ICE. Figure 1 displays the logarithm of information share for CME over ICE under the one minute sampling interval in 2010. The logarithm of information share for CME over ICE is positive in most of the sample period. The evidence provided in Figure 1 indicates that CME dominates price discovery in the EURO/USD futures market. Therefore, the results are fairly robust with respect to sampling intervals.

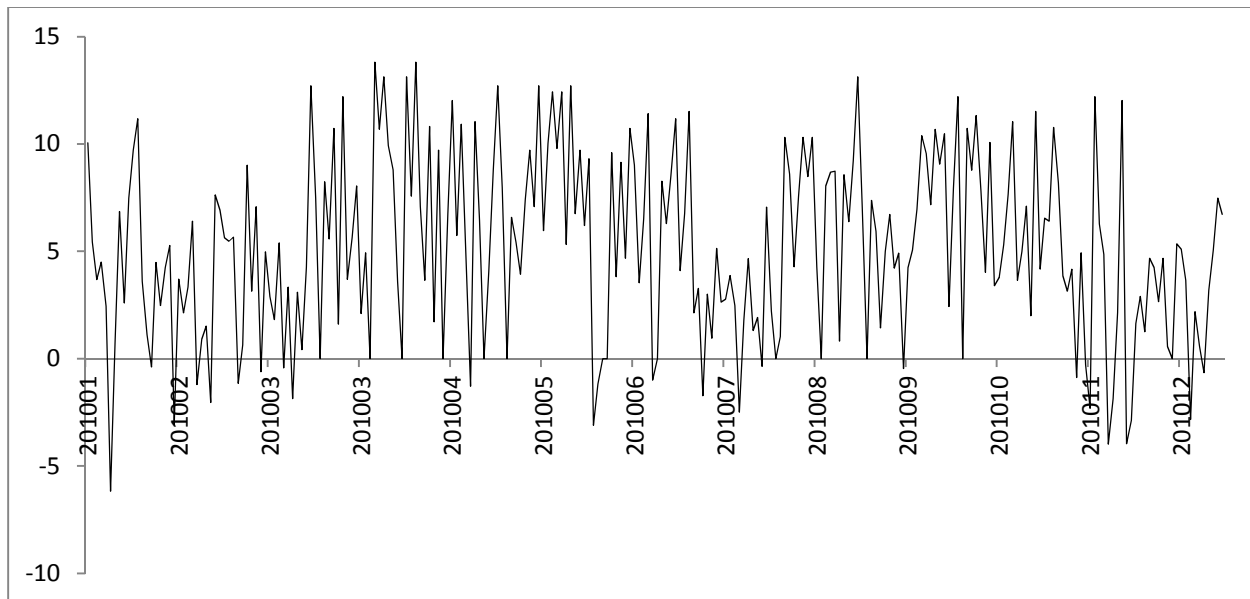
Table 3 Information Shares of CME

The sample period is from January 2010 to December 2010. The number of observations in the one-minute sampling interval is 231,868 while that in the five-minute sampling interval is 53,610. Information shares are computed from the vector error correction model (VECM) suggested by Hasbrouck (1995). The null hypotheses test whether the information shares in the mornings and afternoons are the same. The mean and median differences are tested based on the t-statistics. The notation *** denotes the significance level at 1%.

	All Day	Morning	Afternoon	Difference
<i>Panel A: One-minute sampling interval</i>				
Mean	0.865	0.906	0.822	0.084***
Median	0.993	0.999	0.969	0.031***
<i>Panel B: Five-minute sampling interval</i>				
Mean	0.873	0.925	0.818	0.107***
Median	0.993	0.999	0.959	0.041***

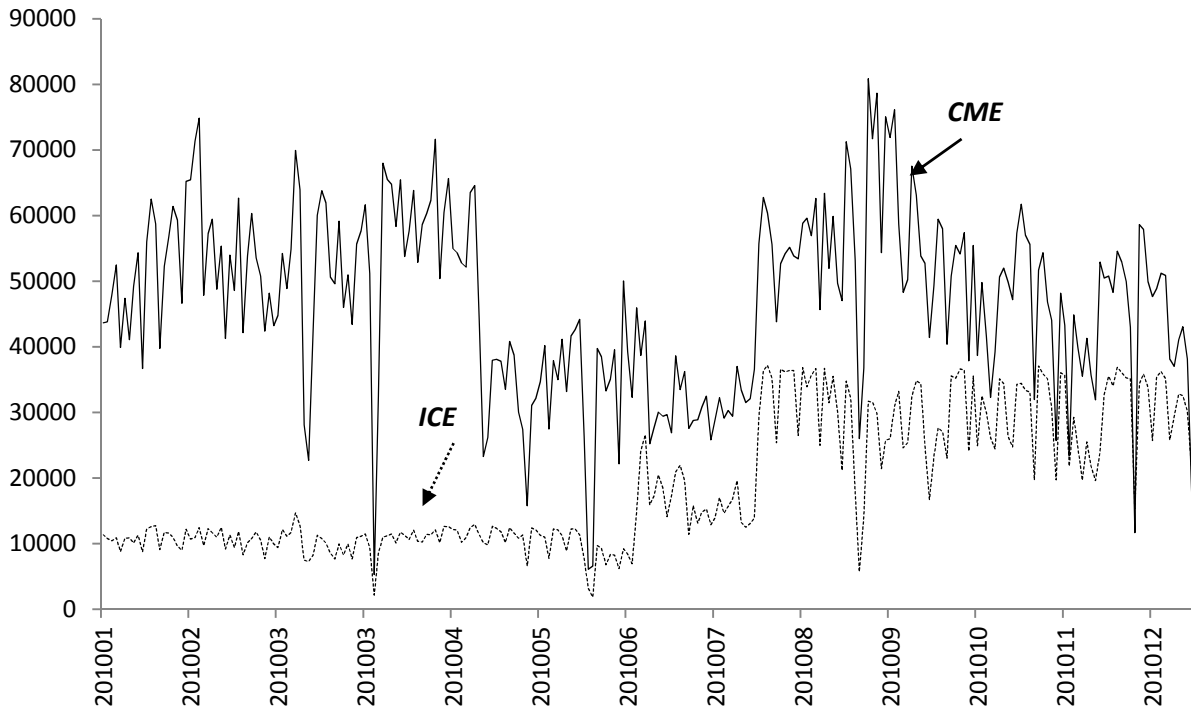
Figure 1 Hasbrouck Information Share

This figure shows the logarithm of information share for CME over ICE during the Year 2010.

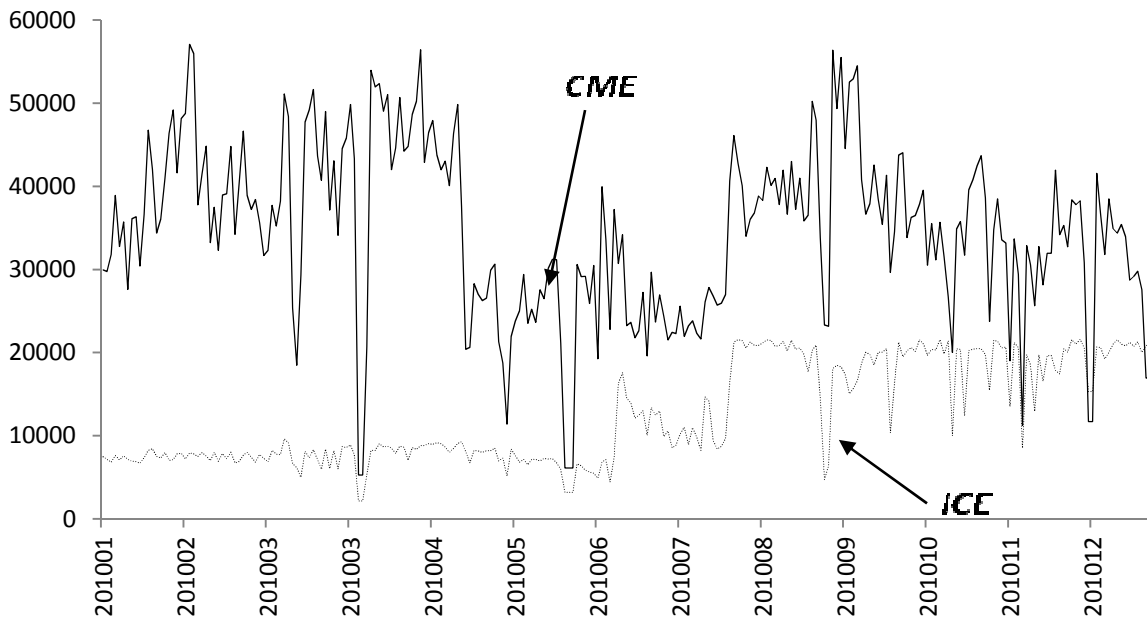


Figures 2-4 present the daily variation of liquidity during the year, and the variations in the morning and afternoon. As Figure 2 shows, volume in CME demonstrates greater fluctuations and is higher than that on ICE. However, the quoted spread is relatively stable and is approximately \$0.0001 (about \$12.5 per contract) as shown in Figure 3. The quoted spread on ICE has more fluctuations and is much larger than that on CME. This implies that CME is a broader and liquid market. Combined with the result of Figure 1, evidence supports the notion that a more liquid market is also an informative market. Figure 4 presents that the daily volatility of prices on CME and ICE. As seen in the figure, the volatility in both markets almost moved together but ICE has more volatility pikes.

Figure 2 CME and ICE EURO/USD Futures Volume of Quotes



A. Full sample



B. Morning (0000-1200 CST)

Figure 2 continued

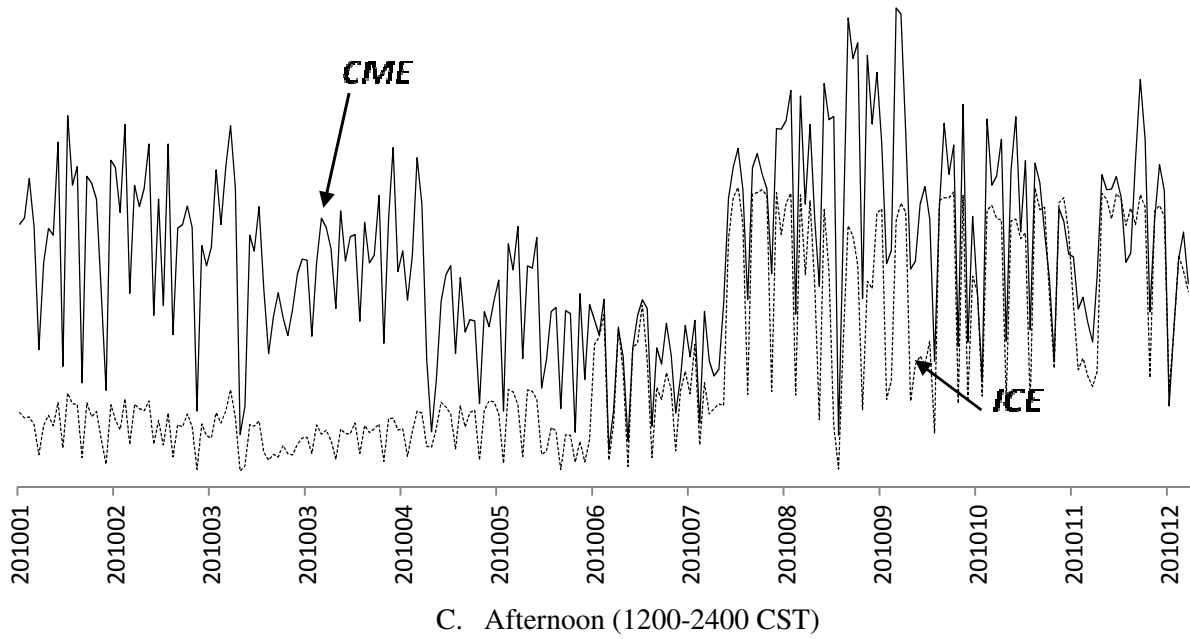


Figure 3 CME and ICE EURO/USD Futures Quoted Spread

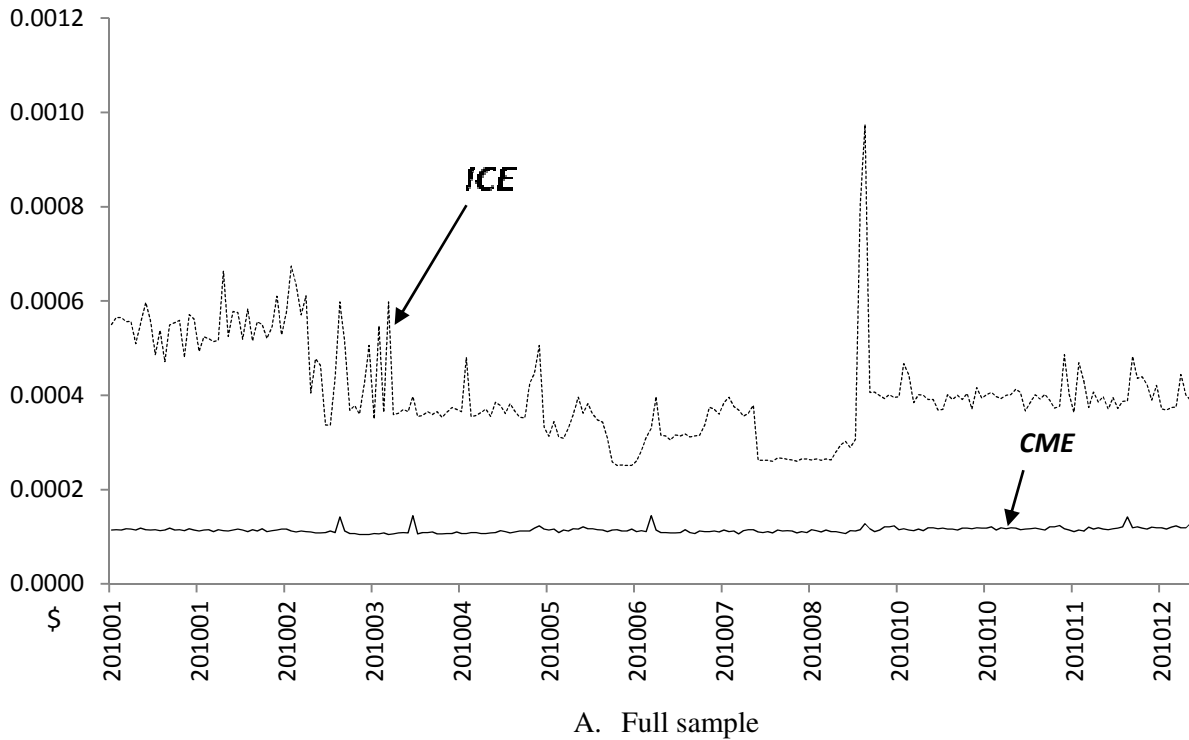
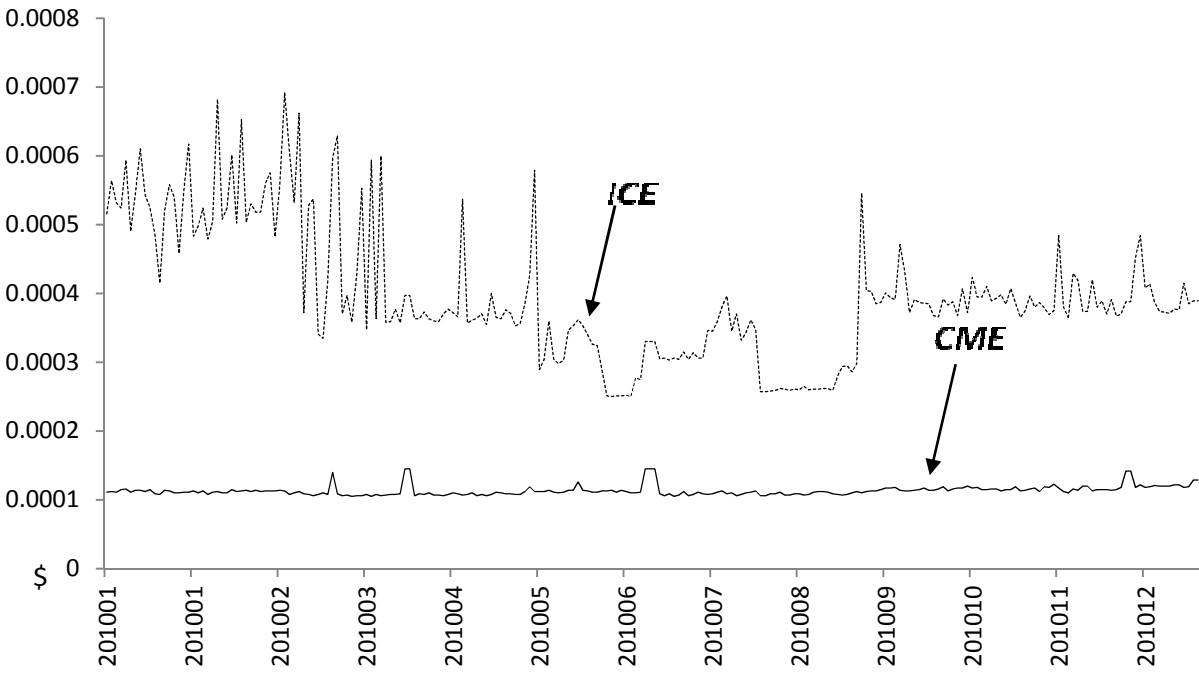
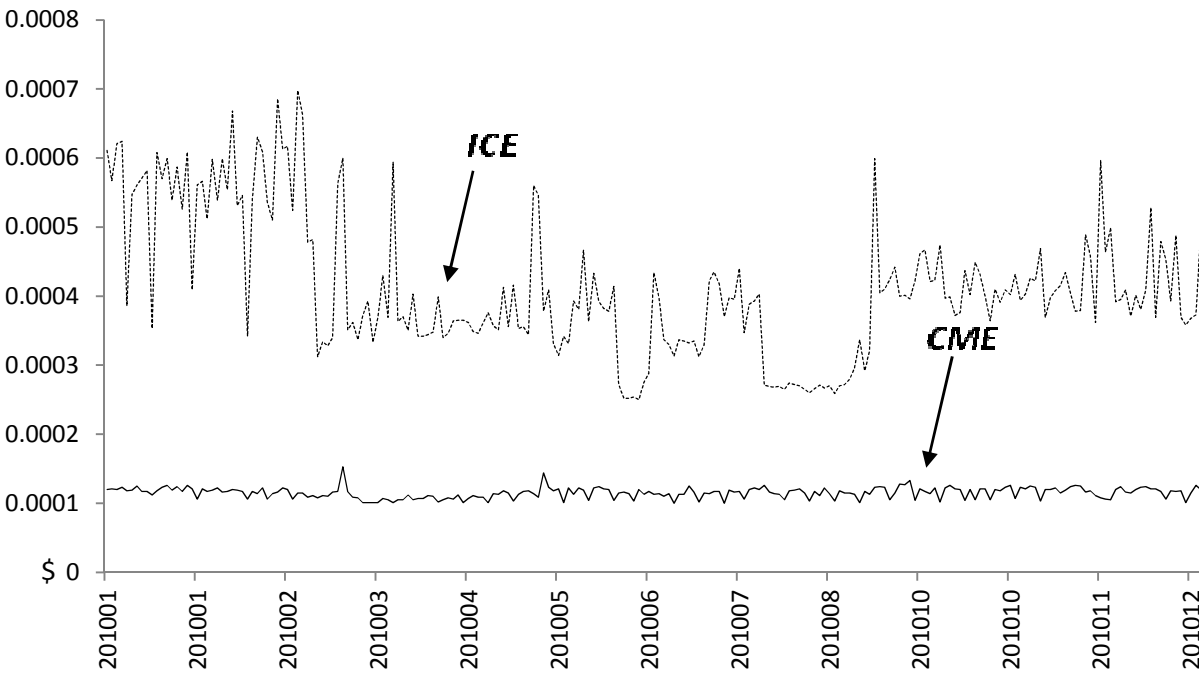


Figure 3 continued

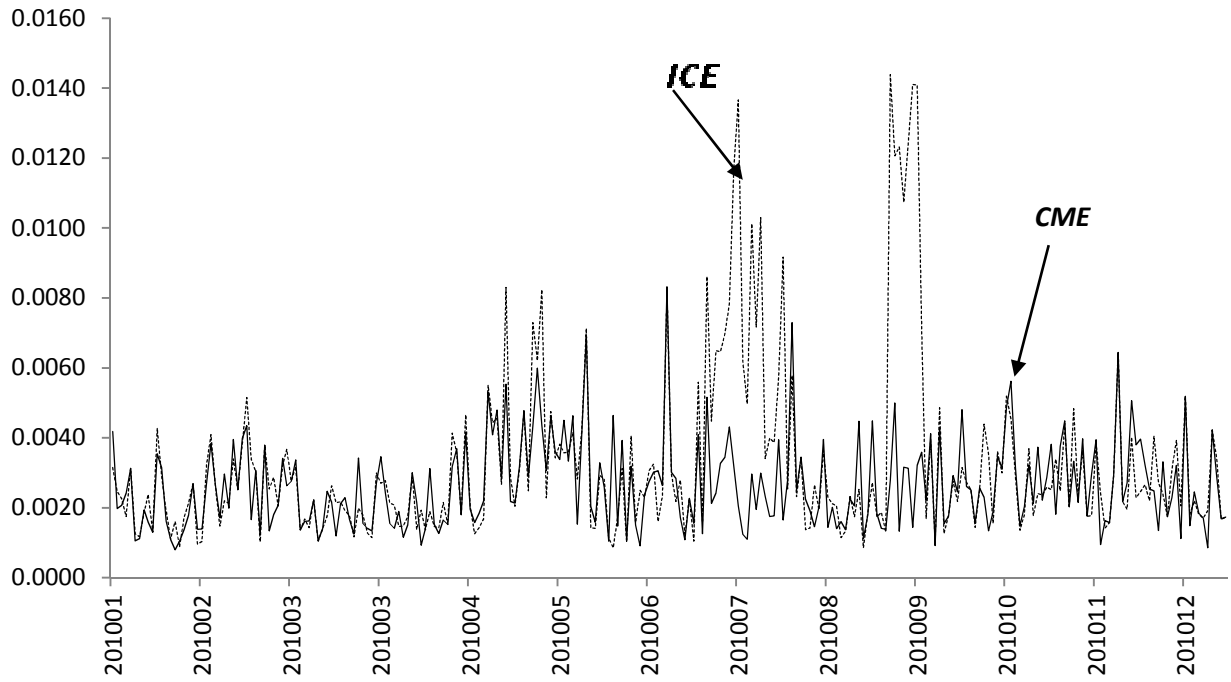


B. Morning (0000-1200 CST)

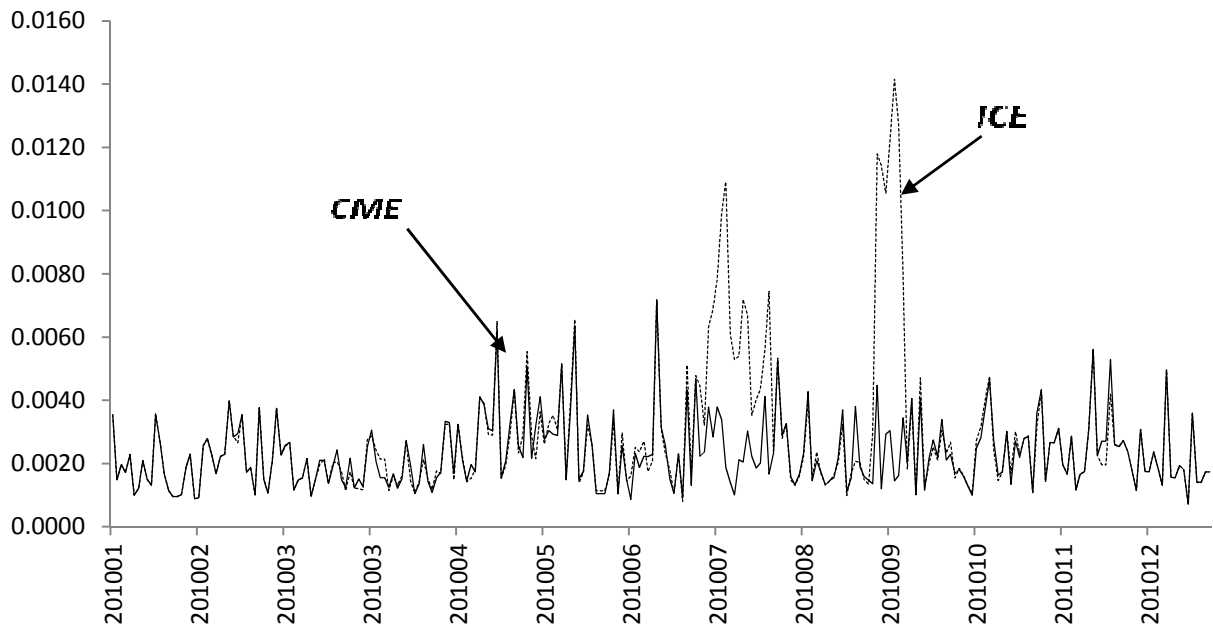


C. Afternoon (1200-2400 CST)

Figure 4 CME and ICE EURO/USD Futures Price Volatility



A. Full sample



B. Morning (0000-1200 CST)

Figure 4 continued

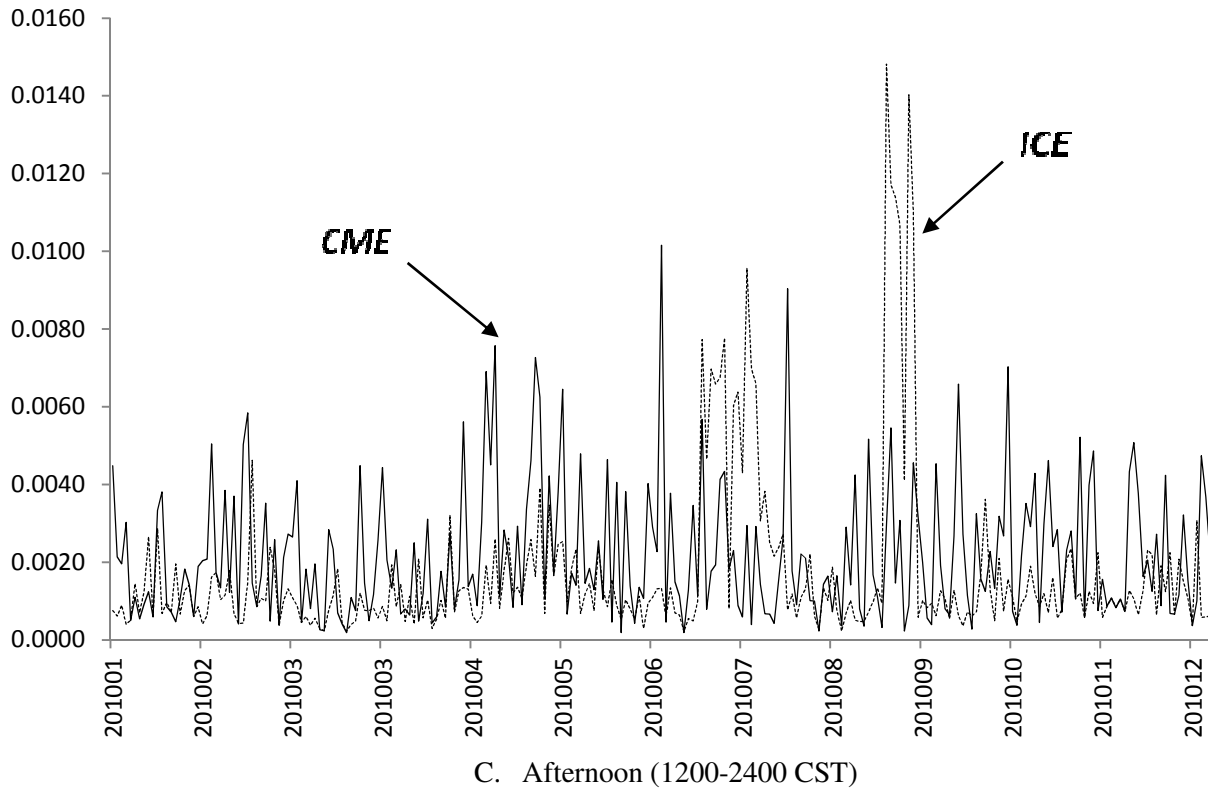


Table 4 provides summary statistics of the explanatory variables in Equation (6): volume, quoted spread, and price volatility for CME and ICE in EURO/USD futures in twelve-hour interval.¹⁷ The number of observations is 231,868. The patterns are fairly similar with those in the figures. The average volume on CME is at least twice higher than that on ICE for the full sample, mornings and afternoons. On average, the variations for volume on CME are greater than that on ICE except afternoons. The mean quoted spread on CME is \$0.0001 for the full sample, mornings and afternoons. The average quoted spread on ICE is \$0.0043 in the full sample. Its spread has higher fluctuations than that on CME. The quoted spread on ICE is 43, 34, and 53 times higher than that on CME for the full sample, mornings, and afternoons,

¹⁷ The highest frequency in this study that information share can be estimated is the 12-hour interval.

Table 4 Summary Statistics of Liquidity Variables

Variables include volume, spread, and volatility of the EURO/USD traded on CME and ICE in the period of January 2010 to December 2010. *Volume* is the volume of quotes over the 12-hour interval. *Spread* is the quoted spread at the end of the 12-hour interval. *Volatility* is the standard deviation of midquotes during the 12-hour interval.

	Full sample		Morning		Afternoon	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
<i>Panel A. CME</i>						
Volume	23,655	13,879	34,673	10,365	12,186	4,814
Spread (\$)	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000
Volatility	0.0023	0.0015	0.0023	0.0011	0.0022	0.0017
<i>Panel B. ICE</i>						
Volume	9,571	6,253	12,527	6,054	6,496	4,814
Spread (\$)	0.0043	0.0149	0.0033	0.0130	0.0053	0.0166
Volatility	0.0023	0.0022	0.0028	0.0021	0.0017	0.0022

respectively. As for the volatility measure, ICE has higher standard deviation of prices than CME. Overall, trading is heavier in the morning than those in the afternoon. The EURO/USD futures in CME is more liquid than that in ICE.

Table 5 reports regression results of information share on trading characteristics including changes in volume, spread, and price volatility. These explanatory variables are relative measures; more specifically, for volume and spread, they are computed as the value of CME over that of ICE, and for price volatility, it is calculated as the ratio of ICE volatility to that of CME; a time dummy variable for the mornings is included in the regression to examine the time effect on the contribution to price discovery. For robustness check, various regression models are performed. The unrestricted model (Model 1) includes all three explanatory variables and the time dummy, while the restricted models (Models 2-4) include two of the three explanatory variables and the time dummy. In Model 1, the estimates of change in logarithm of relative volume, logarithm of relative spread, and logarithm of relative volatility are all

Table 5 Regression Analysis of Share of Price Discovery

IS denotes the CME’s information share. Independent variables are volume, spread, volatility, and dummy of morning. *Volume* is the relative volume of quotes, computed as ratio of volume of quotes on CME over the volume of quotes on ICE during the k-hour interval. Ln denotes logarithm. Δ represents the difference between current and previous 12-hour intervals. *Spread* is the ratio of quoted bid-ask spread on CME over the quoted bid-ask spread on ICE at the end of the k-hour interval. *Volatility* is the ratio of standard deviation of midquotes on ICE over the standard deviation of midquotes on CME during the k-hour interval. k denotes the 12-hour interval. D_time_k is a time dummy variable; $D_time_k = 1$ if interval k is in the morning (0000– 1200 CST); $D_time_k = 0$ if interval k is in the afternoon (1200– 2400 CST). An F test is used to test the hypothesis that the parameters in the restricted model [model (2), (3), and (4)] are jointly zero. The numbers in parentheses are p-values. The standard errors of the estimates are computed based on the procedure of Newey-West (1987) to adjust for the presence of heteroskedasticity and autocorrelation in the regression errors. The symbols ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

The regression model is specified as follows:

$$\ln[IS_k / (1 - IS_k)] = c + \beta_1 \Delta \ln(\text{Volume}_k) + \beta_2 \ln(\text{Spread}_k) + \beta_3 \ln(\text{Volatility}_k) + D_time_k$$

Dependent variable: the relative contribution to price discovery								
$\ln[IS_k / (1 - IS_k)]$								
	(1)		(2)		(3)		(4)	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	4.261***	[0.000]	3.763***	[0.000]	3.826***	[0.000]	4.602***	[0.000]
$\Delta \ln(\text{Volume})$	1.824**	[0.017]			1.921**	[0.013]	1.726**	[0.021]
$\ln(\text{Spread})$	-1.636**	[0.028]	-1.765**	[0.014]			-2.433***	[0.000]
$\ln(\text{Volatility})$	0.585**	[0.024]	0.541**	[0.036]	0.838***	[0.000]		
D_time	2.146***	[0.010]	3.139***	[0.000]	2.238***	[0.000]	1.934***	[0.001]
Adjusted R ²	0.147		0.135		0.142		0.141	
F statistic			10.680***		4.381**		4.944**	

significant at 5% level. The signs of these estimates are consistent with what theories predict. The results imply that when there is a 1% increase in the change of relative volume on CME to ICE, the relative information share of CME is expected to increase by 1.824%; a 1% increase in relative spread is expected to decrease CME's relative information share by 1.636%; for a 1% increase in relative volatility of ICE to CME, CME's relative information share is expected to increase by 0.585%. Compared to afternoons, morning sections contribute more to price discovery by 2.146%. All these results are consistent with the liquidity hypothesis—CME's information share is greater when its volume is greater (and this occurs more often in the mornings), when its spread is lower, and when its relative volatility or uncertainty is lower. The coefficients in restricted models (Models 2-4) are significant at 5% level. The results are consistent with those in the unrestricted model (Model 1). Therefore, the results are fairly robust.¹⁸

For robustness check, we winsorize the data, removing observations where the values of any explanatory variables fall outside the 1st and 99th percentiles. Models 1-4 are re-estimated using the censored data. The estimates are consistent and significant 5% level. The estimates are not reported for the sake of brevity.

6. Conclusions

This study investigates the relative contribution by Chicago Mercantile Exchange (CME) and Intercontinental Exchange (ICE) to price discovery in EURO/USD futures market using high frequency data in 2010. The relative contribution to price discovery is estimated using the information share approach of Hasbrouck (1995). The primary results indicate that CME has

¹⁸An F test is performed to test whether the parameters are jointly zero in the restricted models (Models 2-4). The F statistics show that these three trading characteristics are jointly statistically significant.

higher volume and lower bid-ask spread, and dominates price discovery. On average, CME contributes 87% to price discovery in the EURO/USD futures market. Its contribution level is higher in the morning than that in the afternoon by an average of 8.4%.

This study also examines the effect of trading characteristics including volume, spread, and volatility, on information share (i.e., contribution to price discovery). The results indicate that the higher contribution of the CME market is attributed to its high trading activity, low transaction costs, and lower volatility. Therefore, the findings support the liquidity hypothesis. As mentioned earlier, this paper compares two futures markets that are virtually identical except liquidity, hence it represents a cleaner test of the liquidity hypothesis. This paper is also the first that analyzes the information share of these two very important currency futures markets.

7. Appendix A EURO/USD Currency Futures Contract Specifications

Trading exchange market	Chicago Mercantile Exchange (CME)	Intercontinental Exchange (ICE)
Contract size	125,000 euro	125,000 euro
Minimum price increment	\$0.00005 per euro	\$0.00005 per euro
Contract month	March, June, September and December	March, June, September and December
Last trading day	9:16 a.m. Central Time (CT) on the second business day immediately preceding the third Wednesday of the contract month (usually Monday).	Two Business days prior to the third Wednesday of the expiring month.
Trading hours	Sundays: 5:00 p.m. – 4:00 p.m. Central Standard Time (CST) next day. Monday – Friday: 5:00 p.m. – 4:00 p.m. CT the next day, except on Friday - closes at 4:00 p.m. and reopens Sunday at 5:00 p.m. CST.	Open on Sunday night is 5:00 PM CST; Pre-Open at 4:30 PM CST
Settlement Type	Physical	Physical

8. References

- Andersen, T.G., Bollerslev, T., Diebold, F.X., Vega, C., 2007. Real-time price discovery in global stock, bond and foreign exchange markets. *Journal of International Economics* 73 (2), 251-277.
- Ates, A., Wang, G., 2005. Information transmission in electronic versus open-outcry trading systems: An analysis of U.S. equity index futures markets. *Journal of Futures Markets* 25 (7), 679-715.
- Baillie, R.T., Booth, G., Tse, Y., Zobotina, T., 2002. Price discovery and common factor models. *Journal of Financial Markets* 5(3), 309-321.
- Binh, K. B., Chong, B., Eom, K. S., 2010. Cross-border price discovery and a new motivation for cross-listing. *International Research Journal of Finance & Economics* 42, 89-95.
- Blasco, N., Corredor, P., Santamaria, R., 2007. Information spillovers between derivative markets with differences in transaction costs and liquidity. *Applied Economics Letters* 16 (10), 1039-1047.
- Booth, G., Brockman, P., Tse, Y., 1998. The relationship between U.S. and Canadian wheat futures. *Applied Financial Economics* 8, 73-80.
- Cabrera, J., Wang, T., Yang, Jian, 2009. Do futures lead price discovery in electronic foreign exchange markets?. *Journal of Futures Markets* 29(2), 137-156.
- Capelle-Blancard, G., 2001. Volatility trading in the option market: how does it affect where informed traders trade?. Working Paper, University of Paris.
- Chatrath, A., Song, F., 1998. Information and volatility in futures and spot markets: The case of the Japanese Yen. *Journal of Futures Markets* 18, 201-223.
- Chen, Y.L., Gau, Y.F, 2010. News announcements and price discovery in foreign exchange spot and futures markets. *Journal of Banking & Finance* 34 (7), 1628-1636.
- Chowdhry, B., Nanda, V., 1991, Multimarket trading and market liquidity. *Review of Financial Studies* 4, 483-511.
- Crain, S.J., Lee, J.H., 1995. Intraday volatility in interest rate and foreign exchange spot and futures markets. *Journal of Futures Markets* 15(4), 395-421.
- De Jong, F. 2002. Measures of contributions to price discovery: A comparison. *Journal of Financial Markets* 5(3), 323-327.
- Easley, D., O'Hara, M., 1987. Pirce, trade size, and information in securities markets. *Journal of Financial Economics* 19, 69-90.

- Engle, R.F., Granger, C.W., 1987. Cointegration and error correction: Representation, estimation, and testing. *Econometrica* 55, 251-276.
- Eun, C.S., Sabherwal, S., 2003. Cross -border listings and price discovery: Evidence from U.S.-listed Canadian stocks. *Journal of Finance* 58, 549-576.
- Fleming, J., Ostdiek, B., Whaley, R.E., 1996. Trading costs and the relative rates of price discovery in stock, futures, and option markets. *Journal of Futures Markets* 16, 353-387.
- Foucault, T., Lescourret, L., 2003. Information sharing, liquidity and transaction costs. *Finance* 24, 45-78.
- Forte, S., Peña, J.I., 2009. Credit spreads: An empirical analysis on the informational content of stocks, bonds, and CDS. *Journal of Banking & Finance* 33, 2013-2025.
- French, K., Roll, R., 1986. Stock return variances: The arrival of information and the reaction of traders. *Journal of Financial Economics* 17, 5-26.
- Frijns, B., Gilbert, A., Tourani-Rad, A., 2010. The dynamics of price discovery for cross-listed shares: Evidence from Australia and New Zealand. *Journal of Banking & Finance* 34, 498-508.
- Garbade, K.D., Silber, W.L., 1983. Price movements and price discovery in futures and cash markets. *Review of Economics & Statistics* 65, 289-298.
- Gonzalo, J., Granger, C.W., 1995. Estimation of common long-memory components in cointegrated systems. *Journal of Business and Economic Statistics* 13(1), 27-36.
- Grammig, J., Melvin, M., Schlag, C., 2005. Internationally cross-listed stock prices during overlapping trading hours: Price discovery and exchange rate effects. *Journal of Empirical Finance* 12, 139-164.
- Hamao Y., Masulis, R.W., Ng, V., 1990. Correlations in price changes and volatility across international stock markets. *Review of Financial Studies* 3, 281-307.
- Hasbrouck, J., 1995. One security, many markets: determining the contributions to price discovery. *Journal of Finance* 50, 1175-1201.
- Hsieh, W.L., Lee, C.S., Yuan, S.F., 2008. Price discovery in the options markets: An application of put-call parity. *Journal of Futures Markets* 28, 354-375.
- Johansen, S., 1988. Statistical analysis of cointegrating vectors. *Journal of Economics Dynamics and Control* 12, 231-254.
- Kehrie, K., Peter, F.J., 2010. International price discovery in stock markets-a unique intensity based information share. Working paper.

- Kim, M., Szakmary, A.C., Schwarz, T.V., 1999. Trading costs and price discovery across stock index futures and cash markets. *Journal of Futures Markets* 19(4), 475-498.
- Korajczyk, R.A., Sadka, R., 2008. Pricing the commonality across alternative measures of liquidity. *Journal of Financial Economics* 87, 45-72.
- Koutmos, G., Booth, G.G., 1995. Asymmetric volatility transmission in international stock markets. *Journal of International Money and Finance* 14(6), 747-762.
- Kyle, A., 1985. Continuous auctions and insider trading. *Econometrica* 53, 1315-1335.
- Liu, Y. A. Pan, M. S., 1997. Mean and volatility spillover effects in the U.S. and Pacific- basin stock markets. *Multinational Finance Journal* 1(1), 47-62.
- Lyons, R., 1997. A simultaneous trade model of the foreign exchange hot potato. *Journal of International Economics* 42, 275-298.
- Martens, M., Kofman, P., 1998. The inefficiency of Reuters foreign exchange quotes. *Journal of Banking and Finance* 22, 37-366.
- Mizrach, B., Neely, C. J., 2008. Information shares in the US Treasury market. *Journal of Banking & Finance* 32(7), 1221-1233.
- Newey, W.K., West, K.D., 1987. A simple, positive semi-definite heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica* 55, 703-708.
- Poskitt, R., 2009. Price discovery in electronic foreign exchange markets: The sterling/dollar market. *Journal of Futures Markets* 30(6), 590-606.
- Rosenberg, J.V., Traub, L.G, 2009. Price discovery in the foreign currency futures and spot market. *Journal of Derivatives* 17, 7-25.
- Schwarz, G., 1978. Estimating the dimension of a model. *The Annals of Statistics* 6, 461-464.
- Wang, S.S., Firth, M., 2004. Do bears and bulls swim across oceans? Market information transmission between greater China and the rest of the world. *Journal of International Financial Markets, Institutions and Money* 14, 235-254.
- Yang, J., Zhang, J., Leatham, D.J., 2003. Price and volatility transmission in international wheat futures markets. *Annals of Economics and Finance* 4, 37-50.
- Tse ,Y., Xiang, J., Fung, J., 2006. Price discovery in the foreign exchange futures market. *Journal of Futures Markets* 26, 1131-1143

Vita

Chia-Sheng Chen was born in Taichung, Taiwan. She earned her B.S. degree from Providence University in Taichung, Taiwan. She went to graduate school at University of Wisconsin in Milwaukee in Milwaukee, Wisconsin, and received her M.S. in Finance degree in 2006. She was enrolled in the Doctoral Program in Financial Economics at the University of New Orleans in August 2007. Chia-Sheng completed and received her M.S. and PhD in Financial Economics in May 2009 and December 2011, respectively.