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Essays on Cash Holdings, Governance, and Firm Valuation

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ESSAYS ON CASH HOLDINGS, GOVERNANCE, AND FIRM VALUATION

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Abstract

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There are three essays in this dissertation. First essay provides empirical evidence that agency cost is a significant determinant of firms' cash holdings. We reach the following three conclusions: (i) firms' cash holdings increase in the strength of investor protection, (ii) excess cash holdings are valued more with better investor protection, and (iii) cross-listed firms that improve investor protection through "bonding" hold relatively more cash than non-cross-listed firms. In the second essay, we find that consistent with agency theory and free cash flow hypothesis, the effect of the combination of excess cash and strong governance on firm valuation varies by firms' investment opportunities and acquisitions. We find a value-added effect of excess cash for firms with strong governance when there is low level of free cash flow and acquisitions. On the contrary, for firms with high free cash flow that engage in acquisitions, the combination of excess cash and governance does not add value. Further, poor investment opportunities are value-destroying, although excess cash adds value for firms with stronger governance regardless of the level capital expenditure. In the third essay, we find that there is a uniform co-movement liquidity beyond the BBO as measured by strings. The liquidity beyond the BBO is ubiquitously invariant across trading days, while remarkably variant across securities. The variations of depth and the variations of immediacy needed for the common movement of liquidity beyond BBO, however for the first time, are found to be

moderate and large respectively across trading days. These aspects of liquidity beyond the BBO are positively correlated with return volatility of strings.

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Preface

Chapter 1 of this dissertation has been published in the Journal of Banking and Finance, volume 37, page numbers 937-951.

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Chapter 1 Introduction

There are three essays in this dissertation. First essay provides empirical evidence that agency cost is a significant determinant of firms' cash holdings. The second essay shows that the effect of the combination of excess cash and governance on firm valuation varies by firms' growth potential and the scale of free cash flow and acquisitions. The third essay investigates the existence and extent of liquidity beyond the best bids and best offers.

In the first essay, we examine (i) whether the level of firms' cash holdings differ depending on the strength of investor protection, (ii) whether excess cash holdings are valued more with better investor protection, and (iii) whether cross-listed firms that improve investor protection through "bonding" hold relatively more cash than non-cross-listed firms. We analyze 1,405 ADR firms and their corresponding matched firms from 39 different countries and document that ADR firms have significantly higher cash holdings relative to their non-cross-listed peers, especially in recent years. The increase in cash holdings is much higher for emerging market firms because of their transition from particularly poor home country investor protection and accounting standards before cross listing to much higher standards after cross listing. In addition, firms with level III ADR listing, which represents the strongest investor protection, have higher cash holdings relative to other types of ADR firms.

In the second essay, we find that, consistent with agency theory and free cash flow hypothesis, the effect of the combination of excess cash and strong governance on firm valuation varies by firms' investment opportunities and acquisitions. We find a

value-added effect of excess cash for firms with strong governance when there is low free cash flow and acquisitions. On the contrary, when high free cash flow is coupled with engaging in acquisitions, the combination of excess cash and governance does not add value for well-governed firms and destroys value for poorly-governed firms. Further, poor investment opportunities decrease firm value, although excess cash adds value for firms with strong governance regardless of the level capital expenditure.

In the third essay, we investigate the existence and the extent of liquidity beyond the best bid and offer (BBO) using Tokyo Security Exchange tick-by-tick daily trading data. We find that there is a uniform co-movement liquidity beyond the BBO as measured by strings. Strings are a series of trades each of which is at a price that is inferior to or equal to the price of the previous trade in the series. The liquidity beyond the BBO is ubiquitously invariant across trading days, while remarkably variant across securities. The variations of depth and the variations of immediacy needed for the common movement of liquidity beyond BBO, however for the first time, are found to be moderate and large respectively across trading days. These aspects of liquidity beyond the BBO are positively correlated with return volatility of strings. Moreover, we are also the first to show that the information content is a significant determinant of the return for trades beyond BBO by using the LOB slope, the beginning price, the beginning volume, the beginning spread, and the duration of strings as proxies for the measure of the informative-ness in the LOB.

Chapter 2 Investor Protection and Cash Holdings: Evidence from U.S. Cross listing

I. Introduction

The proverb "*Cash is King*" has attained renewed clout as corporate America's cash holdings have hit their highest level in half a century. Recent articles in the popular business press suggest that nonfinancial companies in the U.S. increased their holdings of cash and other liquid assets in 2011 to a record $2 trillion, which represents 7.1% of the companies' total assets. Our analysis indicates that the proportionate cash ratio is even higher for international firms. According to Myers and Majluf's (1984) pecking order theory, retained cash holdings provide a quick way to fund profitable expansion opportunities without resorting to costly external financing, thus reducing the marginal cost of liquid asset shortage. In this sense, cash is a desirable asset. On the negative side, Jensen (1986) posits that the deployment of cash is central to the agency conflict between managers and shareholders. Managers have strong incentives to build large piles of cash due to the relative ease with which cash can be expropriated or used for non-value-maximizing corporate activities for their own private benefit. Cash is also viewed as an idle and unproductive asset earning a minimal rate of return. This perspective implies that holding less cash is desirable due to its relatively high marginal cost compared to more productive assets. This trade-off between the positive and negative effects of cash has important implications for the optimal level of cash reserves that firms actually maintain.

In this study, we show that a reduction in agency costs obtained through strong investor protection plays a significant role in a firm's decision of how much cash to hold. Consistent with agency theory explanations of cash holdings, we show that better

shareholder protection and better accounting standards are associated with higher levels of cash holdings. Moreover, we show that the positive association between investor protection and cash varies over and our results in the recent years depart significantly from our results in the prior years and from the prior literature (e.g., Dittmar, Mahrt-Smith, & Servaes, 2003). Specifically, after 1998 the relation between shareholder protection and cash holdings strengthens. We attribute this finding to changing investor perceptions on the efficiency of firms' use of cash. Investors value excess cash significantly more for firms with better investor protection after 1998. Because liquid assets are the most vulnerable to misappropriation, we conjecture that the period coinciding with the Asian, Russian, and Latin American financial crises of 1997-1998 caused investors to scrutinize more closely managerial behavior and infer productivity of cash based on observable country and firm-level attributes. Thus, investors assign higher valuations to firms that are less likely to misuse cash due to better shareholder protection.

Since investors value cash more highly in strong investor protection environments, how can managers reliably commit to subject themselves to increase investor protection? A popular answer to the question is in the "bonding hypothesis" proposed by Coffee (2002) and Hope, Kang, and Zang (2007) which predicts that firms cross listed on a U.S. stock exchange provide better investor protection than their domestic peers in their respective home markets.[1] This hypothesis posits that heightened scrutiny by investors, analysts, traders, exchanges, the SEC, and government enforcement agencies effectively

[1] Coffee (2002) defines "bonding" as a term of art in modern institutional law and economics. It refers to the costs or liabilities that an agent or entrepreneur will incur to credibly signal and assure investors that it will perform as promised, thereby enabling it to market its securities at a higher price.

restrain managers of foreign firms cross listed in the U.S. markets from expropriating minority shareholders. Therefore, bonding leads to a significant reduction in agency costs. Recent empirical research (e.g., Frésard and Salva, 2010) shows that firms enjoy higher valuation of cash and other liquid assets by shareholders when they have better governance and lower agency costs. Given the prediction about the effects of bonding on mitigating agency conflicts, we hypothesize that the improved governance associated with cross listing enables firms to retain a higher level of cash holdings for the purpose of increasing shareholders' wealth through easier exploitation of future business opportunities. With better investor protection in the U.S. markets, managers are less inclined to misappropriate cash. Therefore, investors are less likely to discount the cash holdings of these firms. Thus, all else equal we expect that cross-listed firms will hold more cash than firms that do not cross list in the U.S.[2]

We focus our analysis on the period from 1992 to 2009 during which 95% of the currently cross-listed firms entered the U.S. exchanges. We test the hypothesis that investor protection is a significant determinant of corporate cash holdings by studying the level of cash holdings of 1,405 ADR firms in our final merged sample from 39 countries with varying levels of shareholder protection and accounting standards. We also form a matched control sample of non-cross-listed domestic firms that have similar firm characteristics as the cross-listed firms. We find that the average cash holding, which is defined as cash plus equivalents divided by firm's net assets, is higher for cross-listed

[2] While cross-listed firms have greater access to external finance and thus should have less need to hold cash, we assume the governance explanation dominates the effects of ease of access to external capital.

firms than for their matched counterparts listed only in the domestic markets. For cross-listed firms themselves, the ratio is higher after cross listing than before. In our robustness tests, following Harford, Mansi, and Maxwell (2008) we use the ratio of cash to sales as an alternative measure of liquidity and find that this ratio also increases with the degree of shareholder protection and cross listing.

The bonding effect of cross listing is more pronounced for firms from emerging markets which may previously suffer from inferior home country investor protection compared to that in developed markets. We observe a substantially higher increase in cash holdings of emerging market firms relative to cross-listed firms from the developed markets or matched samples of non-cross-listed home market firms. We also interact a home market investor protection variable with cross listing in the U.S. market to understand these differential impacts on cash holdings. Whereas firms from home markets with poor investor protection initially hold a lower level of cash than firms from home markets with better investor protection, firms in the former category also experience a much higher increase in the level of their cash holdings after cross listing. Moreover, cross-listed level III ADR firms hold more cash than level I, level II or restricted ADR firms. Because level III ADRs require the strictest compliance with U.S. laws and regulations and, therefore, represent the highest level of shareholder protection and information disclosure, shareholders discount the cash holdings of these firms less than the lower level ADR listings. The effect of level III ADR cross listing is robust to the removal of sample firm-years that may have higher cash holdings due to the effects of new financing. In summary, the increase in the level of cash holdings depends on the degree of improvement in investor protection. To our knowledge, ours is the first study to

show that an improvement in investor protection and reduction in agency costs resulting from cross listing enables firms to hold more cash.

The remainder of the paper is organized as follows. Section 2 presents a brief literature review focusing on theories of excess cash valuation and other potential determinants of a firm's cash holdings. We then formulate testable hypotheses from this literature. We describe our data and the variables of our final sample in Section 3. We discuss our analyses and empirical results in section 4, and section 5 concludes the paper.

II. Literature

Agency theory

As agents of shareholders, corporate managers often have conflicts of interests dubbed as agency problems by Jensen and Meckling (1976). Corporate managers have a strong incentive to hoard cash, either to increase private benefits or to increase their power via greater control of resources. Large cash holdings enable managers to over-invest in projects, even if some of those projects have a negative NPV, because it is in the managers' best interests to let the firm grow into a corporate empire (Jung, Kim, & Stulz, 1996). On the other hand, shareholders who are concerned about managers' inclinations to extract excessive private benefits of control, , aim at a lower level of cash holdings (Stulz, 1990). They prefer a payback of the return on their investment in the form of dividends or a stock repurchase instead of leaving the cash to the managers' discretion.

Thus, a testable implication of the agency cost model on the effect of information asymmetries between shareholders and managers, is that the level of cash holdings should optimally be kept low if the conflicts of interest between these two parties are

high. With more severe conflicts, investors discount cash holdings more heavily. Dittmar and Mahrt-Smith (2007) document the relation between corporate governance and the relative valuation of a firm's cash holdings in the stock market, and provide empirical evidence that the value of cash is substantially less if corporate governance is poor. Pinkowitz, Stulz, and Williamson (2006) and Frésard and Salva (2010) show that the stock market discounts the value of cash held by poorly governed firms by 10% to 60% compared to well-governed matching firms in countries with better investor protection.

Strong investor protection makes it very costly for managers to pursue their conflicting personal interests over shareholders' interests, thus mitigating agency problems. For example, Lang, Lins, and Miller (2003), Hope, Kang, and Zang (2007), and Bailey, Karolyi, and Salva (2006) show that high quality accounting disclosures increase firm valuation by limiting the flexibility that the managers have for potentially abusing corporate assets. Drobetz, Grüninger, and Hirschvogl (2010) find that the value of corporate cash holdings is lower in states with a higher degree of information asymmetry, which is inversely related to the degree of investor protection. As a result, we posit that shareholder protection and accounting standards are significant predictive factors in determining the level of a firm's cash holdings. None of the papers cited above examine the effects of a valuation premium due to better investor protection on the actual level of cash holdings of the firm.

With growing investor sophistication, we expect time series variations in the importance of investor protection. For example, Mitton (2002), Johnson, Boone, Breach, and Friedman (2000), Stiglitz (1998), and Rajan and Zingales (1998) conclude that the emerging market crises in 1997-98 highlighted the importance of good corporate

governance for firms' operating performances and stock market returns. Firsthand experience from emerging stock market losses, and investor education from the academic analysis of crises may prompt equity market participants to pay more serious attention to investor protection issues after 1997-98. Mitton (2002) specifically states that "the actions of firms and institutions following the crisis have demonstrated at least a recognition of the role of weak governance in the crisis and of the need to change governance practices." We explicitly incorporate this time series variation in our first hypothesis and separately analyze the periods before and after the international crises of 1997-98 in our empirical tests. After the crises, corporations in countries with poor investor protection took action to relieve investors' concerns and to solve agency issues through various means such as cross listing.

Bonding hypothesis

Doidge, Karoyli, Lins, Miller, and Stulz (2009) and Hope, Kang, and Zang (2007) propose cross listing as an effective mechanism for managers to signal their commitment to the best practices in shareholder protection and accounting and disclosure standards, with adverse consequences for violating their commitment. They suggest that firms cross listed on U.S. stock exchanges have unique governance benefits relative to firms cross listed in London (Doidge, Karolyi, & Stulz, 2009) and are better governed than their domestic peers, because they are subject to more stringent U.S. laws and regulations designed to protect the interests of minority shareholders. For example, firms are subject to the Foreign Corrupt Practices Act, the Sarbanes Oxley Act, Securities and Exchange Commission (SEC) reporting requirements, and stricter enforcement of investor

protections laws. Each of these serves to effectively limit managers' ability to manipulate reported earnings or misappropriate corporate resources for their private benefits. Additionally, U.S. listed firms must adhere to the disclosure requirements set out by Generally Accepted Accounting Principles (GAAP) and International Financial Reporting Standards (IFRS[3]) in the U.S. markets, thereby largely reducing the information asymmetry between managers and investors. The specific predictions of the bonding hypothesis according to Lel and Miller (2008) are as follows: (1) investors expect cross-listed firms to have better corporate governance than non-cross-listed firms, (2) the improvement in corporate governance of firms from weaker shareholder protection regimes (e.g., emerging markets) is greater than those from stronger shareholder protection regimes (e.g., developed markets), and (3) the improvement in corporate governance of firms that are subject to the most stringent U.S. rules through a level III ADR listing is greater than those with lower levels of listing. The enforcement mechanism driving these predictions is apparent in their empirical work, which shows that poorly performing CEOs of cross-listed firms are more likely to be terminated than poorly performing CEOs in non-cross-listed firms. Similarly, Khanna, Palepu, and Srinivasan (2004) find that cross listing is associated with a higher level of accounting disclosure and corporate transparency. Additionally, Fernandes, Lel, and Miller (2010) find that the requirement to adhere to U.S securities regulations has a positive impact on shareholder valuation, particularly for firms from home country with weak governance.

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[3] U.S. Securities and Exchange Commission (SEC) has been in the process of developing and executing a Work Plan to incorporate IFRS into the U.S. financial reporting system since early 2010.

Cross listing also exposes a firm to closer scrutiny by expert analysts who can more accurately forecast the firm's future prospects. Lang, Lins, and Miller (2003) find that cross-listed firms experience greater analyst coverage and higher valuation. Frésard and Salva (2010) show that the value that investors attach to excess cash holdings is substantially larger for firms cross listed in the U.S. stock market relative to their domestic peers, due to stronger enforcement of U.S. legal rules and stricter disclosure requirements in the U.S. stock market. While none of these papers focus explicitly on the impact of enhanced investor protection on the level of firms' cash holdings, our analyses extend the literature on the relation between bonding through U.S. cross listing and the amount of cash held.

Determinants of the optimal level of cash holdings

Kim, Mauer, and Sherman (1998) posit that firms determine the optimal level of cash and other liquid assets by evaluating a tradeoff between the low return earned on liquid assets compared to the benefit of minimizing costly external financing. Opler, Pinkowitz, Stulz, and Williamson (hereafter OPSW, 1999) use their transaction cost model of cash holdings for the U.S. market to identify a number of important idiosyncratic determinants of cash holdings. Specifically, cash holdings increase with cash flow volatility (industry sigma), the market-to-book ratio, R&D expenditure, and operational expenditure. Cash holdings decrease with firm size due to economies of scale and the relative ease of obtaining external financing as the firm grows. A major difference between OPSW (1999) and our study is that we provide empirical evidence that investor protection is an important determinant of corporate cash holdings. Our study

is the first to draw a positive link between cash holding levels and the value of cash holdings due to a reduction in agency costs. Furthermore, ours is also the first study to document increases in cash holdings when a firm cross lists in the United States.

Another important control variable that has received scarce attention in the corporate finance literature is the degree of inflation in the economy. Economists have demonstrated that inflation affects asset allocation, wealth, and expenditures (Ungern-Sternberg, 1981). As such, we expect that similar behavior exists among firms. In addition to the idiosyncratic determinants identified by OPSW (1999), we show that inflation also significantly affects the optimal level of corporate cash holdings.

Hypotheses

The discussion presented above leads to the following hypotheses:

Hypothesis I: Investor protection is a significant determinant of firms' cash holdings in that: (a) The quality of investor protection and accounting standards, through their role in reducing agency costs, significantly affect firms' cash holdings. (b) Investors value excess cash more for firms with stronger investor protection, particularly after the onset of the emerging market crises of the late 1990s.

Since a firm can improve its investor protection with its decision to cross list in the U.S. markets (Doidge, Karolyi, & Stulz, 2004; Hope, Kang, & Zang, 2007), we hypothesize that cross-listed firms have a higher level of cash holdings because such bonding mitigates the adverse selection problem for investors. Figure 1 demonstrates the trade-off between the costs (opportunity costs and agency costs) and benefits (avoidance of shortages) of holding cash. Suppose the optimal level of cash holdings without agency

costs is at point *a*. With agency costs, the total cost of holding cash shifts upward and reduces the optimal level of cash holdings to point *b* in poor investor protection environments. Resolution of agency problems by cross listing in the U.S. markets allows the firm to increase its cash holdings back to the optimal level at point *a* because cross listing serves as an effective bonding mechanism for investors who now trust that the firm will use cash effectively.

Hypothesis II: Firms can subject themselves to improved investor protection by cross listing in developed markets such as the U.S.. Thus, this bonding hypothesis extends the predictions of the first hypothesis and states that cross listing increases cash holdings as a result of improved shareholder protection, higher accounting standards, and less information asymmetry between managers and investors.

The magnitude of the benefits of cross listing depends on the difference between the degree of investor protection before cross listing and after cross listing. Factors such as the listing level affect the degree of investor protection after cross listing whereas the environment in the home country affects the degree of investor protection before cross listing. Among the various types of ADRs[4], level III ADRs need to adhere to the most stringent rules and requirements. Hence, a level III ADR listing should improve investor protection more than a level II or level I ADR listing.

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[4] To qualify for having a sponsored level I ADR, the only requirements are that a company's shares must be traded on at least one non-U.S. exchange and the firm must post an annual report in English on its web site, but the company is not required to meet U.S. accounting standards. In addition there are two types of unlisted restricted ADRs with minimal U.S. requirements: a) SEC Rule 144(a) private placements ADRs and Regulation S foreign listed ADRs. To qualify for a Level II sponsored ADR, a firm must register with the SEC and comply with U.S. accounting standards. Firms wishing to raise capital in the U.S. from investors can do so through a level III ADR program by meeting the strictest standards similar to those for U.S. companies.

The difference also depends on the firm's home market financial development. Firms from countries with very poor investor protection benefit more from cross listing, than firms from an already advanced country (Hail and Leuz, 2009, and Doidge, Karolyi, & Stulz, 2004).

Hypothesis III: The magnitude of cross listing on cash holdings depends on the difference between the ending value of investor protection in the U.S. markets and the beginning value of investor protection in the home market: (a) Since a level III ADR cross listing offers the highest degree of investor protection, firms listing as level III ADRs are expected to hold more cash relative to other types of ADR firms. (b) The impact of cross listing on cash holdings is greater for firms from weaker investor protection environments such as those from emerging markets than for firms from countries where investor protection is already strong.

We test these hypotheses in the following sections using panel data regressions and matched control sample analysis. Throughout our analysis, we control for several alternative reasons that may result in higher cash holdings such as growth opportunities (Hail and Leuz, 2009) and access to external financing. As mentioned earlier, cross-listed firms have greater access to outside sources of capital which might mitigate their need for cash relative to non-cross-listed firms. Thus, to be economically and statistically significant, the agency and bonding effects have to offset more than the effects of the relative ease of obtaining external financing. In this sense, the results we report are conservative estimates of the effects of cross listing.

III. Data sources for the main sample and a matched control sample

We obtain our data from the following major sources: DataStream, World Bank, J.P. Morgan, and academic articles such as La Porta, Lopez-de-Silanez, Shleifer, and Vishny (LLSV hereafter, 1997, 1998) and Kaufmann, Kraay, and Mastruzzi (KKM hereafter, 2010). For our primary dependent variable, we measure cash holdings as the ratio of cash and equivalents (DataStream item 02001: cash and short term investments) to net assets. Net assets are computed as total assets (DataStream item 02999) minus cash and equivalents. For an alternative measure of cash holdings, we divide cash and equivalents by sales (DataStream item 01001).

Corporate governance studies such as Aggarwal, Erel, Stulz, and Williamson (2009) show that countries' characteristics are major forces in shaping corporate governance. Thus, we examine two country-level facets of investor protection quality, which include the level of shareholder protection and the degree of accounting disclosure. We use two alternative definitions of an Investor Protection Index (IPI) and also compare our results with a couple of other IPI measures used in prior literature. For our first measure, KKM (2010) provide a time series of six governance indices relating to voice and accountability, political stability and absence of violence or terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption for 213 countries from 1996-2010. We construct the *KKM-IPI* as the sum of these six country level investor protection indicators over our study period. We compute the second investor protection measure *LLSV2-IPI*, following Berkman and Nguyen (2010) by dividing the product of rule-of-law index (LLSV, 1997) and anti-director rights index (LLSV, 1998) by 10. Next, we obtain the accounting disclosure standard ratings from LLSV (1998) where the United States has a score of 71 and Sweden the highest score of 83. From

DataStream, we also collect accounting and financial ratios and other control variables that explain the level of the firms' cash holdings according to the transaction cost model of OPSW (1999). For example, we measure firm size as the natural log of the total assets in 2009 dollars based on the CPI. We define leverage as the ratio of total debt to net assets. Next, we create a dividend indicator variable, which is set to 1 if the firm paid out dividends in the given year, and 0 otherwise. Another important determinant of observed cash holdings is the firms' operating cash flow. We follow OPSW (1999) and begin with earnings before interest and taxes, depreciation, and amortization. From this, we deduct only the cash outflows, i.e., interest, taxes, and common dividends, to arrive at firms' operating cash flow. Also following OPSW (1999) and Dittmar, Mahrt-Smith, and Servaes (2003), we include R&D expenditure as a proxy for information asymmetry, which can be a measure of agency costs. We compute it as a ratio of R&D expense to sales and set to 0 in the years when the firm does not incur any R&D expenses. We control for growth prospects of the firm by including the M/B ratio (market value of equity divided by book value of equity). Lastly, following Bates, Kahle, and Stulz (2009) and the Appendix in Dittmar and Mahrt-Smith (2007), we measure volatility of cash flow by computing the rolling average of the cash flows for each firm during the prior 10 years and then obtaining the standard deviation of the averaged cash flow for all the firms in a given industry sector. We obtain the types of ADR (Level I, Level II, Level III, 144A, or restricted program) from the J.P. Morgan website (www.adr.com) for 2,087 cross-listed firms included in their list. From these, 321 firms operating in the financial services industry such as banks, insurance and real estate firms, and utility firms are removed according to the common practice in corporate finance research. To keep an ADR in the

sample, we require that it is from one of the countries that have LLSV's accounting standard rating available. Our sample period ranges from 1992 to 2009.[5]

For each of these ADR-issuing firms, we find a matching non-ADR-issuing domestic firm from the same country of origin without replacement based on three additional stock attributes: industry sector, market value, and market-to-book ratio. Following Huang and Stoll (1996), we first require the industry code to be the same for cross-listed and non-cross-listed firms and then minimize the composite matching score (CMS) as shown in equation (1):

$$CMS = \sum_{i=1}^{2}[(X_i^C - X_i^D)/(X_i^C + X_i^D)/2]^2 \quad (1)$$

where X_i represents one of the remaining two stock attributes of market value, and market-to-book ratio; the superscripts of C and D represent the cross-listed firm and the domestic firm respectively. In our final sample, there are 1,405 ADR firms and their corresponding matched firms from 39 countries for a total of 39,766 firm-year observations. [6]

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[5] In 1973, there were a total of 27 foreign firms cross-listed as American Depository Receipts (ADR) in the U.S. markets. In 1992, which is the starting point of our sample, there are 99 cross-listed ADRs and at the end of our sample period in 2009 there are 2,187 active ADRs.

[6] The t-test shows that there is no statistically significant difference in the market-to-book ratio between the ADR firms and matched non-ADR firms. In addition, the t-test indicates that ADR firms' market values are larger than the matched non-ADR firms. However, according to OPSW (1999), firm size is inversely related to the level of cash holdings. Thus, cross-listed firms, which are typically larger, are expected to hold less cash relative to smaller sized firms due to the size effects. But cross-listed hold more cash due to bonding effects. In this sense, the 'bonding increases cash holding' results we report are conservative estimates of the effects of cross-listing. Our results in the multivariate section show that firm size is negatively related to the level of cash holdings, consistent with OPSW (1999). More importantly, the effect of cross-listing survives the inclusion of firm size both as a matching criterion and a control variable in the regression. A few ADRs for Greece and Brazil dropped out from the final sample due to unavailability of the data.

IV. Empirical results

Univariate analysis

Table 1 Panel A depicts means, standard deviations, and medians of key firm specific variables for our final sample. The average net cash ratio across all firms is 23%. This number is close to the range reported in the previous literature for the U.S. firms, e.g., 17% in OPSW (1999) and 22% in Dittmar and Mahrt-Smith (2007).[7] We winsorize the net cash ratio at its 1st and 99th percentile to mitigate the effect of any outliers. Panel B shows the distribution of firms by country of origin. The United Kingdom has a total of 5,120 firm-year observations from 364 firms included in the final sample, among which 182 firms are cross listed firms. The United Kingdom is followed by Japan, which has 362 total firms and 182 cross-listed firms. At the lower end of the range is Jordan with 6 firms or 57 firm-year observations. Firms from Switzerland have the highest level of cash holdings, while those from Portugal and Colombia have some of the lowest cash holdings levels. The KKM-IPI composite index can theoretically range from -15 for the poorest investor protection to +15 for the best investor protection. Finland has the highest KKM-IPI score of 11.35 and is followed by Denmark with a score of 11.04. Venezuela has the lowest KKM-IPI score of -5.27. Although we do not list the U.S. in Table 2 because it is not the country of origin for any ADR issuers, the U.S scores the highest in the LLSV2-IPI with a full score of 5 and the United Kingdom scores the second highest with a score

[7] Larger firms hold less cash. Firms in the largest quartile of total assets hold an average of 10% of their net assets in cash in our sample.

of 4.3. The relative strength of KKM-IPI over LLSV-IPI used in prior literature is also apparent from the values for countries like Germany and Belgium. KKM-IPI indicates a better than average protection in these countries which is more likely the case than the below average investor protection suggested by LLSV-IPI for these countries.[8] In terms of accounting disclosure standards ranking, Sweden ranks at the top with a score of 83, while Indonesia ranks at the bottom with a score of 4.2.

In Figure 2, we plot the cash/net asset ratio five years prior to the year of cross listing (gray bar) and five years after cross listing (black bar) for all cross-listed firms in Panel A. For comparison we also plot the ratio for the matched non-cross-listed control firms. The matched control firms do not actually cross list but we create hypothetical before and after periods for the matched firms using the cross listing date of the corresponding ADR sample firms. As shown in the figure, cross-listed firms have a substantially larger increase in cash holdings after cross listing in the United States compared to the non-cross-listed firms. In Panel B of Figure 2, we plot the cash holdings before and after cross listing separately for developed market firms and emerging market firms. Firms from the emerging markets have a higher increase in cash holdings after cross listing than the increase experienced by their developed markets counterparts.

[8] For example, the LLSV2-IPI for Belgium is 0, while the corresponding KKM-IPI is 8.02. According to LLSV, Germany's investor protection index oddly is 0.9, which is lower than 11 out of the 18 emerging markets. Thus, KKM-IPI that we use appears to be a better representation of investor protection for our study than LLSV-IPI used in prior literature.

Multivariate regression analysis

We continue to examine the relation between cash holdings and investor protection in multivariate regression analysis where we control for inflation rates and a number of other determinants of cash holdings suggested by OPSW (1999). We also control for cross-sectional systemic variations in cash holding policies across countries over time both by estimating fixed effects models and, separately, by estimating the regression models using two-way clustered standard errors (Petersen, 2009) without fixed effects.

Investor protection variables as determinants of cash holdings

We use four measures to evaluate each country's investor protection quality and its effect on reducing agency costs and enhancing cash holdings. The first two measures are the Investor Protection Indexes – KKM-IPI and LLSV2-IPI – as defined in the data section. In Panel A of Table 2 we show the results for the entire sample period. In column (1) the KKM-IPI has a statistically significant positive coefficient of 0.047 where the logged net cash ratio is the dependent variable. In column (2) The LLSV2-IPI has a statistically significant positive coefficient of 0.10. Thus, firms operating in countries with stronger shareholder protection appear to hold more cash, consistent with the prevailing U.S evidence (Harford, Mansi, and Maxwell, 2008). The next measure of investor protection in our study is the quality of accounting disclosure standards in the firms' home country, as reported by LLSV (1998). The statistically significant and

positive coefficient of 0.018 in column (3) suggests that the higher the accounting standards, the greater the amount of cash held. The findings suggest that various aspects of investor protection appear to play a significant role in alleviating agency problems. With improved investor protection, firms are able to hold more cash, which is in line with our hypothesis.

Dittmar, Mahrt-Smith, and Servaes (2003) investigate cash holdings for international firms in 1998 and find that firms from low shareholder protection countries actually held more cash than those from better shareholder protection countries. The authors attribute these findings to an agency problem that allows managers in weak protection countries to hold cash which can then be misappropriated. Their results are opposite to those we report in Panel A of Table 2. To investigate this issue further, we divide our sample into pre and post 1998 which is the year used in the Dittmar, Mahrt-Smith, and Servaes (2003) study and also coincides with the emerging markets financial crises. We also use the alternative measures of investor protection used in their study. In column (1) of Panel B in Table 2, we find that the common law investor protection index used in Dittmar, Mahrt-Smith, and Servaes (2003) does indeed have a negative effect on cash holdings prior to 1998. Interestingly, the effect reverses after 1998. The reversal of this sign suggests increased investor sophistication over time that limits the ability of corporate managers to hold cash for the purposes of misappropriation. Instead, the corporate managers now need to explicitly signal adherence to a higher degree of investor protection in order to maintain higher cash holdings.

We also examine the anti-director rights (LLSV-IPI) also used in Dittmar, Mahrt-Smith, and Servaes (2003) for periods before and after 1998. In Panel B column (3), the

anti-director rights do not affect the level of cash holdings before 1998, while in column (4) the anti-director rights become statistically significant and positive after 1998. More importantly, in columns (5)-(8) we measure the effects of the main investor protection measures in our study – KKM-IPI and LLSV2-IPI – on cash holdings both before and after 1998. The effects of investor protection on cash holdings are positive and significant both before and after 1998 for both measures. We conjecture that there are three possible explanations for the differences in the effect of investor protection between our IPI and the IPI used in Dittmar, Mahrt-Smith, and Servaes (2003). First, investors became increasingly aware of the importance of better protection on the optimal level of cash holdings after the Asian, Russian, and Latin American financial crises of 1997-1998. With this increased awareness, investors forged a stronger link between their valuation of cash and the strength of investor protection. Second, the IPI measures we employ comprehensively capture various facets of investor awareness much better than the earlier IPI measures based on a single factor dummy variable like Common Law. Third, the KKM-IPI measure we use has rich time-series and cross-sectional variation, whereas the earlier measures have fixed values for a given country over time. The examples of Germany and Belgium discussed in the descriptive statistics section highlight some potential concerns with continued use of the LLSV-IPI measure which was constructed in the pre-crisis era. Overall, our findings suggest that managers of firms in poor investor protection countries disgorge excess cash balances after 1998, or investors value cash holdings more for firms in better investor protection environments after 1998[9]. In all of

the regression results reported in Table 2, we control for other firm-specific determinants of cash holdings that are identified by OPSW (1999). Many firm-level characteristics are statistically significant and are in the expected directions in Panels A and B, consistent with prior literature. Larger firms, as well as firms with greater levels of net working capital and debt, hold less cash, while firms operating in industries with more volatile cash flows and greater R&D expense hold more cash.

Valuation of excess cash

Since 1998 was a year encompassing financial crises in Asia, Russia, and Latin America, perhaps investors examined managerial behavior more closely, particularly because poor governance is allegedly a major contributor to the crises (Mitton, 2002; Johnson, Boone, Breach, & Friedman, 2000; Rajan and Zingales, 1998; Stiglitz, 1998). Because managers can easily squander cash in poor investor protection countries, investors view the value of cash differently depending on the IPI of the country that the firm operates in. If the change in sign is due to greater investor awareness after 1998, we expect that the value of cash is greater for firms in better investor protection environments after this period.

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[9] In untabulated robustness tests, we estimate the effect of the IPI on excess cash using the same set of IPI measures reported in Panel B of the Table 2 but using a two-step regression based on a measure of excess cash holdings closely following Frésard and Salva (2010). In step (1) we obtain excess cash (XCash) defined as the residual ($\varepsilon_{i,t}$) from the regression equation shown in the Table header of the Table 3. In step (2) we examine the effects of shareholder protection (IPI) on excess cash holdings. The Common Law-IPI and LLSV-IPI measures used in Dittmar, Mahrt-Smith, and Servaes (2003) have statistically insignificant effects on excess cash holdings for both pre and post-1998 periods. However, the KKM-IPI and LLSV2-IPI measures in this study continue to have statistically significant positive effects on excess cash holdings and the magnitude of IPI coefficient is close to that in Panel B of Table 2.

We examine whether the valuation of excess cash holdings is higher for firms with better shareholder protection in Table 3. We use the Fama and French (1998) model and regress firm value on the excess cash holdings using the same set of control variables as Frésard and Salva (2010). We estimate the model in two steps. The first step regression estimates the normal cash holdings for a firm based on a cash determinants model. The excess cash holding (Xcash) for a firm is the residual term obtained from this first step. In the second step, Xcash becomes an explanatory variable and firm valuation is the dependent variable. The main variable of interest is the interaction between IPI and Xcash. This variable measures if investors value the excess cash more for firms with strong investor protection. The coefficients of the interaction term IPI*Xcash for the period after 1998 are 1.048 for Common Law-IPI, 0.151 for LLSV2-IPI, and 0.144 for KKM-IPI, all statistically significant at the 5% level or better. Indeed, investors value the excess cash more in countries with strong investor protection after 1998, verifying our conjecture that investors became more wary of poor corporate governance after the emerging market crises in 1997-98. This change in sign is also an important contribution to the cash valuation literature and was not documented before. Once again it suggests increased investor sophistication over time. Investors appear to be demanding greater investor protection after 1997-98 and are punishing firms with weaker protection by discounting their cash holdings more heavily.

Cross listing and cash holdings

To test our second hypothesis, we measure the impact of cross listing on the firm's cash holdings. The improvements in investor protection upon U.S. cross listing

include stronger shareholder protection, more stringent disclosure requirements, and a lower degree of information asymmetry between shareholders and managers (Doidge, Karolyi, Lins, Miller, & Stulz 2009). We define *Cross listing* as an indicator variable with the value of 1 for ADR firm-years after their cross listing date and 0 before the cross listing date. The variable is also set to zero for the non-cross-listed matched control sample firm-years for the entire sample period., We create a *level III ADR* indicator variable to test our third hypothesis which states that cash holdings increase more for level III ADRs relative to other types of ADRs. Our main regression analysis has the log of the net cash ratio as the dependent variable, *Cross listing* and *level III ADR* as the key explanatory variables, inflation and firm level characteristics that are identified by OPSW (1999) as control variables, and year (η), country (ω), and industry (v) fixed effects as shown in equation (2) below:

$$LogNetCashRatio_{i,t} = \alpha + \beta_1 CrossListing_{i,t} + \beta_2 LevelIIIADR_{i,t} + \beta_3 Inflation_t + \sum_{k=1}^{9}\left(\beta_{k+3} ContrlVar_{i,t}^{k}\right) + \eta + \omega + \nu + \varepsilon_{i,t} \quad (2)$$

The results of this regression are presented in Table 4. As we hypothesized, cross listing is a significant predictor of cash holdings. For the overall sample, it is associated with a 16.2% increase in cash holdings reported in column (1) and 13.5% increase in excess cash reported in column (2). In the third and fourth columns we show that the effect of cross listing on cash holdings becomes statistically positive only after 1998. Thus, the results lend support to our second hypothesis that by bonding with more stringent rules and laws in the U.S. market, firms are able to increase their cash holdings as their liquid assets receive a higher valuation.

The benefits of bonding can vary significantly across firms because the net improvement in investor protection depends on both the level of ADR listing targeted in the U.S. and the quality of shareholder protection available in the home markets. We first analyze these effects separately in Table 4. The higher the level of ADR listing, the more stringent the listing requirements are and the higher the gains from cross listing should be. The magnitude of the coefficient on level III ADR is economically and statistically significant and positive in five out of the six models with the exception of the regression in column (3).

In the last two columns of Table 4, we divide the sample into two groups based on whether the country of origin for a given ADR is an emerging market or a developed market as the countries in these groups can provide very different levels of investor protection quality. Indeed, the average shareholder protection score of emerging markets is 0.1, much below the average of 8.9 for the developed markets as measured by KKM-IPI. Likewise, the average accounting standards rating of emerging markets is 53.5, which is also below the average rating of 66.3 for the developed markets. Thus, firms from emerging markets may have more to gain from a U.S. listing than firms from developed markets where investor protection is already strong. The statistically significant positive coefficients for the cross listing variable in columns (5) and (6) of Table 4 imply that firms from both emerging markets and developed markets experience an increase in cash holdings after cross listing. The increase in cash holdings of 21.8% for emerging market firms is, however, significantly higher than the increase in cash holdings of 5.9% for the developed market firms. This result represents a preliminary piece of evidence supporting our third hypothesis, which states that the effect of cross

listing in the U.S. on cash holdings is greater for firms from countries with poor investor protection compared to that for firms from countries with relatively better investor protection. The signs on the coefficients for firm level characteristics are similar to those reported in the previous section. We present another test of the third hypothesis in section 4.2.5.

Robustness test of the effects of bonding

So far we have shown a positive association between the magnitude of increase in the cash holdings ratio and the difference between the ending value of shareholder protection (which could be higher with level III ADRs than others) and the beginning value of shareholder protection (which could be lower for ADRs from countries with poorer scores than others). Admittedly, apart from bonding with better investor protection, some firms cross list in the U.S. market to tap the global capital markets for new financing. Intuitively, some of the increase in cash holdings following level III ADRs might be attributable to the cash generating effect of new equity offerings (IPO effect). We remove firm-year observations for two years prior to and after the base year that the firms first cross list in the U.S. market. We report the results in column (1) of Panel A in Table 5. The incremental effect of level III ADRs on cash holdings remains significant and positive after removing the five-year period surrounding the IPO, during which any excess cash is likely to be utilized for capital purchases stated in the prospectus. The statistical significance level, the direction, and the magnitude of the coefficients for the other variables are consistent with results in Table 4. Further, we conjecture that the IPO effect would exist only for level III ADRs and privately placed ADRs (SEC rule 144A)

that actually raise cash by issuing new shares. As a result, we investigate if there is a cross listing effect on cash holdings for level I and level II ADRs and present the results in column (2) of Table 5. We obtain similar results as in column (1). Thus, the conclusion that cash holdings increase with cross listing due to the bonding effects is robust to the exclusion of IPO effects.

Higher cash holdings are potentially more valuable for financially constrained firms than for firms without financial constraints (Gamba and Triantis, 2008). Cross listing enables foreign firms to tap the U.S. capital market and thereby lowers financial constraints. Thus, we verify the robustness of our findings in sub-samples of firms from financially unconstrained countries with high sovereign credit ratings (from AAA+ to A-) and those from constrained countries with lower sovereign credit ratings (i.e., BBB+ and below) by Standard & Poor's. We report the results for these two sub-groups of firms in column (3) and column (4) of Table 5. The findings support our hypothesis that firms hold more cash after cross listing in the U.S market irrespective of the financial constraint status in their home market. Further, in untabulated regressions for a subsample of financially constrained and unconstrained firms, we repeat the same analysis as in Table 3 and 4 and the coefficients of cross listing and type III ADR remain positive and statistically significant. Thus, financial constraints are not driving our main result of higher cash holdings for cross-listed firms.

As a further robustness check, we define cash over total sales as an alternative cash holdings measure and repeat the regression analyses with cash/total sales ratio as the new dependent variable in Panel B of Table 5. We find that the coefficient on cross listing ranges from 0.061 to 0.196 and is always statistically significant, analogous to the

models presented in Table 4 which have cash/net assets as the dependent variable. These additional regression results are further evidence favoring our second and third alternative hypotheses. Likewise, in untabulated regressions of cash/total sales, we also repeat the equity-raising effects analysis of Panel A by excluding a five year period surrounding the listing event. We obtain results similar to those shown in columns (1) and (2) in that cross listing and level III ADRs coefficients are positive and statistically significant. We also perform a number of additional robustness tests and find our key results are robust to alternative sample formation methods and variable definitions.[10]

Interplay of cross listing and home-market investor protection on firms' cash holdings

So far we have shown that firms hold more cash when shareholders are better protected. Since firms commit themselves to a higher degree of shareholder protection by cross listing in the U.S., their cash holdings increase after cross listing. Emerging market firms benefit more from cross listing relative to developed market firms. Since firms in

[10] These additional robustness tests include: (1) propensity score matching (Rosenbaum and Rubin, 1983), in which we obtain a statistically significantly positive effect of cross-listing on cash holdings for matched smaller groups of pairs; (2) the use of all non-cross-listed firms from our sample countries, without matching them with ADRs this time, and treating them as a comparison group relative to the cross-listed firms; (3) following previous studies, re-estimating the model using the Fama and Macbeth (1973) cross-sectional model, which is estimated annually to utilize all the information in the regression for each year (OPSW, 1999); and (4) include the next 2 year's geometric average sales growth as additional control variables in the regressions. The main finding i.e., the positive relation between cross-listing and cash holding continues to hold. These results are available upon request.

our sample are from home markets with varying degrees of investor protection, we calibrate the degree of improvement due to cross listing more accurately in this section.

To assess the joint effect of cross listing and the home markets' investor protection quality, we classify the ADR issuing firms into two groups representing lower home country investor protection standards versus higher home country standards. The cutoff point for the classification is the median value of the respective investor protection variables. In other words, we form the low and high groups separately for the three investor protection variables, yielding six groups in all. Therefore, we classify firms from countries with values less than the median values of the level of KKM-IPI, LLSV2-IPI, and accounting standards in the low investor protection group and flagged them with a 1 for the corresponding indicator variable. The same indicator variable is set to 0 for firms from countries with scores above the median values of the investor protection measure. Then, we interact the low home-country investment quality indicator variable with the cross listing variable.

We present the results of this analysis in Table 6. The effects of low IPI and low accounting disclosure standards are analyzed in three separate columns. In columns (1) and (2) low shareholder protection variables have a statistically significant negative coefficient of -0.489 and -0.417 for KKM-IPI and LLSV2-IPI respectively. These results again confirm that cash holdings are lower for firms operating in countries with poor investor protection. Likewise, the statistically significant positive coefficient on level III ADRs implies that the cash holdings ratio is more than 20% higher for level III cross-listed firms. The statistically significant positive coefficient on the interactive variable implies that the increase in the cash ratio upon cross listing is 43.8% and 26.4% higher

based on KKM-IPI and LLSV2-IPI respectively for the cross-listed firms from low shareholder protection countries than for all other firms in the sample.[11] Similarly, as shown in column (3), low level of accounting standards decreases cash holdings by 43.4% while cross listing increases the cash holdings ratio by 23.9% for a level III listing. Here too, the coefficient on the interaction term suggests the biggest increase in cash holdings of an additional 31.1% is experienced by cross-listed firms originating in countries with low accounting standards. Thus, the increase in the cash holdings ratio upon cross listing is of a higher magnitude for firms originating from countries with lower shareholder protection and lower accounting standards. This result is in line with our third hypothesis that firms from countries with poor investor protection have more to gain from cross listing compared to firms from home countries with relatively better investor protection.

V. Conclusion

Our study extends the transaction cost model of cash holdings by showing that the quality of investor protection is a statistically significant determinant of a firm's cash holdings. While larger cash holdings can also be subject to expropriation, the relatively stronger governance of cross-listed firms suggests that such negative effects are minimized. We show that the relation between higher investor protection and cash holdings is particularly strong for the period after the Asian, Russian, and Latin American financial crises of 1997-1998, relative to the years prior to the crises. We attribute this

[11] These other firms include non-cross-listed firms from all countries as well as cross-listed firms from countries where the shareholder protection score is already high.

change to an increasing awareness among investors about the importance of good corporate governance after the financial crises. Investor protection features such as strong shareholder protection and reliable accounting and corporate information disclosure standards help reduce agency costs by improving corporate governance. Lower agency costs reduce the valuation discount applicable to a firm's cash holdings. In turn, higher valuation of cash creates incentives for corporations to hold more cash.

Our findings support this notion. Cross-listed firms have significantly higher cash holdings than their domestic non-cross-listed peers, even though cross-listed firms have a greater access to external finance. We show that firms hold more cash after cross listing because investors value the firm's excess cash more highly after it cross lists in the United States. This is because investors believe that stronger shareholder protection in the U.S. market is an effective bonding mechanism to ensure that cash will be put to good use as a result of reduced misappropriation by managers. Further, after cross listing, firms originating from weaker shareholder protection markets increase their cash holdings by more than firms from relatively stronger shareholder protection markets. Similarly, firms listed as a level III ADR, which is required to adhere to the most stringent laws and regulations representing the highest shareholder protection, hold more cash relative to other types of ADRs. Thus, we conclude that the relative magnitude by which firms increase their cash holdings is related to the degree of improvement in investor protection.

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Table 1. Summary statistics of key variables for 1992-2009

Descriptive statistics on key firm specific variables are shown in Panel A for our sample of firm-years from 1992 to 2009. Net cash ratio, Cash/NA is the ratio cash and equivalents net assets, the the latter is computed as total assets minus cash holdings. NWC/NA is the ratio of net working capital to net assets. We measure firm size by its natural log of assets, adjusted using the CPI to 2009 dollars. The market-to-book ratio is computed as the ratio of the market value to common equity recorded in the books, which represents common shareholders' investment in a company. Following OPSW (1999), cash flow is calculated as earnings before interest and taxes, depreciation, and amortization, less interest, taxes, and common dividends. Total leverage is the ratio of total debt to total assets. For industry sigma or volatility of cash flows in each industry, we follow the method in Dittmar and Mahrt-Smith (2007). First we compute the rolling average of the cash flows for each firm during the prior 10 years and then obtain the standard deviation of the averaged cash flow for all firms in a given industry sector. Panel B presents country-wise statistics. It describes the number of firm-year observations, number of firms, number of ADR firms, the average cash/net assets, cash/sales, the *Investor Protection Index (IPI),* and accounting standards scores for each country included in the sample. The KKM-IPI (2010) is constructed by summing over six governance indicators reported by KKM (2010) starting from year 1996. The LLSV2-IPI (1997, 1998) is the product of LLSV's (1997, 1998) anti-director rights index and rule-of-law index divided by 10.

Panel A. Summary statistics of key variables for 1992-2009

Variable	Mean	Standard Deviation	Median	Firm-year Observations
Cash/NA	0.23	0.69	0.07	39,766
Cash/sales	0.34	1.40	0.08	39,766
Mark-to-book ratio	2.32	34.01	1.00	24,888
NWC/NA	-0.23	0.40	-0.08	39,766
Log of real total asset	14.23	2.54	14.49	30,766
Total leverage	0.20	0.21	0.15	39,766
R&D/sales	0.02	0.06	0.00	39,766
Cash flow/NA	-0.63	1.15	0.07	39,766
Industry sigma	0.75	0.19	0.76	39,766
Expenditure	0.06	0.06	0.05	39,766

Panel B. Country wise descriptive statistics

Country	No of Sample and matched firms	No of firms cross listed as ADRs	No of firm-year observations	Cash/Net Assets	Cash/Sales	KKM-IPI (2010)	LLSV2-IPI (1997, 1998)	Accounting Standards Score
Developed markets								
Australia	220	110	2,843	0.45	0.21	9.51	4.0	75

Austria	30	15	444	0.17	0.25	9.85	2.0	54
Belgium	24	12	358	0.20	0.25	8.02	0.0	61
Denmark	28	14	369	0.31	0.61	11.04	2.0	62
Finland	26	13	389	0.14	0.10	11.35	3.0	77
France	138	69	1,915	0.27	0.33	7.27	2.7	69
Germany	124	65	1,782	0.21	0.23	9.23	0.9	62
Greece	20	7	321	0.10	0.13	4.35	1.2	55
Hong Kong	216	108	2,929	0.28	0.47	7.57	4.1	69
Ireland	32	18	485	0.54	0.62	9.24	3.1	-
Italy	62	31	818	0.13	0.27	4.32	0.8	62
Japan	362	182	4,512	0.21	0.17	6.58	3.6	65
Netherlands	70	35	1,143	0.16	0.18	10.48	2.0	64
New Zealand	8	4	131	0.07	0.29	10.57	4.0	70
Norway	40	20	586	0.13	0.16	10.21	4.0	74
Portugal	18	9	266	0.06	0.11	7.00	2.6	36
Singapore	54	27	647	0.17	0.24	8.84	3.4	78
Spain	34	17	486	0.07	0.17	6.60	3.1	64
Sweden	47	24	840	0.21	0.43	10.51	3.0	83
Switzerland	55	28	794	0.58	0.69	10.49	2.0	68
United Kingdom	364	182	5,120	0.36	0.63	9.17	4.3	78
Developed Total / *Average*	1,972	990	27,178	*0.41*	*0.28*	*8.90*	*2.7*	*66.3*
Emerging markets								
Argentina	31	17	462	0.07	0.21	-1.01	2.1	45
Brazil	201	100	3,071	0.10	0.16	-0.01	1.9	54
Chile	46	23	765	0.07	0.10	6.75	3.5	52
Colombia	6	3	76	0.06	0.16	-3.29	0.6	Na
India	60	30	1,034	0.23	0.30	-1.34	2.1	57
Indonesia	26	13	342	0.15	0.30	-4.26	0.8	4.2
Israel	34	18	451	0.30	0.39	3.52	3.1	-
Jordan	6	3	57	0.10	0.15	0.03	0.4	-
Malaysia	10	5	148	0.14	0.22	2.16	2.7	76
Mexico	125	63	1,903	0.10	0.23	-0.58	0.5	60
Peru	18	9	288	0.09	0.19	-1.97	0.8	38
Philippines	14	7	226	0.14	0.24	-2.06	0.8	65
South Africa	116	58	1,595	0.12	0.17	2.18	2.2	70

South Korea	47	25	714	0.22	0.24	3.1	1.1	62
Taiwan	38	20	835	0.15	0.18	5.01	2.6	65
Thailand	18	9	288	0.12	0.34	0.31	1.3	64
Turkey	11	6	177	0.13	0.12	-1.06	1.0	51
Venezuela	10	6	156	0.07	0.27	-5.27	0.6	40
Emerging Total / *Average*	817	415	12,588	*0.13*	*0.21*	*0.10*	*1.6*	*53.5*
Overall Total / *Average*	2,789	1,405	39,766	*0.23*	*0.30*	*5.98*	*2.2*	*62*

Table 2. The effect of investor protection on cash holdings in the home markets

Sample period is 1992-2009 and the firms included in this analysis are non-cross-listed. Panel A reports the effects of investor protection index (*IPI*) on cash holdings. The dependent variable in all OLS regressions equation shown below is the natural log of ratio of cash/net assets, which is calculated as cash divided by net assets.

$$LogNetCashRatio_{i,t} = a + \beta_1 IPI_i + \beta_2 Inflation_t + \sum_{k=3}^{12} (\beta_k ContrlVar_{i,t}^k) + \varepsilon_{i,t}$$

The IPI variable has four alternative measures: (1) KKM-IPI, (2) LLSV2-IPI, and (3) the accounting ratings. The KKM-IPI is constructed by summing over six governance indicators reported by KKM (2010) starting from year 1996. The LLSV2-IPI (1997, 1998) is the product of LLSV's (1997, 1998) anti-director rights index and rule-of-law index divided by 10. The accounting disclosure standards scores are from LLSV (1998). Inflation rate for each country in each year is obtained from the World Bank website http://data.worldbank.org/indicator. Firm size, market-to-book ratio, cash flow/net assets, total leverage, and industry sigma are defined in Table 1. Dividend dummy is an indicator variable and set to one if the firm paid a dividend in the observation year. The Panel B presents the changing effects of IPI between two periods: before 1998 and after 1998. The IPI reported in columns 1 through 4 are common law and anti-director rights index employed by Dittmar et al (2003). The *IPI* reported in column 5 and 6 is the LLSV2-IPI. The main IPI measure used in this study is reported in the columns 7 and 8; it is based on the KKM (2010).

The t-statistics are bracketed. Non-fixed effect regressions are computed using two-way clustered robust standard errors from the variance-covariance matrix: $V_{Firm\&Year} = V_{Firm} + V_{Year} - V_{White}$ (Petersen, 2009). The t-statistics for regressions are based on White's heteroscedasticity consistent standard errors. The ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level, respectively.

Panel A: Effects of investor protection index (IPI) on cash holdings			
	(1)	(2)	(3)
Intercept	-1.404***	-1.451***	-2.416***
	(-6.08)	(-5.85)	(-5.11)
KKM-IPI (2010)	0.047***		
	(4.31)		
LLSV2-IPI (1997, 1998)		0.100**	
		(2.90)	
Accounting disclosure standards			0.018***
			(3.49)
Inflation	-0.018**	-0.025***	-0.025***
	(-2.36)	(-3.68)	(-3.52)
Market-to-book ratio	0.000	0.000	0.000
	(0.23)	(0.43)	(0.49)
Real size	-0.090***	-0.086***	-0.084***
	(-5.96)	(-5.69)	(-5.66)
Cash flow/net assets	-0.081	-0.086	-0.115
	(-0.61)	(-0.69)	(-0.96)
Net working Capital/net assets	-0.868***	-0.807***	-0.738***
	(-3.76)	(-3.40)	(-3.07)
Total leverage	-0.904***	-0.860***	-0.859***
	(-3.57)	(-3.46)	(-3.49)
Industry sigma	0.182**	0.186***	0.181**
	(2.93)	(2.93)	(2.89)
R&D/sales	4.073***	4.380***	4.074***
	(5.56)	(6.01)	(5.69)
Dividend dummy	0.237***	0.240***	0.265***
	(3.29)	(3.27)	(3.53)
Expenditure	0.494	0.355	0.554
	(1.16)	(0.91)	(1.28)
Firm-year observations	9,751	10,246	10,044

Adjusted R-squared			0.17		0.16		0.17	

Panel B: Changing effects of investor protection index (IPI) on cash holdings over time

	IPI used in Dittmar, Mahrt-Smith, and Servaes (2003)				LLSV2-IPI (1997-1998)			
	Common law-IPI		LLSV-IPI (1998)				KKM-IPI (2010)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Before 1998	After 1998	Before 1998	After 1998	Before 1998	After 1998	Before 1998	After 1998
Intercept	-1.929***	-1.556***	-2.095***	-1.561***	-2.502***	-1.622***	-1.653***	-1.583***
	(-7.46)	(-11.17)	(-8.46)	(-9.94)	(-10.23)	(-11.44)	(-5.71)	(-11.88)
Common Law	-0.442**	0.203***						
	(-2.41)	(2.63)						
LLSV-IPI (1998)			-0.024	0.061**				
			(-0.61)	(2.54)				
LLSV2-IPI (1997, 1998)					0.149***	0.105***		
					(4.42)	(4.43)		
KKM-IPI (2010)							0.032*	0.034***
							(1.78)	(4.25)
Inflation	-0.001***	-0.005	-0.001***	-0.004	-0.001***	-0.001	0.000	-0.002
	(-6.90)	(-1.20)	(-6.85)	(-0.99)	(-8.38)	(-0.31)	(-0.12)	(-0.37)
Market-to-book ratio	0.006***	0.000	0.006***	0.000	0.005***	0.000	0.004***	0.000
	(3.20)	(-1.38)	(3.26)	(-1.43)	(3.07)	(-1.38)	(3.57)	(-1.41)
Real size	-0.044***	-0.088***	-0.038***	-0.087***	-0.046***	-0.088***	-0.080***	-0.089***
	(-3.07)	(-11.77)	(-2.64)	(-11.58)	(-3.26)	(-11.71)	(-4.13)	(-11.85)
Cash flow/net assets	0.045	-0.102***	0.051*	-0.103***	0.012	-0.107***	-0.003	-0.107***
	(1.52)	(-2.97)	(1.72)	(-3.00)	(0.40)	(-3.11)	(-0.05)	(-3.10)
Net working capital/net assets	-0.499***	-0.445***	-0.528***	-0.452***	-0.460***	-0.447***	-1.139***	-0.444***
	(-5.03)	(-5.08)	(-5.33)	(-5.17)	(-4.51)	(-5.11)	(-6.42)	(-5.08)
Total leverage	-0.576***	-0.934***	-0.597***	-0.929***	-0.171	-0.926***	-0.908***	-0.933***
	(-4.41)	(-11.24)	(-4.51)	(-11.16)	(-1.33)	(-11.16)	(-5.04)	(-11.25)
Industry sigma	1.135***	0.074	1.138***	0.013	1.111**	0.011	0.339	0.075
	(2.69)	(1.55)	(2.70)	(0.25)	(2.55)	(0.22)	(0.68)	(1.56)
R&D/sales	3.582***	4.268***	3.661***	4.262***	3.080***	4.166***	2.008***	4.176***
	(5.27)	(12.01)	(5.37)	(11.92)	(4.57)	(11.65)	(2.58)	(11.71)
Dividend dummy	0.226***	0.177***	0.240***	0.175***	0.295***	0.184***	0.080	0.183***
	(3.86)	(4.90)	(4.08)	(4.87)	(4.87)	(5.09)	(0.98)	(5.07)
Expenditure	0.852*	-0.171	0.89*	-0.176	0.955	-0.169	0.820	-0.173
	(1.67)	(-0.82)	(1.74)	(-0.84)	(1.63)	(-0.80)	(1.05)	(-0.82)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-year observations	3,750	11,139	3,750	11,139	1,898	11,139	3,750	11,139
Adjusted R-squared	0.39	0.23	0.39	0.23	0.34	0.23	0.34	0.23

Table 3. Changing effects of shareholder protection on the valuation of excess cash over time

We estimate Frésard and Salva (2010) cash valuation model for 2,012 firms from 39 countries for 1992 to 2009 period. We estimate a two-step regression. In step (1) we obtain excess cash (XCash) defined as the residual from the regression equation:

$$\text{Log Net Cash Ratio}_{i,t} = \beta_0 + \beta_1 \text{Inflation}_{i,t} + \beta_2 \text{MV/BV}_{i,t} + \beta_3 \text{FirmSize}_{i,t} + \beta_4 \text{CashFlow/NA}_{i,t} + \beta_5 \text{NWC/NA}_{i,t} + \beta_6 \text{Leverage}_{i,t} + \beta_7 \text{IndSigma}_{i,t} + \beta_8 \text{RD/Sales}_{i,t} + \beta_9 \text{DIVDummy}_{i,t} + \beta_{10} \text{Expenditure}_{i,t} + \varepsilon_{i,t} \quad (1)$$

In step (2) we analyze the valuation of excess cash holding based on the following model:

$$\text{MV} = \beta_0 + \beta_1 \text{IPI*XCash}_{i,t} + \beta_2 \text{IPI}_{i,t} + \beta_3 \text{XCash}_{i,t} + \beta_4 \text{E}_{i,t} + \beta_5 \text{dE}_{i,t} + \beta_6 \text{dE}_{i,t+2} + \beta_7 \text{dNA}_{i,t} + \beta_8 \text{dNA}_{i,t+2} + \beta_9 \text{RD}_{i,t} + \beta_{10} \text{dRD}_{i,t} + \beta_{11} \text{dRD}_{i,t+2} + \beta_{12} \text{I}_{i,t} + \beta_{13} \text{dI}_{i,t} + \beta_{14} \text{dI}_{i,t+2} + \beta_{15} \text{DIV}_{i,t} + \beta_{16} \text{dDIV}_{i,t} + \beta_{17} \text{dDIV}_{i,t+2} + \beta_{18} \text{dMV}_{i,t+2} + \eta + \omega + v + \varepsilon_{i,t} \quad (2)$$

The dependent variable, MV, is computed as the sum of market value of equity and book value of debt (all variables including MV are scaled by book value of total assets; thus, the final dependent variable is the market to book ratio (MB)). IPI is the Investor Protection Index. IPI*XCash is the interaction term of IPI and XCash. Earnings before interest, E, is defined as net income plus interest. NA is net assets defined as total assets minus cash and equivalent. RD is the research and development expense and set to 0 if missing. I is the interest expense and DIV is the common dividend paid. $dX_{i,t}$ refers to the change in variable X_t from year t-2 to year t and $dX_{i,t+2}$ represents the change in variable X from year to year t+2. The η, ω, and v are firm, year, industry fixed effects. The ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level, respectively.

	Common Law-IPI		LLSV-IPI		LLSV2-IPI		KKM-IPI	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Before 1998	After 1998	Before 1998	After 1998	Before 1998	After 1998	Before 1998	After 1998
Intercept	0.278***	0.135	0.259***	0.126	0.270***	0.139	0.280***	0.138
	(5.43)	(1.24)	(4.21)	(0.94)	(5.27)	(1.27)	(5.34)	(1.27)
IPI*Xcash	1.329	1.048***	-0.018	0.033	-0.734	0.151**	-0.184	0.144**
	(1.01)	(5.27)	(-0.03)	(0.56)	(-0.51)	(2.41)	(-0.16)	(2.31)
IPI	0.052	0.052	0.014	0.012	0.058	0.047	-0.017	-0.071
	(0.91)	(0.48)	(0.97)	(0.45)	(1.01)	(0.44)	(-0.62)	(-0.23)
Xcash	-0.330	-1.011***	0.473	-0.109	0.942	-0.107*	0.510	-0.101*
	(-0.33)	(-5.12)	(0.26)	(-0.45)	(0.77)	(-1.82)	(0.54)	(-1.73)
E_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(-0.76)	(0.93)	(-0.70)	(0.91)	(-0.71)	(0.91)	(-0.70)	(0.91)
dE_t	0.000*	0.000	0.000*	0.000	0.000*	0.000	0.000*	0.000
	(-1.68)	(-0.09)	(-1.71)	(-0.09)	(-1.70)	(-0.09)	(-1.74)	(-0.09)
dE_{t+2}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.21)	(0.83)	(0.21)	(0.80)	(0.23)	(0.80)	(0.18)	(0.80)
dNA_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(1.33)	(-0.80)	(1.34)	(-0.78)	(1.33)	(-0.79)	(1.38)	(-0.79)
dNA_{t+2}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(1.20)	(-0.92)	(1.20)	(-0.91)	(1.19)	(-0.91)	(1.24)	(-0.91)
RD_t	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(-0.21)	(0.96)	(-0.19)	(0.98)	(-0.17)	(1.00)	(-0.19)	(1.00)
dRD_t	0.000*	0.000	0.000*	0.000	0.000*	0.000	0.000*	0.000
	(1.89)	(-0.36)	(1.88)	(-0.34)	(1.88)	(-0.35)	(1.88)	(-0.35)
dRD_{t+2}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(1.59)	(0.26)	(1.60)	(0.30)	(1.61)	(0.29)	(1.60)	(0.29)
I_t	0.000***	0.000	0.000***	0.000	0.000***	0.000	0.000***	0.000
	(4.06)	(-0.07)	(4.07)	(-0.12)	(4.06)	(-0.13)	(4.05)	(-0.13)
dI_t	0.000**	0.000	0.0000**	0.000	0.000**	0.000	0.000**	0.000
	(-2.01)	(1.07)	(-2.04)	(1.08)	(-2.02)	(1.09)	(-2.07)	(1.09)
dI_{t+2}	0.000**	0.000	0.0000**	0.000	0.000**	0.000	0.000*	0.000
	(2.06)	(1.04)	(2.03)	(1.03)	(2.04)	(1.02)	(1.96)	(1.02)
DIV_t	0.000***	0.000	0.000***	0.000	0.000***	0.000	0.000***	0.000
	(-3.44)	(-0.32)	(-3.40)	(-0.30)	(-3.38)	(-0.29)	(-3.38)	(-0.29)

$dDIV_t$	0.000**	0.000	0.0000**	0.000	0.000**	0.000	0.000**	0.000
	(2.44)	(0.51)	(2.42)	(0.49)	(2.41)	(0.49)	(2.42)	(0.49)
$dDIV_{t+2}$	0.000*	0.000	0.000*	0.000	0.000*	0.000	0.000*	0.000
	(-1.91)	(-0.07)	(-1.89)	(-0.09)	(-1.89)	(-0.08)	(-1.85)	(-0.08)
dMV_{t+2}	-0.398***	-0.816***	-0.394***	-0.816***	-0.394***	-0.816***	-0.388***	-0.816***
	(-7.59)	(-71.21)	(-7.53)	(-70.92)	(-7.54)	(-70.95)	(-7.29)	(-70.95)
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-year observations	945	4,904	945	4,812	945	4,904	945	4,904
Adjusted R^2	0.64	0.92	0.64	0.92	0.64	0.92	0.64	0.92

Table 4. Impact of cross listing on firms' cash holding

This table presents results of panel regressions estimated to test the impact of cross listing on firms' cash holdings using cross-listed ADR firms and matched non-cross-listed control firms from 1992-2009. The dependent variable in all regressions except column (2) is the natural log of ratio of cash/net assets, which is calculated as cash divided by net assets. Column (2) uses the same 2-step regression for excess cash as reported in Panel C of table 2. Column (1), (5) and (6) are fixed-effects regressions. Cross listed is an indicator variable set to one if a firm is cross listed in the U.S.. Level III is an indicator variable set equal to 1 for level III ADR and 0 for level I, level II, and restricted ADRs. Inflation rate is obtained from the World Bank. Firm size, market-to-book ratio, Cash flow/NA, total leverage, and industry sigma are defined in Table 1. Dividend dummy is an indicator variable set to one if a firm paid a dividend in the observation year. The t-statistics are bracketed. Non-fixed effect regressions are computed using two-way clustered robust standard errors from the variance-covariance matrix: $V_{Firm\&Year} = V_{Firm} + V_{Year} - V_{White}$ (Petersen, 2009). The t-statistics for regressions are based on White's heteroscedasticity consistent standard errors. The ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full-Period	Excess Cash	Before 1998	After 1998	Emerging	Developed
Intercept	-1.446**	0.315	-0.93**	-0.709***	-1.341**	-0.031
	(-1.99)	(1.68)	(-2.78)	(-3.61)	(-2.44)	(-0.33)
Cross-listed	0.162***	0.135**	0.188	0.160**	0.218***	0.059**
	(7.11)	(2.43)	(0.19)	(2.90)	(5.16)	(2.21)
Level III ADR	0.181***	0.216***	0.091	0.250***	0.163***	0.147***
	(5.83)	(3.03)	(0.09)	(3.77)	(2.99)	(3.97)
Inflation	-0.007***	-0.027***	-0.014***	-0.043***	-0.001	-0.046***
	(-2.75)	(-5.08)	(-4.10)	(-5.51)	(-0.33)	(-6.07)
Market-to-book ratio	0.000	0.000	0.679	0.000	0.011*	0.000
	(0.17)	(-0.44)	(0.68)	(0.66)	(1.94)	(-0.76)
Firm size	-0.097***	-0.022*	-0.133***	-0.108***	0.013	-0.099***
	(-15.34)	(-1.92)	(-5.42)	(-9.38)	(0.91)	(-14.18)
Cash flow/net assets	-0.125***	0.003	-0.945	-0.024	0.271***	-0.302***
	(-3.29)	(0.03)	(-0.95)	(-0.21)	(4.64)	(-6.94)
Net working capital/net assets	-0.900***	-0.250	-1.39	-0.945***	-0.002	-1.096***
	(-11.45)	(-1.29)	(-1.39)	(-4.67)	(-0.01)	(-11.78)
Total leverage	-0.726***	-0.748***	0.482	-0.888***	0.025	-0.992***
	(-9.69)	(-4.17)	(0.48)	(-5.11)	(0.20)	(-10.90)
Industry sigma	-0.131	0.111***	1.628	0.116**	-2.639***	0.123***
	(-0.12)	(3.00)	(1.63)	(2.97)	(-3.53)	(6.12)
R&D/sales	3.500***	-1.504**	7.364***	4.926***	5.213***	2.922***
	(12.89)	(-2.72)	(5.00)	(8.78)	(7.20)	(10.05)
Dividend dummy	0.123***	0.139**	0.32*	0.102	0.629***	-0.255***
	(3.93)	(2.40)	(2.49)	(1.80)	(11.72)	(-6.96)
Expenditure	0.102	0.835**	1.647	0.596	0.714**	0.086
	(0.61)	(2.23)	(1.65)	(1.72)	(2.32)	(0.43)
Year fixed effect	Yes	No	No	No	Yes	Yes
Country fixed effect	Yes	No	No	No	Yes	Yes
Industry fixed effect	Yes	No	No	No	Yes	Yes
Firm-year observations	17,307	17,307	2,267	15,040	5,100	12,207
Adjusted R^2	0.18	0.04	0.11	0.19	0.15	0.31

Table 5. Robustness tests

The dependent variable in Panel A regressions is the natural log of the ratio of cash/net assets, which is calculated as cash divided by net assets. Net assets are total assets net of cash holdings. Columns (1) shows the regression results by removing observations of cross listing year and two years before and after the cross listing. Column (2) presents the effects of cross listing on level I and level II ADR firms' cash holdings by excluding level III ADRs. Firms with and without financial constraint in columns (3) and (4) are firms from countries rated A- and above (BBB+ and below), respectively, by Standard & Poor's. The dependent variable in Panel B regressions is the natural log of the ratio of cash/total sales. Cross listed is an indicator variable that is set to one if a firm cross listed in the U.S. and 0, otherwise. Level III is an indicator variable set equal to 1 for level III ADR and 0 for level I, level II, and restricted ADRs. Inflation rate is obtained from the World Bank. Firm size, market-to-book ratio, Cash flow/NA, total leverage, and industry sigma are defined in Table 1. The t-statistics for regressions are based on White's heteroscedasticity consistent standard errors. The ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level, respectively.

	Panel A: Cash/Net Assets				Panel B: Cash/Total Sales		
	(1) Excluding 2 years before and after cross-listing	(2) Excluding level III ADRs	(3) Financially Constrained	(4) Financially Unconstrained	(5) All	(6) Emerging	(7) Developed
Intercept	-1.248***	-1.674**	-2.926***	-0.214	-1.744***	-3.194***	-1.632***
	(-12.88)	(-2.28)	(-6.44)	(-1.09)	(-15.21)	(-17.91)	(-18.70)
Cross-listed	0.168***	0.152***	0.404***	0.135**	0.180***	0.196***	0.061**
	(6.78)	(6.56)	(4.32)	(2.65)	(10.32)	(4.90)	(2.17)
Level III ADR	0.184***		0.109	0.178**	0.114***	0.224***	0.159***
	(5.37)		(0.98)	(2.40)	(4.73)	(4.37)	(4.58)
Inflation	-0.013***	-0.006**	-0.001***	-0.087***	-0.001***	-0.004**	-0.052***
	(-5.43)	(-2.14)	(-7.112)	(-6.23)	(-9.02)	(-2.04)	(-7.18)
Market-to-book ratio	0.001	0.000	0.024**	0.000	0.000	0.004	0.000
	(1.05)	(0.21)	(2.84)	(0.54)	(0.00)	(1.33)	(-1.32)
Firm size	-0.097***	-0.093***	-0.042	-0.121***	-0.026***	0.078***	-0.031***
	(-15.55)	(-14.08)	(-1.20)	(-10.61)	(-5.38)	(6.54)	(-4.90)
Cash flow/NA	0.040	-0.137***	0.140	-0.146*	-0.098***	0.157***	0.275***
	(0.87)	(-3.50)	(1.67)	(-2.09)	(-5.19)	(2.62)	(5.81)
NWC/NA	-0.878***	-0.911***	-0.092	-0.810**	-0.820***	-0.648***	-0.777***
	(-10.15)	(-11.36)	(-0.42)	(-3.85)	(-15.44)	(-4.94)	(-8.78)
Total leverage	-0.652***	-0.720***	-0.060	-1.035***	-0.539***	-0.279**	-0.185**
	(-7.97)	(-9.10)	(-0.26)	(-5.68)	(-10.60)	(-2.45)	(-2.39)
Industry sigma	0.125***	0.024	0.485	0.131	0.001***	-0.007	-0.020
	(8.36)	(0.02)	(1.72)	(0.97)	(6.77)	(-0.28)	(-1.46)
R&D/sales	5.072***	3.572***	7.097***	4.741***	6.457***	7.767***	8.475***
	(19.07)	(12.74)	(5.73)	(11.59)	(31.01)	(9.92)	(34.97)
Dividend dummy	0.137***	0.126***	0.463***	-0.094	-0.259***	0.169***	-0.297***
	(4.00)	(3.86)	(4.60)	(-1.64)	(-10.44)	(3.38)	(-8.03)
Expenditure	0.294	0.062	1.079***	0.468	1.635***	1.184***	1.825***
	(1.59)	(0.35)	(2.29)	(1.15)	(11.16)	(3.98)	(8.05)
Year fixed effect	Yes	Yes	No	No	Yes	Yes	Yes
Country fixed effect	Yes	Yes	No	No	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	No	No	Yes	Yes	Yes
Firm-year observations	15,824	15,824	16,855	6,922	17,351	5,112	12,239
Adjusted R^2	0.28	0.18	0.25	0.12	0.24	0.15	0.23

Table 6. Impact of cross listing on firms' cash holdings – by home market investor protection

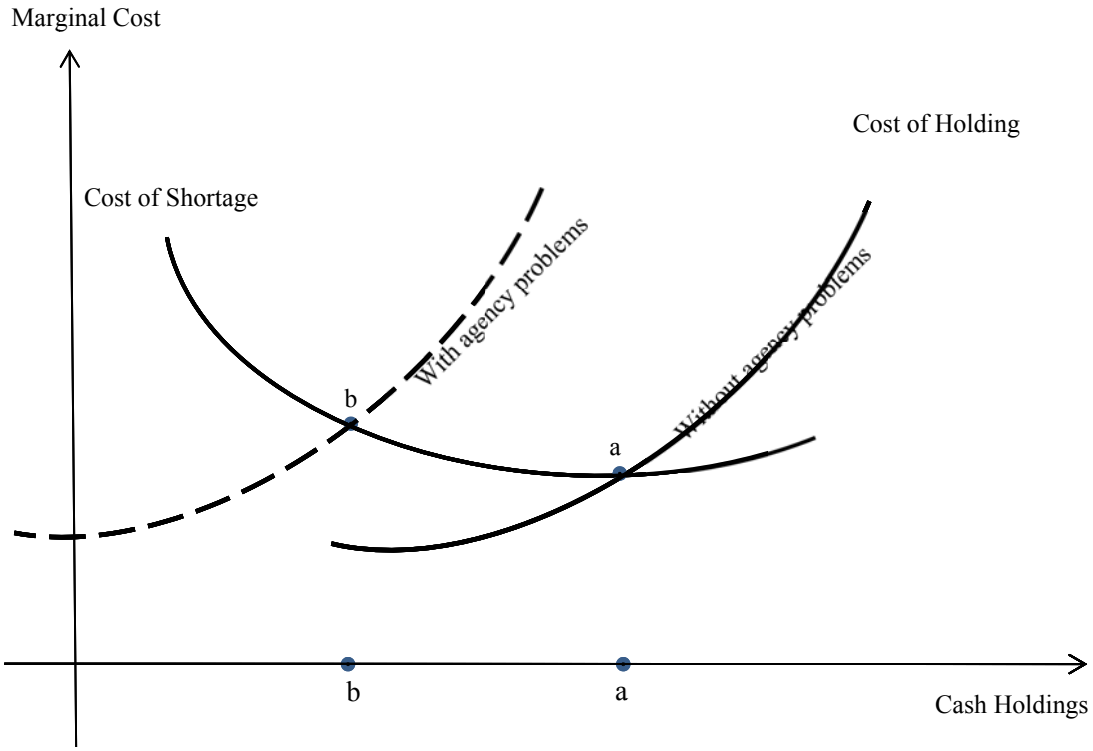
This table presents results of panel regressions for the impact of cross listing on firms' cash holdings using a matched control sample from 1992-2009. The dependent variable in all regressions is the natural log of ratio of cash/net assets:

$$LogNetCashRatio_{i,t} = \alpha + \beta_1 CrossListing_{i,t} + \beta_2 LevelIIIADR_{i,t} + \beta_3 InterTerm_t + \beta_4 LowIPI_t + \beta_5 Inflation_t + \sum_{k=1}^{8} (\beta_{k+5} ContrlVar^k{}_{i,t}) + \varepsilon_{i,t}$$

where cross listed is an indicator variable set to one if a firm cross listed in the U.S.. Level III is an indicator variable set equal to one if the firm is level III ADR and zero otherwise. Cross listing is interacted with the investor protection quality in the firms' home market, which itself is constructed as a dichotomous variable set to 1 if the measure is below the median and 0 otherwise. Inflation rate is obtained from World Bank. Firm size, market-to-book ratio, Cash flow/NA, total leverage, and industry sigma are defined in Table 1. Dividend dummy is an indicator variable set to one if a firm paid a dividend in the observation year. The t-statistics are bracketed and are computed using two-way clustered robust standard errors computed from the variance-covariance matrix: $V_{Firm\&Year} = V_{Firm} + V_{Year} - V_{White}$ (Petersen, 2009). The ***, **, * indicate statistical significance at the 0.01, 0.05 and 0.10 level, respectively.

	(1)	(2)	(3)
Intercept	-0.676***	-0.819***	-0.763***
	(-3.96)	(-5.03)	(-4.38)
Low KKM-IPI (2010)	-0.489***		
	(-4.90)		
Low LLSV2-IPI (1997, 1998)		-0.417***	
		(-7.11)	
Low accounting disclosure standards			-0.434***
			(-4.37)
Cross-listed	0.001	0.045	-0.016
	(0.01)	(0.80)	(-0.21)
Level III ADR	0.223***	0.203***	0.239***
	(3.23)	(3.01)	(3.17)
Cross-listing*low KKM-IPI (2010)	0.438***		
	(4.05)		
Cross-listing*low LLSV2-IPI (1997, 1998)		0.264***	
		(3.30)	
Cross-listing*low accounting disclosure standards			0.311**
			(2.84)
Inflation	-0.016**	-0.001***	-0.017***
	(-2.83)	(-7.04)	(-3.77)
Market-to-book ratio	0.000	0.000	0.000
	(0.65)	(0.81)	(0.78)
Real size	-0.107***	-0.105***	-0.098***
	(-9.53)	(-9.96)	(-8.62)
Cash flow/net assets	-0.018	0.021	-0.028
	(-0.19)	(0.43)	(-0.31)
Net working capital/net assets	-0.884***	-0.354**	-0.782***
	(-4.51)	(-2.70)	(-3.96)
Total leverage	-0.789***	-0.585***	-0.703***
	(-4.62)	(-3.71)	(-4.05)
Industry sigma	0.108**	0.216***	0.106***
	(2.89)	(5.66)	(2.93)

R&D/sales	4.91***	6.119***	5.099***
	(9.29)	(13.41)	(9.59)
Dividend dummy	0.102*	0.158**	0.09
	(1.94)	(2.87)	(1.68)
Expenditure	0.744*	0.706*	0.706*
	(2.01)	(2.03)	(2.01)
Firm-year observations	16,563	22,584	17,351
Adjusted R^2	0.18	0.16	0.17



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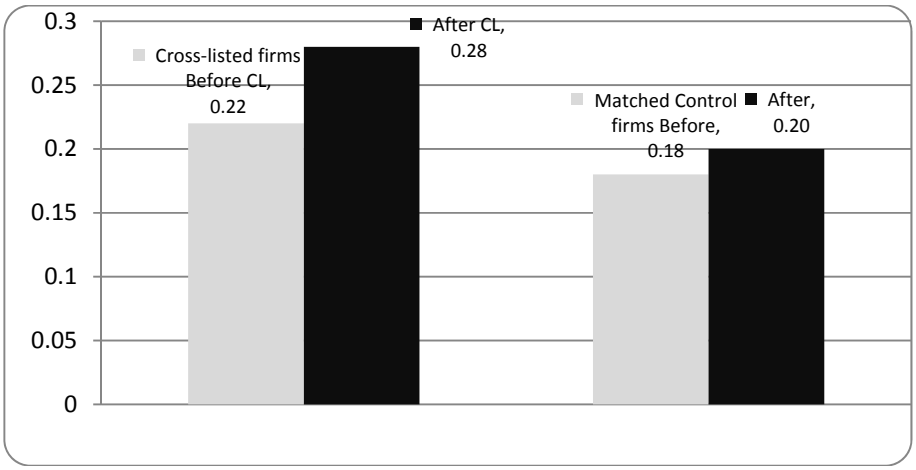
Panel A: Cash/Net assets five years before and five years after cross listing: Cross-listed versus matched firms



Panel B: Cash/Net assets before and after cross-listing: Developed versus emerging by market

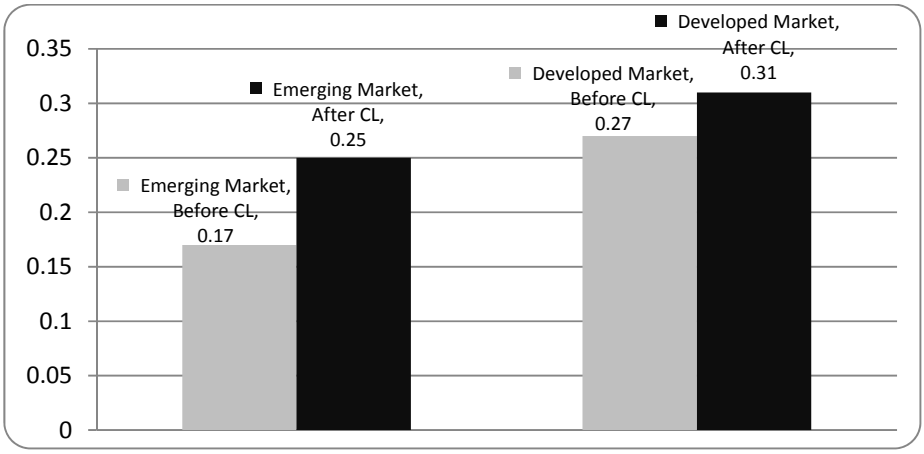


Figure 2. Cash/Net assets 5 years before and 5 years after the base year for cross-listed (CL) and non-cross-listed (NCL) firms

Cash/Net assets is the ratio of cash and equivalents to the net assets computed as total assets less cash and equivalents. The base year is the year that the firm cross listed. Average cash/net asset ratio in 5 years prior to cross listing and 5 years after cross listing are plotted.

Chapter 3 Value of Excess Cash: The Role of Governance and Investment Policy

ABSTRACT

Previous literature has reached a unanimous conclusion that excess cash is value-enhancing for good governance firms. We find that, however, excess cash exacerbates agency problems such as excessive perquisites and overinvesting. Our empirical findings indicate that investors recognize these trade-offs and assign the highest value for excessive cash holdings of firms with good governance practices and low acquisitions. Excessive cash holdings are increasingly discounted as a firm engages heavily in external acquisitions. Further, investors attach lower value to excess cash for low growth firms, which are defined as firms with problems of overinvestment, poor management's performance, and poor investment opportunities.

I. Introduction

Investors' valuation of excess cash mirrors how they expect the cash to be used (Fresard and Salva, 2010). When assessing the value of excess cash, investors account for factors that increase or decrease of their wealth. Among these factors, agency costs, according to Jensen and Meckling, 1976, are linked to a reduction in valuation of excess cash, evidenced by Fresard and Salva (2010) and Huang, Elkinawy, and Jain (2012). The problems with excess cash holding is that it can be legally deployed to undertake negative NPV acquisition for hidden motives such as empire building (Harford, Mansi, & Maxwell, 2008; Richard, 2006). Prior literature has suggested that strong shareholder protection mechanism can mitigate agency problems (La Lorta, Lopez-de-Silvanes, Shleifer, & Vishny, LLSV hereafter, 1998), and thereby increase valuation of the excess cash (Dittmar and Mahrt-Smith, 2007; Frésard and Salva, 2010). However, these papers have relied heavily on country level indices or firm level governance variables instead of investigating the actual use of excess cash. Therefore, even though the results of aforementioned papers have made significant contribution to the literature in agency theory, they have left a substantial gap in testing free cash flow hypothesis in terms of deployment of excess cash and the firms' investment policy. In this study, we disentangle the effect of investment policy and governance on excess cash. We find that the valuation of excess cash varies by free cash flow, growth opportunities, investment policy, and acquisitions. More specifically, excess cash is valued more for firms with good governance, low free cash flow, and low acquisitions. The free cash flow hypothesis predicts managers' fringe benefits such as power, prestige, job satisfaction, etc. increase

with rapid acquisitions although these have negative NPV (Lang, Stulz, & Walking, 1991). Thus, for poorly-governed firms, it destroys valuation of excess cash when high free cash flow is coupled with an investment policy of aggressively engaging in acquisitions. We find that excess cash is positively valued for organic capital expenditure, which we call built investment. This result is in sharp contrast with that of bought investment, i.e., acquisitions. Our study is the first to show that although the value that investors attach to excess cash is greater for a firm with good investor protection, the value-added effect disappears if (1) the firm has low growth and (2) the firm engages in acquisitions, particularly if it has high free cash flow.

We focus our analysis on a sample of 3,679 U.S. firms over the study period from 2003 to 2009. The proxy for corporate governance, *GOV,* is produced by Institutional Shareholder Services (ISS)[12] and is a comprehensive firm-level governance measure incorporating 50 governance items and six governance categories which measure a variety dimension of minority shareholder protection. We examine whether the value of excess cash is affected by governance, free cash flow, acquisitions, and investment policy using panel regression. We show that the combination of investor's valuation of excess cash is not only dependent on the strength of investor protection, but also contingent on the investment policy. We differentiate firms by the level of free cash flow, the scale of acquisitions, and investment opportunities. From the multivariate evidence, the positive value attached to the excess cash for well-governed firms disappears for low growth firms. Further, we show that the excess-cash premium is essentially zero for low firms

[12] ISS is a research firm and was acquired by RiskMetrics Group in 2007.

who invest in negative NPV project and has a shortage of positive NPV investment project even with the presence of good governance and low free cash flow. In contrast, there is a positive excess-cash premium for high growth firms. Finally, investors attach no positive value to excess cash if there is high level of free cash flow.

II. Literature

Agency Costs—Valuation of Excess Cash under Governance Framework

Firms with good governance efficiently allocate resources, prohibiting managers from contemplating and undertaking unwarranted projects. Agency problems are manifested by the level of cash reserve (Frésard and Salva, 2010; Zerni, Kallunki, & Nilsson, 2010). The divergent interests managers and investors gives excess cash a significantly different meaning for each. For the agent, cash can be more easily converted to private benefit (Jensen, 1986). Hence, cash holding is a proxy for the desire of the agent to expropriate wealth from minority shareholders. Further, depending on the strength of investor protection, investors discount the value of excess cash. Dittmar and Mahrt-Smith (2007) document the relation between corporate governance, the relative valuation of a firm's cash holdings and the firm's market value. They provide empirical evidence that the value of cash is substantially less if corporate governance is poor. Zerni, Kallunki, and Nilsson (2010) reveal that firms enjoy higher valuation of cash and other liquid assets by shareholders when they have better governance. Further, Frésard and Salva (2010) show that firms cross listing in the U.S., thereby incurring obligations to better protect investors and provide better governance, receive a higher valuation for excess cash.

Huang, Elkinawy, and Jain (2013) show that better governance leads to an increase in valuation of excess cash, further resulting in an increase in excess cash. The positive association between excess cash, good governance, and high firm valuation and the inverse association between excess cash, poor governance, and low firm valuation are further bolstered by the evidence reported by Kalcheva and Lins (2007) and Pinkowizt, Stulz, and Williamson (2006) for global firms.

However, an unresolved question is whether the valuation of excess cash depends on potential investment opportunities that firms face. More specifically, we assume that value attached to excess cash varies depending on investment policy, i.e., on whether or not firms have good investments opportunities available and how firms deploy their excess cash such as by engaging in acquisitions.

Free Cash Flow Hypothesis—Valuation of Excess Cash under Investment Policy Framework

Cash rich firms may overinvest (Richardson, 2006). Free cash flow, as defined by Jensen (1988), is cash flow left after investing in all available positive NPV projects. Jensen (1988) free cash flow hypothesis states that managers will invest in negative NPV projects if there is ample free cash flow. Thus, there is an inverse relationship between the cash flow and valuation. Because excess cash is essential for growth firms (Almeida, Campello, & Weisbach, 2004), we hypothesizethat the value attached to excess cash varies by the level of free cash flow and the availability of investment opportunities. According to Lang, Stulz, and Walking (1991), Tobin's q can serve as a proxy for firm growth opportunity set because Tobin's q is less than 1 when the value of the firm's assets in place is less than their replacement cost. This is a sufficient condition to define

firms with low q as firms have poor investment opportunities, [13], although there is bias in this measure (Lang, Stulz, and Walking, 1991). Additionally, the most recent empirical studies find supporting evidence to the notion that poor governance is associated with overinvestment (Billett, Garfinkel, & Jiang, 2011; Harford, Mansi, & Maxwell, 2008; Richardson, 2006). As such, effective and strong corporate governance would alleviate the agent problems of investing in wasteful projects and have less instances or less likelihood of overinvestment. According to Richardson (2006), overinvesting is spending decisions or activities beyond the needs to maintain assets in place. He finds that free cash flow hypothesis predicts that cash-rich firm may undertake overinvesting activities.

The free cash flow hypothesis posits that cash flow increases the agency costs of firms with poor investment opportunities (Stulz, 1990, Lang, Stulz, & Walking, 1991). As a result, unless positive NPV projects are readily available, negative NPV projects are likely to be undertaken by managers with ample excess cash. In such cases, excess cash does not have attached positive value. For instance, in examining U.S. acquisition of foreign firms, Doukas (1994) reveals that the bidder returns are inversely related to free cash flow for firms with low q firms. Based on the foregoing discussion, we test the following hypothesis:

Hypothesis I: For firms with poor availability of investments, the value of excess cash cash is <= 0.

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[13] Doukas (1995) treat low q firms as poorly managed overinvesting firms and in Lang and Litzenberger (1989), the Tobin's q is an indicator of overinvestment. Lang, Stulz, and Walking (1989) interpret Tobin's q as a measure of management's performance. Lang, Stulz, and Walking (1991) classify low q firms as firms with poor investment opportunities because overinvesting activities involve investing negative NPV project when the positive NPV projects are exhausted. In this study, we generalize it as low q firms, representing firms with problems of overinvestment, poor management's performance, and poor investment opportunities.

Free cash flow and acquisitions often go together. The free cash flow hypothesis suggests that firms with high cash flow and poor investment opportunities are more likely to engage in acquisitions that do not increase firm value (Lang, Stulz, & Walking, 1991; Stulz, 1990). Cash flow is one of the sources of financing for acquisitions. Cash-rich makes acquisitions affordable. Harford (1999) concludes that cash-rich firms have higher likelihood than other firms to attempt acquisitions and these acquisitions are value decreasing. Moreover, a stream of literature has shown that firms' cash reservoir significantly determines the investment policy. But what is unclear is whether investors attach positive valuation to excess cash with respect to acquisition decisions. Although it has been documented that good governance could mitigate value-destructive mergers and acquisition (Billet, Garfinkel, & Jiang, 2011; Lewellen, Loderer, & Rosenfeld, 1985; Masulis, Wang, & Xie, 2007), Richardson (2006) suggests that out of a large set of governance measures, they may not effectively curb overinvestment. We suspect that unless the free cash flow is consistently put into a good use and vigilantly -monitored by strong governance, investors attach non-positive value to excess cash, especially in the case of engaging in acquisitions when firms have large free cash flow. Hence, we test the following hypothesis:

Hypothesis II: For firms with excess acquisitions, excess cash has a value <= 0.

III. Data and Methodology

Test Design

Our initial sample comprises firms in the Corporate Governance Quotient (CGQ) dataset. According to Brown and Caylor (2006) the CGQ has a broader scope,

incorporates more firms and is more dynamic than other governance indices. The firm-level minority shareholder protection data are available for a total of 8,735 firms for the years 2003 through 2009. Starting from 2003, every two years, the CGQ has added additional governance attributes to the CGQ matrix and more firms to the dataset. For consistency, we construct governance measures using the attributes that are available across all 7 years. Our sample comprises 5,696 firms. Following Jiraporn, Kim, and Kim (2011), we compute a comprehensive measure of the quality of the minority shareholder protection, *GOV*, which is constructed by awarding one point for each of the 50 governance standards listed in the Appendix.[14] The 50 items are divided into eight categories measuring a different dimension of minority shareholder protection. Topics covered include audit, board of directors, charter/bylaws, director education, executive and director compensation, ownership, progressive practices, and state of incorporation. Moreover, the effectiveness of governance index used in our study in relating to firm valuation has been documented by Aggarwal, Erel, Stulz, and Williamson (2009) for in a global context.

For firms for which we have *GOV*, we obtain accounting and financial ratios from Compustat and the U.S. annual CPI index from CRSP. We convert CAD to USD. Following previous research, we assign zero to records with missing values for research and development expenses, taxes and interest expense, and dividend and share repurchase. We drop financial firms (SIC codes from 6000 to 6999) and utility firms (SIC codes 4900

[14]The minimum standard is provided and described in ISS Corporate Governance Quotient- CGQ Best Practices Manual published December, 2008.

to 4999) and firms with incorrect SIC codes (SIC codes 9900 to 9999). Further, we winsorize our sample at the 1 percentile and 99 percentile. Our final sample comprises 3,808 firms and 19,946 firm-year observations. Variable definitions are provided in Table 7.

Test Design

Value-Added Effect of Excess Cash and Good Governance.

To gauge the effect of excess cash and governance on firm valuation contingent on investment strategy and decision, we employ valuation regression developed by Fama and French (1998). We regress firm value on the excess cash holdings using the same set of control variables as Dittmar and Mahrt-Smith (2007). The valuation regression is based on a two-step regression system employing excess cash to investigate the joint effect of governance and excess cash on firm valuation. For the first step we estimate:

$$LogNetCashRatio_{i,t} = \beta_0 + \beta_1 Inflation_{i,t} + \beta_2 Tobinsq_{,t} + \beta_3 FirmSize_{i,t} + \beta_4 CF/NA_{i,t} + \beta_5 NWC/NA_{i,t} + \beta_6 Leverage_{i,t} + \beta_7 VolCash_{i,t} + \beta_8 R\&D/Sales_{i,t} + \beta_9 DivDummy_{i,t} + \beta_{10} CapExp/NA_{i,t} + \varepsilon_{i,t} \quad (1)$$

where *LogNetCashRatio* is the logarithm of *Cash* divided by *NA* in the main analysis and is the logarithm of the ratio of *Cash* to *Sales* in the robustness tests. The remaining variables are defined in Table 7[15]. *Excess cash* is the residual obtained from the step 1

[15] In equation (1), we do not include *GOV* as a control variable. As stated in Dittmar and Smith (2007, footnote 14), including or excluding governance measure in the optimal cash regression does not affect the excess cash estimates. In unreported results, we confirm that our conclusions remain unchanged with governance measures included or excluded.

regression. We include all the cash holdings determinants identified by Opler, Pinkowitz, Stulz, and Williamson (1999) and by Huang, Elkinawy, and Jain (2013).

In the second step, we estimate the valuation regression, which has been shown in previous studies to perform well. For a given variable, let $X_{i,t}$ be the valuation of the variable for firm *i* at time *t*, $\Delta X_{t-1} = (X_{i,t}-X_{i,t-1})/\text{Net Assets}_{i,t}$, and $\Delta X_t = (X_{i,t+1}-X_{i,t})/\text{Net Assets}_{i,t}$. We estimate the following equation:

$$V_{i,t} = \beta_0 + \beta_1 \text{GOV*XCash}_{i,t} + \beta_2 \text{GOV}_{i,t} + \beta_3 \text{XCash}_{i,t} + \beta_4 E_{i,t} + \beta_5 \Delta E_t + \beta_6 \Delta E_{t-1} + \beta_7 \Delta NA_t + \beta_8 \Delta NA_{t-1} + B_9 R\&D_{i,t} + \beta_{10} \Delta R\&D_t + \beta_{11} \Delta R\&D_{t-1} + \beta_{12} I_{i,t} + \beta_{13} \Delta I_t + \beta_{14} \Delta I_{t-1} + \beta_{15} \text{Div}_{i,t} + \beta_{16} \Delta \text{Div}_t + \beta_{17} \Delta \text{Div}_{t-1} + \beta_{18} \Delta V_{t-1} + \eta_{i,t} + \omega_{i,t} + \varepsilon_{i,t} \quad (2)$$

All the variables are deflated using the net assets in the year t. The main variable of interest is the interaction between governance and *XCash*. The coefficient β_1 represents the marginal effect of excess cash and corporate governance on firm valuation.

VI. Empirical Results

Univariate Results

Table 7, Panel A, presents descriptive statistics for all firms. The mean and median of *GOV* are 30.13 and 30 (n = 19,946 firm-years), respectively, which is close to the value of 22.82 (n = 9,878 firm-years) reported by Jiraporn, Kim and Kim (2011). Mean cash holdings is 23%, which is similar to the 17% reported by Opler, Pinkowitz, Stulz and Williamson (1999) and the 22% reported by Dittmar and Mahrt-Smith (2007) for U.S. firms. Huang, Elkinawy, and Jain (2013) report 23% for a sample of American Deposit Receipts (ADR).

In Table 7, Panel B, we report results of the tests of the null hypothesis of equality of means for our sample of good and poor governance firms. We reject the hypothesis of equality for all of the variables except *EBITSALES, ER, NWC/NA,* and *ROE.* However, we find that poorly-governed firms have lower *Tobin's q*, *RD* and *VolCash*. *Cash/NA* and *Cash/Sales* for poorly-governed firms are both higher. On the contrary, firms with good governance have remarkably higher levels of *Cash* and *E*. In addition, firms with good governance generally have larger *Firm size* and *Leverage*. More importantly, the well-governed firms have greater *Free Cash Flow* and a higher *AcquisitionRatio*.

Figure 3 shows the plot of *Cash/NA* by good vs. poor governance and by high vs. low *Tobin's q* firms. We find that high *Tobin's q* firms have higher *Cash* than low *Tobin's q* firms regardless of the quality of governance.

Multivariate Results

Valuation by FCF, Acquisitions, Capital Expenditure, and Tobin's q

Using a two-step procedure, we investigate whether there are differences in the valuation of firms' *Free Cash Flow* related to *Free Cash Flow, Acquisitions*, *CapExp*, and *Tobin's q*. We form eight samples by classifying firms as follows: high (low) *Free cash flow*, high (low) *Acquisitions*, high (low) *CapExp,* and high (low) *Tobin's q*, using a median cutoff in each case except for *Tobin's q* where the cutoff is 1.

In step 1, we regress the log of *Cash/NA* against *Inflation*, *Tobin's q*, *Firm Size*, *CF/NA*, *NWC/NA*, *Leverage*, *VolCash*, *R&D/Sales*, *DivDummy*, and *CapExp/NA* and obtain the residuals, which we call *XCash.*

In step 2, we regress *V* against *GOV*XCash, GOV, XCash, E, ΔE, Δ*E, ΔNA, Δ*NA, RD, ΔRD, Δ*RD, I, ΔI, Δ*I, DIV, ΔDIV, Δ*DIV, Δ*V*. Δ indicates the change in a variable from t+1 to t and Δ* indicates the change in a variable from t to t-1.

The results for the eight regressions are reported in Table 9, Panels B and C. As shown in Table 9, Panel B, column (1), the coefficient of the *GOV*XCash* is 0.18, which is statistically significant at the 0.01 level, indicating that the combination of excess cash and governance adds value for low *Free cash flow* firms. However, it does not add value for high *Free cash flow* firms as the interaction term GOV*XCash is statistically insignificant in column (2). On the effects of *Acquisitions*, the high *Acquisitions* appear to reduce valuation with statistically significant coefficient of -0.730. *CapExp* does not differ much between high and low firms as seen in Panel C, columns (5) and (6). Thus, our first hypothesis that there is no difference in value-added effect of excess cash and governance between high capital expenditure and low capital expenditure firms holds.

In Table 9, Panel C, the columns (7) and (8), we report the valuation differences by high and low *Tobin's q*. Obviously, excess cash and governance lowers valuation for low

Tobin's q firms and improves valuation for high *Tobin's q* firms, supporting our first hypothesis. To further investigate this valuation difference, we classify firms into four groups according to median values of both *Free cash flow* (FCF) and *Tobin's q* (q). The results are shown in Table 10. The coefficient of the key variable GOV*XCash is statistically significantly negative for low *Free cash flow* and low *Tobin's q* firms, however, is statistically significantly positive for low *Free cash flow* and high *Tobin's q* firms. Thus, we conclude that excess cash and governance does not add value to low *Tobin's q* firms, supporting our first hypothesis.

The Effect of FCF and Acquisition

Continuing our investigation of firms' investment, in this section, we examine the impact of the acquisitions. We create a dichotomous variable, *AfterBefore*, with value of 1 indicating after acquisitions and 0 before. We let *FCF* = 1 (= 0) if a firms' *Free Cash Flow* is greater (less) than its median value in a given year. We conduct a difference-in-difference (DID) test by interacting *AfterBefore* with *FCF*, creating DID values. DID measures the impact of high *FCF* and acquisitions on valuation after taking into account the valuation difference between the high and low *Free Cash Flow* firms before acquisitions. We report the result for poorly-governed firms in column (1) and for firms with good governance in column (2). The DID is statistically significantly negative in column (1), implying that high free cash flow and engaging in acquisitions is value-destructive for poorly-governed firms. This does not hold for firms with good governance, however, because the DID is statistically insignificant in column (2). To further advance our analysis, we then form four groups: low FCF low acquisitions, high FCF high

acquisitions, high FCF low acquisitions, and low FCF high acquisitions using the median value of the free cash flow and acquisitions. The analysis results are given in Table 10. Again, the statistically significantly positive coefficient of 0.14 reported in column (2) suggests that there is an increase in valuation as a result of excess cash and good governance, when both free cash flow and acquisitions are low. In column (3) where both the free cash flow and acquisitions are high, the *GOV*XCash* is statistically insignificant. In contrast, excess cash and good governance reduce valuation if high acquisitions, albeit the free cash flow is low as can be seen in column (5). These results support our second hypothesis that excess cash and governance does not add value to firms that engage in acquisitions and are consistent with the notion that high acquisitions destroy value.

Determinants of Acquisitions

It has shown that the high acquisitions do not add value to firms. Thus, it is natural to explore the determinants of firms' decision and the likelihood of acquiring other firms. To this end, we estimate a three-step regression. First, we obtain the excess cash from the first step one regression as shown in equation (1). Then we use a logit model by regress firm characteristics on a dummy variable, which is set to 1 if the firm acquired other firms in a given year and set to 0 if there are no acquisition activities. In the third step, we interact the predicted probability obtained from the second step logit model with the excess cash derived from the first step to estimate the combined effect of excess cash and firms' likelihood to acquire other firms on valuation. The logit regression outcomes are shown in columns Panel A, columns (1) and (2) where we report the coefficient estimates and odds ratio (OR). The OR facilitates the interpretation of the coefficient. The

probability of acquiring is positively associated with the strength of governance with an OR 1.009. That is, one unit increase in governance, we expect to see 1 % increase the odds of acquiring. This result is consistent with our univariate result reported in Table 7 that the acquisition ratio in good governance firms is statistically higher than that of poor governance firms. In addition, firms that issue debt is associated with nearly 1.4 times higher odds to acquire other firms than firms that do not issue debt. Moreover, for one unit increase in R&D expense, we expect to see 54% increase in the odds of acquiring other firms. Similarly, one unit increase in firm size and in cash flow volatility is associated with respetive14% and 8% increase in odds of acquiring. However, one unit increase in leverage ratio, capital expenditure, tax ratio, and cash holdings is associated with a decrease in the odds of acquiring. Firms with losses have 14% decreases in odds to acquire relative to the firms with profits. Next, we move to the effect of excess cash and expected probability to acquire on valuation. As shown in columns (1) to (4), the excess cash together with the estimated probability to acquire does not add value to firms with high free cash flow. There is an increase in value when firms have low capital expenditure, high capital expenditure, and low free cash flow with low capital expenditure firms have highest improvement in valuation. In Panel B, we groups firms by good vs. poor governance and by high vs. low free cash flow. Again, the interaction term of Prob*XCash is statistically insignificant when poorly-governed firms have high cash flow. The coefficient estimate is statistically significantly positive for all other groups with the incremental change in a descending order of low FCF and good governance > good governance > good governance and high FCF >poor governance > poor governance and low FCF. We believe that the valuation difference and the sequence of valuation by

groups result from the fact that good governance firms tend to make wise acquisition decisions that create wealth for investors, while poorly-governed firms may invest in marginal profit acquisition projects. This result is parallel to the Doukas's (1995) finding that high q bidders have substantially higher returns than low q bidders. As a result, we find strong evidence that excess cash does not add value to firms with high acquisitions, particularly for poorly-governed firms with high free cash flow.

Robustness

We have presented the evidence in supporting our hypotheses using the conventional measures of cash ratio. Now we move to probe into the validity of our findings. We employ a battery of robustness tests. First, we examine whether our results still hold using alternative measure of cash ratio. Following Harford, Mansi, and Maxwell (2008) we use the log value of the ratio of cash to sales as an alternative measure of liquidity. In untabulated tables, the results are consistent as reported in Tables 9 to Table 13.[16]

The paper tests the robustness of these results using alternative empirical models including two-step Heckman Selection Model[17] to approach the endogeneity inherent in the relationship between governance and firms' excess cash and between the governance and acquisition decision. As presented in Table 14, the firms in high acquisition group in columns (2) and (4) have statistically insignificant coefficient for the variable of interests

[16] These results are available upon request.

[17] Acquisition decision mechanism: $Acquisition_i^* = z'_i r + u_i$, $Acquisition_i = 1$ if $Acquisition_i^* > 0$ and 0 otherwise; observed only if $Acquisition_i = 1$, (u_i, ε_i) ~bivariate normal $[0,0,1,\sigma\varepsilon, \rho]$;

GOV*XCash. The combination of excess cash and governance is only statistically significant and positive for low free cash flow and low acquisitions firms. This confirms our conclusion reached in the previous session that excess cash and governance does not add value to high free cash flow firms who engage in acquisitions.

Further, we investigate to see if firms' valuation varies depending on the available investment opportunities using the alternative cut-off point of Tobin's Q. Although Tobin's q greater (less) than unity has a theoretical appeal to classify firms as having poor (good) investment opportunities, which has been used in many studies (Lang, Stulz, and Walkling,1991, Lang and Litzenberger, 1989), we use alternative way of identifying firms' available investment opportunities by following Yoon and Starks (1995). Specifically, firms that have three year average Tobin's q above (below) the unity are classified as having good (poor) investment opportunities. The conclusions remain the same as already reported in the Tables 6 through 10. Thus, our results and conclusion are not sensitive to how the cut-off point for high q and low q firms is determined.

Finally, we perform the same set of analyses using the valuation model in the study of Frésard and Salva (2010) where the total assets is used to normalize the variables rather than net assets. We continue find the same results. Our results are consistent irrespective of the definition of excess cash and the ultimate choice of the cut-off point for classifying the high q and low q firms. Our conclusions remain the same.

IV. Conclusion

Using a comprehensive firm-level governance score for a sample of U.S. firms, we investigate the impact of the excess cash in conjunction with governance on firm

valuation. Our investigation focuses exclusively on the U.S. firms by using a comprehensive firm-level governance score as our governance measure and finds supporting evidence to the agency theory and free cash flow hypothesis in the context of firm valuation. Moreover, contemporaneous studies of Frésard and Salva (2010) and Huang, Elkinawy, and Jain (2013) show that excess cash contributes more to firm valuation for firms with strong country-level governance than that of firms from weak country-level governance. Consistently, our evidence shows that with stronger firm-level governance, firm valuation increases in excess cash. Our findings extend the governance and firm valuation matrix from the country level to the firm level. Further, the effect of the excess cash and governance on valuation varies contingent upon free cash flow and acquisitions. Based on our empirical results, the combination of excess cash and good governance does not enhance valuation if firms have ample free cash flow and also heavily engage in acquisitions.

Further, we differentiate our results by low q and high q firms. Harford (1999) and Richardson (2006) show that firms have rich cash tend to overinvest. From our univariate analysis, we find that high q firms tend to hold higher cash holdings relative to low q firms. Our evidence of low q firms have lower level of excess cash lends further support to spending hypothesis that as shown by Harford, Mansi, and Maxwell (2008) firms with weaker governance will spend cash more quickly rather than hoard it than those with stronger governance. From the panel regression analysis, we show that combination of excess cash and governance does not attribute more value to low q firms.

We are the first study providing empirical evidence that the mechanism of strong governance and excess cash changing firm value is dependent on firms' available

investment opportunity and the decisions and scale of acquisitions. In line with previous research, our findings supply further evidence in support of agency theory and free cash flow hypothesis. Our analysis implies that firms with good governance have higher odds of pursuing acquisitions, which could be due to a high initial market reward than subsequent investments (Doukas, 1995). However our analysis does not try to answer the question which forces in governances and how governance shape the firms' decision in acquisitions and expansion.

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Appendix.

List of Items Comprising the GOV Index

We use the items below taken from the CGQ dataset. There are 50 items in total and each company receives one point for each criterion that it meets, which when summed is the company's *GOV*. The higher the score, the better the company's governance.

Governance standards

A. Audit

1. Audit committee consists solely of independent outside directors.
2. Auditors were ratified at the most recent annual meeting.
3. Consulting fees paid to auditors are less than audit fees paid to auditors.
4. Company has a formal policy on auditor rotation.

B. Board of directors

1. Managers respond to shareholder proposals within 12 months of shareholder meeting.
2. CEO serves on no more than two additional boards of other public companies.
3. All directors attend at least 75% of board meetings or had a valid excuse for nonattendance.
4. Size of the board of directors is at least six but not more than 15 members.
5. No former CEO serves on board.
6. CEO is not listed as having a "related party transaction" in proxy statement.
7. Board is controlled by more than 50% independent outside directors.
8. Compensation committee is comprised solely of independent outside directors.
9. The CEO and chairman duties are separated or a lead director is specified.
10. Shareholders vote on directors selected to fill vacancies.
11. Board members are elected annually.
12. Shareholder approval is required to change board size.
13. Nominating committee is comprised solely of independent directors.
14. Shareholders have cumulative voting rights to elect directors.
15. Board guidelines are in each proxy statement.
16. Policy exists requiring outside directors to serve on no more than five additional boards.

C. Charter/bylaws

1. A simple majority vote is required to approve a merger (not a supermajority).
2. Company either has no poison pill or a pill that was shareholder approved.
3. Shareholders are allowed to call special meetings.
4. A majority vote is required to amend charter/bylaws (not a supermajority).
5. Shareholders may act by written consent and the consent is non-unanimous.
6. Company is not authorized to issue blank check preferred stock.
7. Board cannot amend bylaws without shareholder approval or can only do so under limited circumstances.

D. Director education

1. At least one member of the board has participated in an ISS-accredited director education

program.

E. Executive and director compensation
1. No interlocks exist among directors on the compensation committee.
2. Nonemployees do not participate in company pension plans.
3. Option repricing did not occur within last three years.
4. Stock incentive plans were adopted with shareholder approval.
5. Directors receive all or a portion of their fees in stock.
6. Company does not provide any loans to executives for exercising options.
7. The last time shareholders voted on a pay plan, ISS did not deem its cost to be excessive.
8. The average options granted in the past three years as a percentage of basic shares outstanding did not exceed 3% (option burn rate).
9. Option repricing is prohibited.
10. Company expenses stock options.

F. Ownership
1. All directors with more than one year of service own stock.
2. Officers' and directors' stock ownership is at least 1%but not more than 30% of total shares outstanding.
3. Executives are subject to stock ownership guidelines.
4. Directors are subject to stock ownership guidelines.

G. Progressive practices
1. Mandatory retirement age for directors exists.
2. Performance of the board is reviewed regularly.
3. A board-approved CEO succession plan is in place.
4. Board has outside advisors.
5. Directors are required to submit their resignation upon a change in job status.
6. Outside directors meet without the CEO and disclose the number of times they met.
7. Directors' term limits exist.

H. State of incorporation
1. Incorporation in a state without any antitakeover provisions.

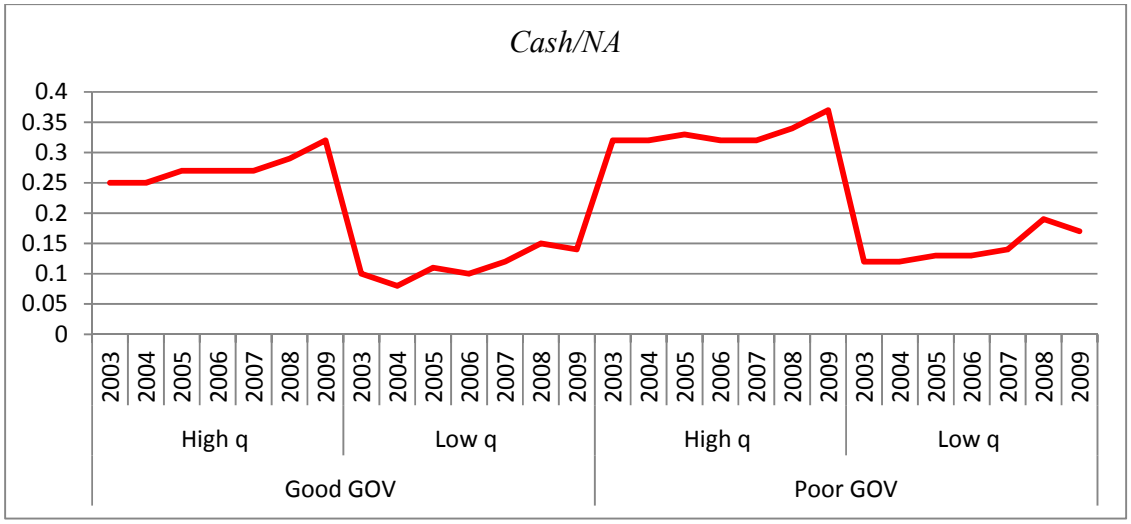

***Figure 3. Cash/NA* by Governance and Tobin's q**

We measure the quality of a company's firm-level governance using GOV, a comprehensive firm-level governance measure incorporating 50 governance items and six governance categories that measure a variety of dimensions of minority shareholder protection. Higher GOV score indicates better the firm-level governance. We classify firms as good (poor) governance firms when the GOV is above (below) the median. *Cash/NA* is cash and cash equivalent divided by *NA*. *NA* is the difference between total assets and cash and equivalent. Low (high) q firms are defined as firms have Tobin's q greater (less) than one (Lang and Litzenberger, 1989).

Table 7. Definition of Variables

This table reports the definition of the variables. The first variable is the governance measure and the remaining variables are listed alphabetically.

Variable	Definition
GOV	Firm-level governance measure: A comprehensive governance quality measure that is the sum of the 50 firm-specific items listed in the Appendix.
AcquisitionDummy	Dummy variable that equals to 1 if the acquisition method is not missing and 0 otherwise.
AcquisitionRatio	Acquisition (Compustat item 838) divided by *NA*.
CapExp/NA	Capital expenditure (Compustat item 842) divided by *Total Assets*.
Cash	Cash and short-term investments (Compustat item 120).
Cash flow	Earnings Before Interest (Compustat item 552) minus Interest paid-net (Compustat item 894)] minus Income tax-total (Compustat item 747) minus Dividends common/ordinary (Compustat item 542)]
Cash/NA	*Cash* divided by *NA*.
Cash/Sales	*Cash* divided by *Sales*.
CF/NA	*Cash flow* divided by *NA*.
DIV	Common dividend paid (Compustat item 845).
DivDummy	A dummy variable that equals 1 if the firm pays a dividend in a given year and 0 otherwise.
E	Sum of Earnings (Compustat item 364), interest expense (Compustat item 894), deferred tax credits (Compustat item 950), and investment tax credits (Compustat item 275).
EBITSALES	Earnings Before Interest and Taxes (Compustat item 815) divided by *Sales*.
ER	Retained earnings (Compustat item 364) divided by common/ordinary equity-total (Compustat item 116)
Firm Size	Logarithm of *Total Assets*.
Free cash flow	*Operating Cash Flow* minus capital expenditure (Compustat item 842) minus *RD* (see Denis and Sibilkov (2010).
Free cash flow ratio	*Free cash flow* divided by *Total Assets.*
I	Net interest paid (Compustat item 894).
Inflation	Computed based using annual Consumer Price Index (CPI) from 2002 to 2009 as $(CPI_t\text{-}CPI_{t-1})/CPI_{t-1.}$

Table 8. Definition of Variables (Cont.)

IssueDebt	Dummy variable that equals 1 if the change in book value of total long-term debt (data 9 plus data 34) exceeds five percent of the pre-issue book value of assets (data 6-data 9) and 0 otherwise—following D'Mello and Miranda (2010).
Leverage	Long-term debt (Compustat item 150) divided by *Total Assets*.
LossDummy	A dummy variable that equals 1 if net income is negative and 0 otherwise.
NA	*Total Assets* minus *Cash*.
NWC/NA	Net working capital (Compustat item 473) divided by *NA*.
Operating Cash Flow	Earnings before interest and taxes (Compustat item 551) minus income taxes-total (Compustat item 747) plus depreciation and depletion (Compustat item 856)]
R&D/Sales	*RD* divided *Sales*.
R&D/TA	*RD* divided by *Total Assets*.
RD	Research and development expense (Compustat item 815).
ROE	Net income (loss) (Compustat item 630) divided by common/ordinary equity-total (Compustat item 116).
Sales	Sales/Turnover (Net) (Compustat item 715).
Salesgrowth	$(S_t + S_{t-1})/2$ where S = Sale/turnover net (Compustat item 715) and t is a given year.
TaxRatio	Income Tax (Compustat item 747) divided by *Total Assets.*
Tobin's q	[Market Value-Total minus Fiscal (Compustat item 1027)] divided by *Total Assets.*
Total Assets	Total assets (Compustat item 109).
V	Market value-total-fiscal (Compustat item 1027) plus liabilities–total (Compustat item: 307).
VolCash	For each firm, we collect a time series of yearly values of *Cash Flow*. For each industry (based on 4 digit SIC codes), we pool the observations of *Cash Flow* for the years 1992 through 2001 for all of the firms within the industry and calculate the standard deviation of these values. We assign this standard deviation to each of the firms in the industry for 2001. Values for other years are calculated similarly.
VolEarnings	For each firm, we collect a time series of yearly values of *E*. For each industry (based on 4 digit SIC codes), we pool the observations of *E* for the years 1992 through 2001 for all of the firms within the industry and calculate the standard deviation of these values. We assign this standard deviation to each of the firms in the industry for 2001. Values for other years are calculated similarly.

Table 9. Descriptive Statistics and Comparison of Firm Characteristics

We measure the quality of a company's firm-level governance using *GOV*, a comprehensive firm-level governance measure incorporating 50 governance items and six governance categories that measure a variety of dimensions of minority shareholder protection. The variables are defined in Table 7. A higher *GOV* score indicates better firm-level governance. In Panel B, we classify firms as good (poor) governance firms when *GOV* is above (below) its median. We test the null hypothesis that the means for good- and poor-governance firms are equal using a t test. N ranges from 18,150 to 19,946. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively.

Firm characteristics	N	Mean	Median	STD	25th	75th
Panel A: All Firms						
GOV	19,946	30.13	30.00	4.97	27.00	34.00
AcquisitionDummy	19,946	0.17	0.00	0.38	0.00	0.00
AcquisitionRatio	19,276	0.02	0.00	0.07	0.00	0.01
CapExp/NA	19,946	0.05	0.03	0.06	0.01	0.06
Cash[1]	19,859	320.5	39.57	1,701	8.05	152.6
Cash flow	19,946	230.5	18.29	1,174	0	104.5
Cash/NA	19,946	0.23	0.14	0.24	0.04	0.35
Cash/Sales	19,946	1.02	0.12	4.43	0.03	0.41
CF/NA	19,946	-0.01	0.07	0.29	0.00	0.11
DIV[1]	19,946	51.82	0.00	447.9	0.00	1.84
DIVDummy	19,946	51.82	0.00	447.9	0.00	1.84
E[1]	19,849	140.7	6.25	1,173	-5.28	56.78
EBITSALES	19,601	-5.97	0.06	264.8	-0.02	0.12
ER	19,807	-1.53	0.30	66.28	-0.71	0.76
Firm Size	19,946	6.09	6.32	2.64	4.34	7.99
Free cash flow	19,861	-0.19	0.02	3.13	-0.10	0.07
Free cash flow ratio	19,861	-0.19	0.02	3.13	-0.10	0.07
I[1]	18,150	50.19	2.56	311	0.20	22.35
Inflation	19,946	2.55	2.72	1.22	1.88	3.42
IssueDebt	19,946	0.52	1.00	0.50	0	1
Leverage	19,946	0.49	0.45	0.32	0.27	0.63
LossDummy	19,946	0.36	0.00	0.48	0.00	1.00
NA[1]	19,862	2,918	307.5	13,800	72.56	1,327
NWC/NA	19,946	0.04	0.04	0.22	-0.06	0.16
Operating Cash Flow	19,849	325.6	24.51	1,596	1.09	139.8
R&D/Sales	19,946	0.37	0.01	1.84	0.00	0.10
R&D/TA	19,946	0.07	0.01	0.14	0.00	0.08
RD[1]	19,946	45.03	0.86	166.5	0.00	18.59
ROE	19,845	-0.15	0.08	8.87	-0.07	0.16
Sales						
Salesgrowth	19,946	2,053	336.4	5,445	39.83	1,376
TaxRatio	19,843	0.02	0.01	0.05	0.00	0.04
Tobins' q	19,946	2.69	2.05	4.69	1.20	3.53
Total Assets[1]	19,862	2,919	308	13,800	73.26	1,327
V[1]	19,862	5,128	532.4	22,490	124.5	2,221
VolCash	19,946	0.47	0.17	0.81	0.07	0.58

Table 8—Continued

Panel B: Comparison of Firm Characteristics by Governance Category

	Good Governance		Poor Governance		
	Mean	STD	Mean	STD	T-statistics
GOV	34.31	2.63	26.20	3.10	199.8**
AcquisitionRatio	0.03	0.07	0.02	0.07	4.84**

AcquisitionDummy	0.19	0.39	0.15	0.36	7.35**
CapExp/TA	0.05	0.06	0.05	0.06	3.98**
Cash[1]	540.1	2,371	114.1	488.2	17.28**
Cash flow	401.7	1,630	69.83	356.7	19.57**
Cash/Sales	0.79	3.79	1.24	4.95	-7.24**
Cash/NA	0.21	0.22	0.25	0.25	-11.21**
CF/NA	0.02	0.25	-0.04	0.32	13.19**
DIV[1]	95.61	633.1	10.74	97.23	13.03**
DIVDummy	0.99	0.07	0.99	0.10	3.63**
E[1]	255.3	1,649	32.87	293.2	13.04**
EBITSALES	-5.40	211	-6.51	307	0.30
ER	-1.32	85.00	-1.73	41.59	0.42
Firm Size	6.53	3.01	5.67	2.16	23.01**
Free cash flow	183.2	1,176	22.30	245.2	13.17**
Free cash flow Ratio	-0.09	0.76	-0.28	4.29	4.52**
Inflation	2.51	1.35	2.59	1.08	-4.75**
I[1]	83.42	433.6	18.20	81.89	13.96**
IssueDebt	0.64	0.48	0.41	0.49	33.84**
Leverage	0.51	0.29	0.47	0.35	8.05**
LossDummy	0.31	0.46	0.40	0.49	-14.08**
NA[1]	5,042	19,191	921	3,883	20.67**
NWC/NA	0.04	0.19	0.04	0.25	0.62
RD[1]	72.74	218.1	19.05	88.03	22.53**
R&D/TA	0.06	0.13	0.08	0.15	-6.94**
Operating Cash Flow	569.5	2,216	95.9	464.5	20.55**
R&D/Sales	0.30	1.64	0.43	2.01	-5.11**
ROE	-0.13	9.26	-0.17	8.49	0.32
Salesgrowth	3,206	6,892	972	3,240	28.99**
TaxRatio	0.02	0.06	0.02	0.05	7.06**
Tobins' q	2.76	4.62	2.63	4.76	2.01*
Total Assets[1]	5,043	19,190	922	3,883	20.67**
VolCash	0.43	0.77	0.51	0.85	-6.85**
V[1]	8,762	30,913	1,712	7,679	21.75**

Table 10. Valuation of Excess Cash

In step 1, we regress the log of *Cash/NA* against *Inflation*, *Tobin's q*, *Firm Size*, *CF/NA*, *NWC/NA*, *Leverage*, *VolCash*, *R&D/Sales*, *DivDummy*, and *CapExp/NA* and obtain the residuals, which we call *XCash.* Panel A presents the results for stage 1.

All variables not defined here are defined in Table 7. We create a new variable, *GOV*XCash*, by multiplying *GOV* by *XCash*. If *Tobin's q* >= 1 (< 1) the firms are classified as having a high (low) value (see Lang and Litzenberger, 1989). For each of the remaining classification variables, high (low) is greater (less) than the median. Each variable is for firm *i* at time *t* unless otherwise indicated. Δ indicates the change in a variable from t+1 to t and Δ* indicates the change in a variable from t to t-1. In step 2, we regress *V* against the variables listed in column 1 of Panels B.

We report the results of the estimation of this regression for eight subsets of the sample, corresponding to low and high values of each of the four variables indicated. Panel B presents results for the firms with low and high values of *Free cash flow* and *Acquisition*, in turn, and Panel C for the firms with low and high values of *CapExp* and *Tobin's q*, in turn. t-statistics are in parentheses. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively.

Panel A: Step 1 results

Variables	Coefficients (t statistics)
Intercept	-1.18**
	(-7.77)
Inflation	-0.03**
	(-3.89)
Tobins' q	0.19**
	(32.02)
Firm Size	-0.04**
	(-11.32)
CF/NA	-0.32**
	(-7.36)
NWC/NA	-2.37**
	(-45.03)
Leverage	-2.17**
	(-68.08)
VolCash	0.17**
	(15.39)
R&D/Sales	0.05**
	(8.52)
DivDummy	0.20
	(1.36)
CapExp/NA	-5.51**
	(-34.85)

Table 9. Valuation of Excess Cash —Continued

Panel B: Results for Free cash flow and Acquisition

Variables	**Free cash flow**		**Acquisition**	
	Low (1)	**High (2)**	**Low (3)**	**High (4)**
Intercept	0.42	0.50	0.39	0.64
	(0.24)	(1.76)	(0.33)	(1.43)
GOV*XCash	0.18**	-0.09	0.04	-0.73**
	(4.00)	(-0.89)	(0.98)	(-4.17)
GOV	0.02	0.00	0.02	0.00
	(1.14)	(-0.79)	(1.20)	(1.05)
XCash	-9.96**	0.47	-5.72**	11.94**
	(-8.87)	(0.18)	(-5.51)	(2.53)

E	-6.22**	6.88**	-6.61**	2.55**
	(-33.09)	(38.82)	(-38.73)	(18.60)
ΔE	3.17**	-1.17**	3.77**	-0.99**
	(18.19)	(-9.29)	(24.59)	(-7.90)
Δ*E	-1.60**	1.90**	-1.51**	0.83**
	(-18.30)	(18.11)	(-18.64)	(9.46)
ΔNA	0.01**	-0.19**	0.01**	0.07**
	(14.81)	(-3.93)	(13.26)	(2.37)
Δ*NA	0.00*	0.12**	0.00**	0.14**
	(-2.05)	(4.42)	(-5.73)	(6.68)
RD	-0.14	10.84**	-1.71**	6.22**
	(-0.32)	(16.51)	(-4.39)	(22.80)
ΔRD	-0.06	-2.94**	0.91**	-3.66**
	(-0.14)	(-7.09)	(2.45)	(-9.11)
Δ*RD	-1.12**	2.71**	-1.49**	0.61**
	(-4.82)	(3.80)	(-6.80)	(1.96)
I	-6.93**	6.87**	-4.88**	2.38**
	(-19.62)	(9.86)	(-15.34)	(2.76)
ΔI	3.66**	1.61	3.96**	0.63
	(14.62)	(1.60)	(17.49)	(0.57)
Δ*I	1.23**	23.63**	2.03**	0.36
	(7.35)	(32.57)	(13.31)	(0.58)
DIV	7.82**	2.85**	11.10**	4.35**
	(2.74)	(8.18)	(7.25)	(6.39)
ΔDIV	-2.81	-1.01**	-4.57**	-0.73**
	(-1.26)	(-4.33)	(-3.71)	(-2.37)
Δ*DIV	2.13	1.38**	3.06**	1.72**
	(1.78)	(5.22)	(3.53)	(3.28)
Δ*V	-0.35**	-0.51**	-0.30**	-0.73**
	(-29.90)	(-40.22)	(-29.10)	(-41.95)
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes
Firm-year obs.	5,016	5,885	6,578	4,323
Adjusted R-sq.	0.96	0.61	0.95	0.63

Table 9. Valuation of Excess Cash —Continued

Panel C: Results for CapExp and Tobin's q

Variables	**CapExp**		**Tobin's q**	
	Low	**High**	**Low**	**High**
	(5)	**(6)**	**(7)**	**(8)**
Intercept	-0.81	0.507	0.45**	0.38
	(-0.31)	(1.42)	(6.19)	(0.15)
GOV*XCash	0.41**	0.48**	-0.16**	0.19**
	(9.74)	(8.70)	(-9.41)	(4.15)
GOV	0.04**	-0.002	0.00**	0.04*
	(2.65)	(-0.55)	(5.31)	(2.50)
XCash	-15.05**	-15.06**	4.00**	-9.31**
	(-14.20)	(-10.33)	(9.25)	(-8.26)
E	-5.37**	-0.39**	0.30**	-6.72**
	(-29.57)	(-3.19)	(9.26)	(-33.72)
ΔE	2.77**	0.74**	-0.03	3.88**
	(15.75)	(6.73)	(-0.92)	(21.65)
Δ*E	0.33**	0.37**	0.16**	-1.55**
	(3.87)	(4.21)	(10.18)	(-17.01)
ΔNA	0.01**	0.006	0.00	-0.69**

	(20.24)	(1.13)	(-1.52)	(-6.18)
Δ*NA	-0.05**	0.02**	0.00	0.00**
	(-37.84)	(12.65)	(-0.59)	(-5.64)
RD	-1.18**	4.18**	0.31**	-1.86**
	(-2.91)	(15.02)	(4.76)	(-4.49)
ΔRD	1.02**	-2.06**	0.19*	0.85*
	(2.81)	(-5.90)	(2.15)	(2.12)
Δ*RD	0.75**	2.41**	0.25**	-1.82**
	(3.58)	(9.99)	(3.64)	(-7.79)
I	-3.57**	12.35**	5.52**	-5.25**
	(-11.70)	(20.09)	(40.00)	(-8.75)
ΔI	2.69**	1.90**	-0.06	3.50**
	(11.82)	(2.91)	(-1.50)	(5.30)
Δ*I	1.30**	11.27**	0.55**	1.75**
	(9.24)	(39.48)	(6.24)	(10.66)
DIV	11.38**	5.32**	1.65**	8.47**
	(6.22)	(9.10)	(7.80)	(5.33)
ΔDIV	-4.65**	-1.11**	-0.94**	-3.40**
	(-3.12)	(-2.91)	(-8.92)	(-2.70)
Δ*DIV	3.50**	2.11**	0.50**	2.60**
	(2.74)	(6.58)	(3.11)	(2.85)
Δ*V	0.03**	-0.88**	0.02**	-0.28**
	(2.82)	(-112.38)	(7.51)	(-23.10)
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes
Firm-year obs.	5,051	5,850	4,810	6,091
Adjusted R-sq.	0.90	0.99	0.49	0.95

Table 11. Valuation of Excess Cash

We retain the variables *XCash* and *GOV*XCash* created in step 1 as described in Table 9. All variables not defined here are defined in Table 7. Each variable is for firm *i* at time *t* unless otherwise indicated. Each variable is for firm *i* at time *t* unless otherwise indicated. Δ indicates the change in a variable from t+1 to t and Δ* indicates the change in a variable from t to t-1. In step 2, we regress *V/NA* against the variables listed in column 1. If *Tobin's q* >=1 (< 1) the firms are classified as having a high (low) value (see Lang and Litzenberger, 1989). For *Free cash flow*, high (low) is greater (less) than the median. t-statistics are in parentheses. ** and * indicate statistical significance at the 0.01 and 0.05 level respectively.

Variables	**Free cash flow**		**Tobin's q**	
	Both Low	**Both High**	**Low FCF High q**	**High FCF low q**
	(1)	**(2)**	**(3)**	**(4)**
Intercept	0.57**	0.88	0.64	0.42**
	(3.97)	(0.92)	(0.16)	(5.59)
GOV*XCash	-0.19**	-0.23	0.29**	0.00
	(-8.34)	(-1.57)	(4.70)	(0.04)
GOV	0.00*	-0.01	0.03	0.01**
	(2.18)	(-1.42)	(0.89)	(6.09)
XCash	4.44**	4.05	-13.49**	0.68
	(8.05)	(1.09)	(-8.48)	(0.61)
E	0.19**	8.86**	-6.31**	0.90**
	(4.09)	(30.15)	(-21.97)	(11.88)
ΔE_t	0.02	-1.25**	3.34**	-0.16**
	(0.55)	(-6.18)	(11.90)	(-3.34)
Δ*E	0.16**	3.38**	-1.96**	0.29**
	(7.69)	(16.56)	(-15.54)	(8.26)
ΔNA	0.00	0.12	-0.50*	0.03
	(-0.30)	(1.39)	(-2.53)	(1.66)
Δ*NA	0.00	0.04	0.00	0.01
	(-0.94)	(0.92)	(-0.44)	(1.02)
RD	0.22**	8.84**	-0.12	1.82**
	(2.60)	(10.46)	(-0.20)	(4.13)
ΔRD	0.20	-2.12**	0.18	-0.61
	(1.87)	(-3.78)	(0.32)	(-1.08)
Δ*RD	0.28**	4.91**	-1.65**	0.42
	(3.44)	(4.95)	(-5.30)	(1.23)
I	5.27**	13.56**	-6.92**	5.42**
	(28.03)	(10.94)	(-8.22)	(20.41)
ΔI	-0.01	-3.76*	1.50	0.22
	(-0.18)	(-2.38)	(1.59)	(0.51)
Δ*I	0.53**	27.63**	0.29	1.53**
	(4.91)	(26.20)	(1.29)	(3.27)
DIV	1.08*	2.09**	6.90	1.53**

	(2.14)	(4.52)	(1.57)	(5.87)
ΔDIV	-0.55	-0.67	-2.40	-0.88**
	(-1.27)	(-1.96)	(-0.78)	(-9.66)
Δ*DIV	0.33	1.27**	2.11	0.33
	(1.09)	(3.90)	(1.34)	(1.80)
Δ*V	0.02**	-0.57**	-0.37**	-0.13**
	(5.16)	(-34.95)	(-20.15)	(-9.31)
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes
Firm-year obs.	2,103	3,178	2,912	2,707
Adjusted R-sq.	0.54	0.63	0.96	0.54

Table 12. The Effect of Free Cash Flow and Acquisitions by Governance—DID

Step 1 is the same as in Table 9. The step 2 dependent variable is *V/NA*. A firm has good (poor) governance if its value of GOV is above (below) the median. Each variable is for firm *i* at time *t* unless otherwise indicated. Δ indicates the change in a variable from t+1 to t and Δ* indicates the change in a variable from t to t-1. *BeforeAfter* is a dummy variable that equals 1 if ACQMETH (Compustat item 63) is not missing. *FCF* is a dummy variable that equals 1 if the firms' *Free cash flow* is high if it is greater than its median value. *DID* is *BeforeAfter* multiplied by *FCF*. t-statistics are in parentheses. The remaining variables are defined in the Table 7. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively.

	Poor Governance (1)	**Good Governance (2)**
Intercept	-0.69	0.40
	(-0.35)	(1.01)
DID	-0.58*	-0.04
	(-1.97)	(-0.47)
FCF	1.46**	0.16**
	(8.17)	(2.68)
Acquisition	0.33	-0.20**
	(1.48)	(-3.14)
XCash	-4.21**	-11.96**
	(-19.72)	(-34.40)
E	-7.42**	1.25**
	(-37.45)	(8.17)
ΔE	4.37**	-0.51**
	(24.41)	(-4.00)
Δ*E	-1.73**	0.06
	(-19.90)	(0.70)
ΔNA	0.01**	0.48**
	(10.91)	(7.08)
Δ*NA	0.00	-0.04
	(-0.79)	(-1.17)
RD	0.32	3.14**
	(0.62)	(12.10)
ΔRD	1.63**	1.26**
	(3.83)	(4.22)
Δ*RD	-0.63	0.08
	(-1.47)	(0.68)
I	-6.49**	7.99**
	(-20.86)	(10.82)
ΔI	4.47**	-0.95
	(17.41)	(-1.18)
Δ*I	1.27**	-0.55
	(6.37)	(-1.28)
DIV	11.79**	4.27**
	(4.42)	(7.77)
ΔDIV	-2.87	-0.87*
	(-1.39)	(-2.23)
Δ*DIV	4.32*	1.39**
	(2.46)	(4.30)
Δ*V	-0.32**	0.08**
	(-28.81)	(7.37)
Year fixed effect	Yes	Yes
Industry fixed effect	Yes	Yes

Firm-year obs.	5,028	5,873
Adjusted R-sq.	0.96	0.54

Table 13. Valuation of Excess Cash by Governance, FCF, and Acquisitions

The dependent variable in the step 1 regression is the logged net cash ratio which is computed as cash/net assets. *XCash* and *GOV*XCash* are from the step 1 regression reported in Table 9. Each variable is for firm *i* at time *t* unless otherwise indicated. Δ indicates the change in a variable from t+1 to t and Δ* indicates the change in a variable from t to t-1. The remaining variables are defined in the Table 7. The step 2 dependent variable is the V/NA and the independent variables are listed in column 1. A firm has good (poor) governance if its value of GOV is above (below) the median. *Free cash flow* is high if it is greater than its median value. *Acquisition* is high if it is greater than its median value. t-statistics are in parentheses. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively.

	Both Low **(1)**	**Both High** **(2)**	**High FCF Low Acquisition** **(3)**	**Low FCF High Acquisition** **(4)**
Intercept	1.11	1.02	0.08	0.41
	(0.46)	(1.57)	(0.24)	(0.63)
GOV*XCash	0.14**	0.04	-0.13	-0.66**
	(2.73)	(0.13)	(-1.05)	(-2.48)
GOV	0.00	-0.01*	0.01	0.02**
	(0.15)	(-2.25)	(1.46)	(2.33)
XCash	-8.86**	-3.24	1.44	9.18
	(-6.73)	(-0.40)	(0.44)	(1.27)
E	-6.53**	5.31**	7.33**	1.20**
	(-28.91)	(23.07)	(25.72)	(5.72)
ΔE	3.42**	-1.91**	-0.83**	-0.42**
	(16.54)	(-10.64)	(-4.63)	(-2.22)
Δ*E	-1.69**	1.23**	2.85**	0.52**
	(-16.16)	(10.89)	(15.08)	(3.69)
ΔNA	0.01**	-0.04	-0.08	0.06
	(11.63)	(-0.79)	(-0.87)	(1.42)
Δ*NA	0.00	0.06	0.11**	0.14**
	(-1.33)	(1.76)	(2.68)	(4.78)
RD	-0.27	12.96**	9.17**	4.50**
	(-0.53)	(15.80)	(9.17)	(12.07)
ΔRD	0.09	-4.99**	-3.03**	-2.50**
	(0.19)	(-5.55)	(-5.36)	(-4.63)
Δ*RD	-1.22**	1.02	4.64**	0.40
	(-4.49)	(1.14)	(4.25)	(1.02)
I	-6.97**	0.99	8.93**	0.06
	(-16.58)	(0.88)	(9.09)	(0.04)
ΔI	3.93**	-2.61	2.31	2.66
	(13.36)	(-1.52)	(1.64)	(1.32)
Δ*I	1.26**	2.84	27.58**	-0.08
	(6.48)	(1.79)	(24.07)	(-0.10)
DIV	8.30*	3.04**	2.52**	1.07
	(2.36)	(3.93)	(5.18)	(0.57)
ΔDIV	-2.99	-0.56*	-1.13**	1.03
	(-1.12)	(-2.04)	(-3.12)	(0.60)
Δ*DIV	2.23	1.80**	1.14**	0.09
	(1.56)	(2.62)	(3.56)	(0.10)
Δ*V	-0.35**	-0.55**	-0.56**	-0.76**

	(-25.58)	(-22.40)	(-32.73)	(-27.66)
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes
Firm-year obs.	3,637	1,379	2,941	2,944
Adjusted R-sq.	0.96	0.73	0.66	0.64

Table 14. Valuation of Excess Cash by Governance, FCF, and Capital Expenditure

The step 1 variables are as described in Table 9. The step 2 regression is a Logit regression model with *Acquisition* as the dependent variable. *Prob* is the predicted probability to acquire obtained from the step 2 regression. The dependent variable in step 3 is *V*. Firms with good (poor) governance have a GOV greater than (below) the median. High and low levels of *Free cash flow*, *AcquisitionRatio* and *CapExp* are judged relative to their medians. The remaining variables are defined in the Table 7. t-statistics are parentheses. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively. Panel A reports step 1 results. Panel B reports step 2 results. Panel C reports step 3 results.

Panel A: Step 2 results

	Coefficients	**Odds Ratio**
	(1)	**(2)**
Intercept	-1.76**	
	(171.22)	
Gov	0.01*	1.01
	(4.26)	
IssueDebt	0.30**	1.34
	(39.85)	
Leverage	-0.89**	0.41
	(98.64)	
Firm Size	0.13**	1.14
	(259.95)	
CapExp/NA	-6.54**	0.00
	(202.10)	
VolCash	0.08**	1.08
	(12.01)	
LossDummy	-0.15**	0.86
	(9.33)	
R&D/Sales	0.43	1.54
	(3.38)	
TaxRatio	-1.17**	0.31
	(6.77)	
CashRatio	-2.11**	0.12
	(240.68)	
MTBV	0.01*	1.01
	(4.91)	
Firm-year obs.	19,843	
Adjusted R-sq.	0.06	

Panel B: Step 2

	Low FCF	***High FCF***	***Low CapExp***	***High CapExp***
	(1)	***(2)***	***(3)***	***(4)***
Intercept	1.18	0.97**	0.16	0.79*
	(0.70)	(3.63)	(0.07)	(2.39)
Prob*XCash	31.62**	1.28	73.79**	35.90**
	(9.13)	(0.21)	(26.28)	(7.16)
ProbAcquisition	-7.00**	-2.95*	-8.86**	-4.32**
	(-26.45)	(-2.53)	(-36.72)	(-14.19)
XCash	-0.15	-2.30**	0.14	-2.17**
	(-0.16)	(-13.97)	(0.21)	(-8.72)
E	-6.26**	6.53**	-4.76**	-0.07
	(-33.24)	(37.17)	(-27.35)	(-0.61)
ΔE	3.46**	-1.11**	3.15**	0.85**
	(19.11)	(-8.99)	(19.07)	(7.60)
Δ*E	-1.89**	1.77**	0.21**	0.32**

	(-23.48)	(17.16)	(2.69)	(3.64)
ΔNA	0.01**	-0.16**	0.02**	0.00
	(17.43)	(-3.37)	(28.64)	(0.59)
Δ*NA	0.00	0.11**	-0.05**	0.03**
	(0.91)	(4.24)	(-42.68)	(22.14)
RD	0.02	10.53**	-0.24	4.38**
	(0.06)	(16.40)	(-0.62)	(15.78)
ΔRD	0.35	-2.85**	1.45**	-2.13**
	(0.87)	(-6.93)	(4.23)	(-6.18)
Δ*RD	-1.18**	2.15**	0.34	2.20**
	(-5.02)	(3.06)	(1.74)	(9.12)
I_i	-7.44**	5.66**	-3.43**	13.02**
	(-23.71)	(8.16)	(-13.12)	(21.08)
ΔI	3.92**	2.19*	3.00**	2.87**
	(15.29)	(2.16)	(13.99)	(4.35)
Δ*I	0.24	23.27**	0.28*	11.05**
	(1.42)	(31.75)	(2.08)	(38.79)
DIV	8.02**	2.46**	10.46**	5.04**
	(2.82)	(7.18)	(6.04)	(8.67)
ΔDIV	-3.19	-0.96**	-4.52**	-1.11**
	(-1.44)	(-4.18)	(-3.22)	(-2.91)
Δ*DIV	2.21	1.15**	3.15**	1.95**
	(1.86)	(4.41)	(2.61)	(6.12)
Δ*V	-0.36**	-0.49**	0.04**	-0.86**
	(-31.71)	(-38.45)	(3.43)	(-109)
Year fixed effect	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes
Firm-year obs.	5,014	5,885	5,050	5,849
Adjusted R-sq.	0.96	0.63	0.91	0.99

Panel C: Step 3 (Poor or Good Governance; High or Low FCF)

	***Poor* (1)**	***Good* (2)**	***Poor/ Low* (3)**	***Good/ High* (4)**	***Low/Good* (5)**	***High/ Poor* (6)**
Intercept	0.82	1.21**	-4.38	1.66**	1.24	0.31
	(0.42)	(3.18)	(-1.37)	(5.47)	(1.94)	(0.72)
Prob*XCash	36.68**	167.1**	22.13**	73.16**	198.24**	3.30
	(10.75)	(17.97)	(4.88)	(3.92)	(13.11)	(0.41)
ProbAcquisition	-6.12**	-23.9**	-5.97**	-15.58**	-25.08**	-6.12**
	(-22.79)	(-33.36)	(-16.62)	(-4.13)	(-22.80)	(-2.25)
XCash	-0.08	-3.73**	-1.20	-2.66**	-4.23**	-2.48**
	(-0.08)	(-15.67)	(-0.61)	(-14.07)	(-7.94)	(-7.05)
E	-7.35**	1.80**	-6.82**	5.39**	0.97**	6.92**
	(-37.15)	(12.52)	(-25.14)	(26.22)	(4.33)	(21.36)
ΔE	4.75**	-0.46**	3.82**	-1.25**	-0.03	-1.11**
	(25.82)	(-3.84)	(14.94)	(-8.84)	(-0.18)	(-5.14)
Δ*E	-1.92**	0.11	-2.30**	2.04**	-0.06	1.79**
	(-22.36)	(1.44)	(-19.92)	(17.69)	(-0.56)	(9.70)
ΔNA	0.01**	0.43**	0.01**	0.17*	0.42**	-0.11
	(15.28)	(6.59)	(11.67)	(2.54)	(3.84)	(-1.51)
Δ*NA	0.00*	-0.09*	0.00*	0.06	-0.20**	0.00**
	(2.33)	(-2.53)	(2.07)	(1.69)	(-3.67)	(2.41)
RD	0.19	3.07**	3.21**	11.49**	1.82**	9.38**
	(0.37)	(12.37)	(4.40)	(14.91)	(5.14)	(8.64)
ΔRD	2.10**	1.51**	1.35*	-3.00**	2.44**	-2.64**

	(4.95)	(5.28)	(2.43)	(-4.00)	(6.19)	(-4.01)
Δ*RD	-0.86*	0.20	0.30	5.91**	-0.04	-0.07
	(-1.98)	(1.83)	(0.53)	(6.96)	(-0.25)	(-0.06)
I	-7.47**	9.06**	-8.85**	-1.94*	8.40**	10.58**
	(-23.70)	(12.99)	(-20.81)	(-2.30)	(7.85)	(8.29)
ΔI	4.77**	-1.14	3.93**	2.19	-1.38	1.67
	(18.21)	(-1.47)	(11.24)	(1.76)	(-1.27)	(0.94)
Δ*I	0.40*	-0.14	-0.63*	-0.38	-1.18*	24.83**
	(2.01)	(-0.35)	(-2.37)	(-0.24)	(-2.18)	(20.43)
DIV	13.54**	3.62**	15.56	4.14**	-1.96	2.12**
	(5.10)	(6.94)	(1.92)	(11.63)	(-1.47)	(2.71)
ΔDIV	-3.83*	-0.72	-7.01	-1.35**	0.99	-0.49
	(-1.85)	(-1.94)	(-0.83)	(-5.96)	(1.09)	(-0.99)
Δ*DIV	4.79**	1.23**	4.02	1.90**	-0.22	0.97
	(2.73)	(4.03)	(1.30)	(7.51)	(-0.43)	(1.62)
$\Delta*V_t$	-0.33**	0.06**	-0.43**	-0.55**	0.11**	-0.56**
	(-29.59)	(5.52)	(-27.43)	(-27.34)	(7.41)	(-29.17)
Fixed effect						
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Firm-year obs.	5,027	5,872	2,561	3,419	2,453	2,466
Adjusted R-Sq.	0.96	0.59	0.97	0.70	0.66	0.65

Table 15. Robustness – Two-step Heckman Selection Model

In step 1, using a probit model, we regress *Acquisition* against *Leverage*, *Firm Size*, *CapExp/NA*, *VolCash*, *LossDummy*, *RD*, *TAXratio*, *Cash/NA*. We use these results to compute the Inverse Mills Ratio. The step 2 dependent variable is *V/NA* and the independent variables are listed in column 1. *Free cash flow* is high (low) if its value is above (below) its median. *Acquisition* is high (low) if its value is above (below) its median. We create four categories: high *Free cash flow* low *Acquisition*; low *Free cash flow* high *Acquisition*; both high; both low. Each variable is for firm *i* at time *t* unless otherwise indicated. Δ indicates the change in a variable from t+1 to t and Δ* indicates the change in a variable from t to t-1. The remaining variables are defined in the Table 7. t-statistics are in parentheses. ** and * indicate statistical significance at the 0.01 and 0.05 levels, respectively.

	Both Low ***(1)***	***Both High*** ***(2)***	***High FCF Low Acquisition*** ***(3)***	***Low FCF High Acquisition*** ***(4)***
Intercept	-3.13**	-0.13	0.80	-0.38*
	(-3.08)	(-1.20)	(0.44)	(-2.19)
GOV*XCash	1.04**	-0.27	0.14	-0.19
	(2.81)	(-0.86)	(0.10)	(-0.78)
GOV	0.02	0.00	-0.01	0.00
	(1.23)	(1.12)	(-0.55)	(0.54)
XCash	-32.74**	1.89	0.22	-2.61
	(-3.17)	(0.22)	(0.01)	(-0.40)
E	-0.36	3.55**	3.43**	1.47**
	(-0.75)	(11.06)	(3.22)	(6.15)
ΔE	0.22	-0.60**	-0.63	-0.36*
	(0.42)	(-3.46)	(-0.75)	(-2.41)
Δ*E	-0.46	1.19**	1.74**	0.39**
	(-1.50)	(7.17)	(3.71)	(2.60)
ΔNA	0.04	0.04	-0.18	0.27**
	(1.08)	(0.47)	(-0.77)	(2.69)
Δ*NA	1.29**	0.15**	-0.03	0.13**
	(5.08)	(5.57)	(-0.22)	(3.40)
RD	2.96**	7.85**	2.73	4.36**
	(3.05)	(7.95)	(0.99)	(9.65)
ΔRD	-1.34	-3.94**	19.02	-1.48*
	(-1.72)	(-2.78)	(1.57)	(-2.46)
Δ*RD	-2.50	0.09	14.23	0.41
	(-1.86)	(0.19)	(1.32)	(0.71)
I	-12.94	3.05**	-8.49	3.07*
	(-1.63)	(2.64)	(-1.52)	(2.02)
ΔI	-0.46	-1.63	3.19	3.12
	(-0.39)	(-1.03)	(0.63)	(1.54)
Δ*I	-6.30	5.33**	7.93	2.73**
	(-0.67)	(3.21)	(1.07)	(5.77)
DIV	33.98	3.64**	5.13	2.72
	(1.75)	(5.20)	(1.00)	(1.91)
ΔDIV	0.54	0.31	-5.18	-0.99
	(0.63)	(0.73)	(-0.96)	(-1.02)
Δ*DIV	84.95	3.28**	0.52	1.10
	(0.84)	(5.77)	(0.09)	(1.79)
Δ*V	-0.15*	-0.55**	-0.72**	-0.39**
	(-2.06)	(-16.44)	(-7.51)	(-9.31)
Mill's Ratio	1.61**	1.00**	0.59	1.37**
	(6.45)	(37.52)	(1.90)	(27.75)
Firm-year obs.	11,037	10,212	2,941	2,944
Adjusted R-sq.	0.93	0.70	0.66	0.64

Chapter 4 Liquidity Beyond the BBO

ABSTRACT

We investigate the existence and the extent of liquidity beyond the best bid and offer (BBO) using Tokyo Security Exchange tick-by-tick daily trading data. We found that there is a uniform co-movement liquidity beyond the BBO as measured by strings. Strings are a series of trades each of which is at a price that is inferior to or equal to the price of the previous trade in the series. The liquidity beyond the BBO is ubiquitously invariant across trading days, while remarkably variant across securities. The variations of depth and the variations of immediacy needed for the common movement of liquidity beyond BBO, however for the first time, are found to be moderate and large respectively across trading days. Moreover, the three aspects of liquidity beyond the BBO are positively correlated with return volatility of strings. We are the first to show that the information content is a significant determinant of the return for trades beyond BBO by using the LOB slope, the beginning price, the beginning volume, the beginning spread, and the duration of strings as proxies for the measure of the informative-ness in the LOB.

I. Introduction

Since the shifting from firm-specific liquidity to common determinants of liquidity started nearly a decade ago, this line of microstructure research has investigated the prevalent traits of trading activities relevant to the market-wide co-movement of liquidity (Aitken, et al., 2007; Coughenour and Saad, 2004; Kamara, Lou, & Sadka, 2008) in addition to the systematic common movement of liquidity (Amihud, 2002; Chordia, Roll, & Subrahmanyam, 2000; Hasbrouck and Seppi 2001; Kempf and Mayston, 2008; Korajczyk and Sadka, 2008). Among these studies, most majorities focus on the commonality in liquidity at or within best bid and offer (BBO). The existence and extent beyond the BBO and the aspects of the liquidity beyond the BBO, however, remain unexplored. In addition, it is unknown as to how the LOB status affects the return of the trades that walk up/down the LOB.

We investigate the existence and extent and liquidity beyond the BBO by using daily trading data of Tokyo Security Exchange (TSE). Bid and ask spread in various forms has been a primary measure of liquidity and liquidity commonality within and beyond the BBOs in prior research. In this paper, rather than using conventional various spread measures, we employ string which is defined as a series of trades each of which is at a price that is inferior to or equal to the price in the series to explore the liquidity of orders that walk up/down the limit order book (LOB). In addition, we gauge the properties of three aspects of liquidity, i.e., width, depth, and immediacy by examining the number of different types of string, the aggregated volume, and the duration measured in minutes elapsed to complete trades in the series of strings. We found that there is a

uniform co-movement of liquidity beyond the BBO. The liquidity beyond the BBO is ubiquitously invariant across trading days, while remarkably variant across securities. The variations of depth and immediacy needed for the common movement of liquidity, however for the first time, are found substantially large across trading days. Moreover, all three aspects of the liquidity beyond the BBO are found to be positively correlated with return volatility of strings. Finally, we show that the state of LOB, i.e., the slope, the beginning price, the beginning spread, and the beginning volume, and the duration of strings are significant determinants of the return of trades that beyond BBO.

The remainder of the paper is organized as follows. Section 2 presents theoretic considerations and development of our empirical hypotheses. In section 3, we provide a detailed description of our methodology. Section 4 shows the development of our hypotheses. Data and empirical design are described in Section 5. Section 6 reports the empirical results. The concluding section contains a summary of findings and the implications.

II. Theoretical Considerations

It is a common knowledge that small trades executed at or within BBO are mostly from small order proprietary traders. The available depths at BBO are sufficiently large to have these traders' orders filled due to their relative small demand in size. For large trades, normally placed by institutional traders and rich individuals, however, walk up/down the LOB by default trading rules when volume is too large to be filled by insufficient available depth at BBO. The related frequencies regarding large orders placed by rich individuals is not available, while there are summary figures about proportion of

institutional traders, although not very precise. Prior empirical studies assert that institutional traders comprise a significant portion of the trading volume on a number of exchanges such as NYSE, London Security Exchange and the Tokyo Security Exchange (Chan and Lakonishok, 1993; Gompers and Metrick, 2001). Additionally, Chan and Lakonishok, 1993; Kamara, Lou, & Sadka, 2008) demonstrate that there is a substantial increase in institutional investing and index trading over the years. Therefore, the extent of the systematic movement of liquidity beyond the BBO, if any, is non-trivial and important. In line with the finding of Kempf and Mayston (2008), we conclude that there is a common existence of liquidity beyond the BBO in TSE, which as with NYSE and other exchanges being examined in prior studies. Moreover, the liquidity beyond the BBO constitutes a substantially large proportion trading activities for institutions traders (Hong and Rady, 2002). In addition, we examine and provide for the first time a conclusive evidence of little or lack co-variation in two liquidity dimensions: depth and immediacy, while in the meantime the third dimension of liquidity: width, co-moves across trading days. Lastly, the three dimensions of the liquidity beyond the BBO are positively correlated with return volatility of strings. Our study is the first, to the best of our knowledge, to show that the information content is a significant determinant of the return for trades beyond BBO by using the LOB slope, the beginning price, the beginning volume, the beginning spread, and the duration of strings as proxies for the measure of the informative-ness in the LOB.

Using the evidence from Australian Security Exchange, Domowitz, Hansch, and Wang (2005) show that there is a linkage between the liquidity commonality and security returns. However, their main focus of the liquidity commonality is at the best bids and

offers. The relationship between the liquidity commonality and return beyond the BBO is unknown. In contrast, our focus of liquidity common movement is on the series of trades where the volume of large orders is too big to be executed by the best bid or the best offer and the remaining unexecuted portion of the order walks up/down the limit order book. As a result, as we conjectured, the beginning price, beginning spread, beginning volume are significant determinants of the number of trades in the series and the duration of strings, thus the return of strings.

III. Method

We employ a distinct approach which differs from previous empirical studies in three ways. First, without access to and relying on price steps of the complete limit order book, we are able to test the proposition that there is a co-variation in liquidity beyond the BBO as advanced by Kemptf and Mayston (2008). The data that provided to us contain no information pertaining order entries such as cancellations, revisions, executions, and expirations as the data used in Kemptf and Mayston's study. The NEEDS data of TSE are typical tick-by-tick trading data with anonymous trades and quotes records and the associated depths and time stamps precision in minutes.

Second, the typical liquidity proxy measures such as various types of bid-ask spreads are not used as our analytical tool because they are more relevant to the cost of demanding for immediacy for small trades. Additionally, liquidity measures of bid-ask spread ignore the liquidity demand and supply at multiple steps by disregarding the price concession in the later steps for large orders. Thus, the number of price steps of large orders walking up/down the book is used as an alternative measure of liquidity for large

trades. Clearly, the motive and widely usage of bid-ask spread as liquidity measure for commonality in liquidity at BBO is due to the fact that permanent component, the information contents of the spread can be factored into common market movement. For large trades, however, the information contents can be revealed by price premium or discount, in our study the price steps, that large buy or sell order traders yield to the liquidity suppliers. As a result, this price concession manifested through the willingness that the large order traders to trade against standing limit orders with more aggressive prices creates a serial consecutive trades that eat up the standing orders in LOB, which could not be taken into account by using the bid and ask spread at the BBO. Further, similar to the information content embedded in the bid and ask spread, these price steps are a proxy for a cost of creating informative prices for large orders. To make these price concession steps concrete, we identify trade patterns as described above and characterize them into string 2, string 3, …., String 9 based on the number of price concessions and form five categories as following:

1. String 2: a series of trades each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, two successively higher/lower prices.
2. String 3: a series of trades each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, three successively higher/lower prices.
3. String 4: a series of trades each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, four successively higher/lower prices.

4. String 5: a series of trades each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, five successively higher/lower prices.
5. String "other": a series of trades (more than five) each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, a total of five, six, seven, eight, or night successively higher/lower prices.

Third, in addition to the common movement in liquidity supply beyond the BBO, the co-variation of depth and immediacy of liquidity beyond the BBO is investigated, which to our knowledge, has received little attention. We show that the variation in three dimensions of liquidity i.e. width, depth, and immediacy deviates from each other. Our empirical evidence shows that volume that it takes large orders to co-move does not necessarily co-vary over time. Additionally, the immediacy of execution of large orders over multiple steps varies significantly through time. These aspects of co-movement of liquidity beyond the BBO are relatively new territories in the microstructure literature. By exposing these features concerning large orders, we hope that these findings shed light on the trading strategies that large order trades could employ to minimize their trading costs using appropriate timing and sizes to maximize their returns and minimize the risks.

IV. Hypotheses

In order-driven market, commonality in liquidity at or within BBO arises when continuous interactions of both the small order liquidity suppliers and liquidity demanders co-move with market or industry. We believe that, further, there is a

systematic co-movement beyond the BBO. As documented by Aitken et al. (2007) in their study of liquidity supply in electronic markets, the institutional investors simultaneously and aggressively supply liquidity at multiple price steps in LOB although the degree of price aggressiveness varies by institutional investors' type. That is liquidity supply is undoubtedly non-negligible at price steps inferior to BBO. Additionally, Keim and Madhavan (1995) state that either due to the fear of high opportunity costs resulting from failing to trade timely or because of the belief that their information is short-lived, institutional traders show a surprisingly strong demand for immediacy. As a result, institutional traders trade aggressively by gradually placing orders inferior to BBO. When large order demanders or suppliers price their order aggressively and continuously and when this strong immediacy demand and supply is consistently inter-temporal invariant, rather than a temporal phenomenon, we are expecting a co-movement of liquidity beyond the BBO. Kempf and Mayston (2008) analyze this co-movement using LOB of Xetra of Frankfurt Security exchange and unsurprisingly conclude that the commonality in liquidity outside of BBO is larger than that of inside BBO. We believe that this commonality is not a unique case of Frankfurt Security exchange due to its relative small market size, yet it is a distinguishable feature of any rapid-paced market. Accordingly, we advance our first hypothesis upon which the consequent hypothesis is built.

Hypothesis 1: There is a strong evidence of the existence of liquidity beyond the BBO across trading days for large orders that walk up/down the LOB. In addition, the related aspects of liquidity, i.e. the width, the depth and the immediacy beyond the BBO have various variability across trading days.

We believe that although there is liquidity beyond the BBO, in particular, a common movement in liquidity beyond the BBO. It takes considerably variant volume and the immediacy in order executions across the trading days to achieve the co-movement. Thus, in addition to the width, aspects of liquidity including the size of large orders, i.e. depth and how quickly trader's trading desire is fulfilled, i.e. immediacy do not necessary co-vary through time.

The consumption of available depths of standing limit orders parallels the immediacy of the execution of trades in strings. Or, the aggressiveness of price steps and the available liquidity supplied jointly determine the immediacy of large order executions. Thus, intuitively, immediacy as the third dimension of the liquidity beyond the BBO varies by its own across the trading days as set forth by our first hypothesis. Keim and Madhavan (1995) show that large orders spread over a long time period in order to be filled i.e., the larger quantities, the longer of trading durations. Based on the unique settings of various tick size and different trading units in Tokyo Security Exchange, we believe that the duration of strings being executed increases with tick size, MTU, and the combination of ticker size and MTU. That is, more specifically, it takes longer duration for large orders walking up/down the LOB for firms that trade at higher tick size, higher MTU, or the combination of higher values in ticker size and MTU.

Amihud and Mendelson (1986) and Datar et al. (1998) show that liquidity plays a significant role in explaining security returns. We conjecture that liquidity beyond the BBO positively correlates with the return volatility and hence affects the return of orders that walk up/down the book. As formulated in the previous session, strings are a series of

trades resulting from the most aggressive order what walks up/down the book. By definition, the most aggressive order is a "large buy" to buy or a "large sell" to sell a larger quantity than that is available at the best bid and offer (Biais, Hillion, & Spatt, 1995). Secondly, the informative traders and their observers and followers give rise to the series of trades in strings by placing a sequence of new orders at or away from the best bid and offer. Consequently, given a considerable liquidity supply/demand beyond the BBO and significant amount of information contained in the series of trades, we believe that the return and the volatility of strings are directly related to the state of the LOB at the beginning of strings. The LOB slope, the beginning volume, the beginning price, and the beginning spread are our measures of state of the LOB. The beginning volume and the beginning price of strings are significant determinants of the return and return volatility of strings because both the beginning volume and the beginning price determine the price steps that strings contain and determine the duration for the series of trades being executed. In addition, we conjecture that the beginning spread of strings which may reflect significant amount of private information of strings has significant role in determining the returns for large trades. Thus, we develop our second hypothesis as following.

Hypothesis 2: The state of LOB, such as the slope, the beginning price, the beginning volume, the beginning spread, and the duration of strings are significant determinants of the return and return volatility of strings.

Thus, we investigate the existence of common movement of liquidity beyond the BBO and the aspects associated with the liquidity beyond the BBO. In addition, the state

of the LOB at the beginning of strings such as the LOB slope, beginning price, beginning spread, beginning volume, and the duration are significant determinants of the return and return volatility of strings. In the next section, we present the description of our data and the methodology.

V. Data and Methodology

Data

The data are obtained from TSE, a purely order-driven market without designated market maker or specialist. There are some special features about the TSE that differentiate it from other security markets around the world. The TSE includes three different security types (sections): first, second and mothers. The first section, also referred to as "Blue Chips" is primarily for the largest and successful companies, while the second section is mainly for investors interested in smaller firms and trades in lower trading volumes relative to the first section. The third, also the mothers, not available until November of 1999 trades both domestic and foreign newer and innovative venture enterprises. The trading comprises two sessions with standard trading hours starting from 9am to 11am in the morning session and from 12:30pm to 15:00pm in the afternoon session. Consequently, there are two opening and two closing periods. The security price formation in these periods is different from that of the regular trading hours. Accordingly, there are two distinct methods: Itayose (single price auction method) and Zaraba (continuous auction method) to determine security prices. The former is primarily used to form the opening and closing prices for each of the trading sessions and the latter is to determine the trading prices in the continuous auction trading right after the opening and

before the closing of the trading sessions. One essential feature of the Zaraba method is that it allows large order to walk up the limit order book if the volume is greater than the depth available at the best quote. As is the same in most order-driven markets, the price takes higher precedence over time in order matching process. However, there are four special features pertaining to the TSE market. In contrast to other order-driven markets around the world, the TSE allows 11 different tick sizes, specifically 1, 5, 10, 50, 100, 500, 1,000, 5,000, 10,000, 50,000, and 100,000 Japanese Yen based on various price ranges. Second, to protect the investor from the excess volatile price changes, daily price limits are set by limiting the maximum range of price fluctuation in accordance to 29 price ranges. Third, unlike other markets around the world where a variety of types of orders are permitted, only two types of order are allowed in TSE market: market order and limit order. As a result, there are only two types of trader, who either provides immediacy or demands immediacy. All trades are computerized. Lastly, perhaps most relevant to our investigation, the trading units can vary. Although trading units can vary from 1 share, 10 shares, 50 shares, 100 shares, 500 shares, 1,000 shares to 3,000 shares, most majority of domestic securities trade in 1,000 trading unit. These tiered tick sizes and trading units, while facilitating the trading activities, are ideal natural breaking points in our research design and analyses.

The sample period is the month June of 2008, which includes a total of 21 trading days. In addition to the records of each trade and quote in the normal trading hours, the data include pre-opening quotes in the period prior to the opening auction, which is specifically from 8:20am till 9:00am for the morning session and from 12:05pm till 12:30pm for the afternoon session. These pre-opening quotes are excluded from our

study. For each trade and quote, it includes time stamp, price, and volume as well as best bid, best ask, bids and asks inferior to BBO up to 5 cumulative tick sizes, and the associated depth. In our sample, the blue-chip securities trading activity accounts for nearly 95% of total trading activity, while second section securities trading activity takes up about 1.42% and mothers section securities 3.84% of total trading activity, both of which trade in trading unit of 1,000 shares or less. We apply three filters to finalize our sample. We limit our analyses to securities that (i) have traded without changing in tick size but allowing various trading units, (ii) have at least 15 trades per firm and per trading day, and (iii) have continuously traded for 21 days in June, 2008. As a result, there are a total of 1,899 distinct securities in our final sample. Of these, 1,608 are "Blue Chips", 150 are small securities, and 141 securities are from the mothers market.

Methodology

In order to measure the common movement of strings, we investigate the co-variations of the number of strings, of the aggregated volume of strings, and of the average duration of strings per trading day across trading days and the co-variations of the number of strings, of the aggregated volume, and of the duration of strings per security across securities. For the former, the total number of strings, the aggregated volume, and the average duration is computed across the securities within one trading day regardless of the string types. Similarly, for the latter the number of strings, the aggregated volume, and the average duration is totaled for each security across trading days with string types disregarded. The variability for each of three aspects of liquidity is measured by the Intra-class Correlation Coefficient (ICC), which differs from Pearson

correlation coefficient in that it deals with observations with same metric (McGraw and Wong, 1996). The ICC is a measure of the proportion of a variance that is attributable to objects of measurement (Shrout & Fleiss, 1979). In this study, the single score ICC for two-way random effects model is applied to measure the variations with respect to the total number of strings across the trading days and across securities. In the case of measuring the variability across trading days, the trading day is regarded as the column effect and the firm as the row effect. Both the row and column effects are deemed random, i.e. exchangeable. The row and column effects are transposed for the case of measuring the variability across securities. Note that ICC can be used to measure either consistency or agreement, although the only difference resides computationally in the denominator of ρ in the equation (1). In the case of consistency, it is used to infer the inter-rater reliability in most cases. For the purpose of this study, the ICC for degree of absolute agreement among measurements as shown in the equation below is used, which is formulated based on the mean squares derived from analysis of variance (McGraw and Wong, 1996).

$$\rho = \frac{MS_R - MS_E}{MR_R + (k-1)MS_E + \frac{k}{n}(MS_C - MS_E)} \quad \text{(McGraw and Wong, 1996)} \qquad (1)$$

Where MS_E is the mean square error, MS_C is the mean square for columns and MS_R is the mean square for rows; k denotes the total number of days (the row effect) and n is the total number of firms (the column effect). The associated F-test and confidence interval is as the following.

$$F = \frac{MS_R}{MS_E} * \frac{1-\rho_0}{1+(k-1)\rho_0} \text{ with degrees of freedom of (n-1) and (n-1)(k-1)} \quad (2)$$

$$\text{Lower Confidence Interval Limit} = \frac{F_L - 1}{F_L + (k-1)} \quad (3)$$

$$\text{Upper Confidence Interval Limit} = \frac{F_U - 1}{F_U + (k-1)} \quad (4)$$

Where $F_L = F_{obs} / F_{tabled}$ and $F_U = F_{obs} * F_{tabled}$. F_{obs} are the row effects of F from two-way Analysis of Variance (ANOVA). F_{tabled} denotes the (1-0.5a)100th percentile of the F distribution with n-1 numerator degrees of freedom and (n-1)(k-1) denominator degrees of freedom.

Next, we use the LOB norm slope as the measure for the degree of agreement/disagreement on securities' valuation among traders. The LOB slope is based on the immediate quotes before the first trade in the string and the computation of the slope is following Næs and Skjeltorp (2006). First, we compute the absolute average slope for the immediate quotes before the first based on the equations (5) and (6) for ask side (absSE) and bid side (absDE) respectively.

$$absSE_{i,t} = \frac{1}{N_A}\left\{\frac{RV_1^A}{abs(p_1^A / p_0^A - 1)} + \sum_{\tau=1}^{N_A} \frac{RV_{\tau+1}^A / RV_\tau^A - 1}{abs(p_{\tau+1}^A / p_\tau^A - 1)}\right\} \quad (5)$$

$$absDE_{i,t} = \frac{1}{N_B}\left\{\frac{RV_1^B}{abs(p_1^B / p_0^B - 1)} + \sum_{\tau=1}^{N_B} \frac{RV_{\tau+1}^B / RV_\tau^B - 1}{abs(p_{\tau+1}^B / p_\tau^B - 1)}\right\} \quad (6)$$

Where N is the total number of ask prices (tick levels) and τ is the tick level; the subscript 0 represents the inner quote; thus p_0^A and p_0^B denotes the bid-ask midpoint; p_1^A and p_1^B are the best ask and best bid respectively. As a result, τ = 0 is the bid-ask midpoint and τ = 1 represents the best ask or bid quote. For both ask and buy side, the RV_τ^A is the fraction of the total volume at snapshot s at price level τ. v_τ^A is the natural logarithm of accumulated total volume at each tick level τ. The fraction is computed for each level as the equation below by following the appendix of Næs and Skjeltorp (2006).

$$RV_\tau^A = V_\tau^A / \sum_\tau V_\tau^A \tag{7}$$

Then we normalize the order book at each snapshot relative to the total number of shares supplied in the order book at the snapshot. We average the slope for security i at time t as

$$Slope_{i,t} = \frac{1}{2}\left(\frac{absSE_{i,t} + absDE_{i,t}}{2}\right) \tag{8}$$

VI. Empirical Results

Univariate Results

We identify a sequence of consecutive trades as strings that are a series of trades each of which is at a price that is inferior to or equal to the previous price to measure the liquidity common movement beyond the BBO. Strings are classified into 5 categories: string of 2, 3, 4, 5, and other. A "string 2" has a series of trades each of which is at a price that is inferior to or equal to the previous price in the series, in which there are a total of

two distinct successively higher/lower prices. Similarly, a “string 3” has a series of trades each of which is at a price that is inferior to or equal to the previous price in the series, among which, there are three distinct successively higher/lower prices. Strings with names “strings 4”, “string 5”, and “string other” are formed in the similar fashion. The descriptive statistics of strings for both the buy and sell side are delineated in the Table 15. For string 2 there are five average numbers of consecutive trades and for string 9 there are an average of 11 numbers of consecutive trades. However, the kurtosis is very high and is in an approximately descending order from string 2 to string 9. It indicates that the distribution of string 2 has a higher peakiness or is more heavily tailed relative to strings of higher number. Or simply put, more of the variance is due to infrequent extreme deviations for string 2 than other types of strings.

The frequencies of strings, average duration of strings, and LOB slopes are presented in Table 16 for both buy and sell sides. The buy side has slightly lower frequencies for strings with length greater than 2 than its sell side counterparts, while the buy side has higher frequencies relative to that of the sell side except for strings 2. Overall, strings compose a little over 14% of all trades on both the buy side and the sell side with most majorities in string 2. Moreover, for both buy and sell side, the general trend is that the proportion decreases when the number of the trades in the string series increases. Moreover, strings with more than 5 trades make up about only 0.10% on both sides. We report the average and the standard deviation of the duration in columns (3) and (4) for buy and sell side respectively. The durations of strings are computed by taking the difference of the minutes between the first trade and the last trade within the string. The duration is the total minutes that consumed to complete the series of trades in the

strings. As seen in the Table 16, the duration is longer for the sell side than the buy side market. It seems that the more trades in the string series there are, the more minutes are needed for the completion of the entire strings series. This is opposite to the order in the frequencies of strings, i.e. the more trades in the string, the less proportion in the whole sample. Additionally, string 5 takes the longest duration to complete among all types of string. The descriptive statistics of slope is reported in column (5). It appears that the lower number of trades in the string, the more gentle the slopes are. In other words, the aggressive traders complete their orders in small number of trades when there is a widely dispersed belief on securities' valuation among investors.

In Table 17, descriptive statistics by tick size and MTU combinations are presented for the frequencies of strings, the average duration of strings, and average aggregated volume of strings by string types. For the same combination of the tick size and the MTU, strings with more trades in the series are associated with longer duration, the same general trend observed in the Table 16. Moreover, across different string types, the average duration of strings and the average aggregated volume of strings generally increase with the MTU regardless of the tick size. Lastly, it is generally true that for the same combination of tick size and MTU, strings that are associated with more trades have higher volumes.

Multivariate Results

If there is a common movement in liquidity beyond the BBO, as we conjectured, there will be little variation in liquidity measure, in our case, the number of strings over time. Table 18 reports the co-variation of number of strings measured by ICC across

trading days and across securities by combinations of tick size and MTU. The ICC is viewed as the proportion of relevant variance that is associated with differences among measured objects or persons. The closer to the unity the ICC is the smaller degree of variability it represents. Conversely, it shows a strong variability if ICC approaches zero. Panel A of Table 18 reports the ICC for the number of strings across trading days. The ICCs are significant at 99% confidence level in nearly all cases. Consistent with our expectation, ICCs are of large size or close to the unit and are indicative of small degree or lack of variation in the number of strings across the trading days. Clearly, there is a pervasively strong co-movement of liquidity beyond the BBO, confirming our first hypothesis. In contrast, the panel B, reporting the ICCs across securities, reveals a pronouncedly strong degree of variation. The less degree or absent of co-movement in liquidity across securities is not abnormal as firms inherently differ. Note that similar sized ICCs across different combinations of the tick size and the MTU in panel A and panel B respectively are indicative of little cross-sectional variation in the intensity of liquidity beyond the BBO.

Given strongly significant evidence of common movement of liquidity, broader questions related to liquidity are asked. Do other aspects of liquidity exhibit same level of variation? Does it take similar length of time to complete the string 2 to that of string "other"? Does it consume similar amount of volume for the completion of different string types or it varies? Liquidity is commonly known to have at least three dimensions: width, depth, and immediacy. As with width, we proceed to examine the variation over depth and immediacy across trading days and across securities. The depth is measured by the aggregated volume and the immediacy is essentially how quickly the series of trades

within the string are executed and is measured in minutes, which is termed as the duration of strings in our study. The empirical results are displayed in columns 8 through 11 for trading volume and columns 12 through 15 for duration accordingly. For aggregated trading volume, the variability across trading days is considerably stronger relative to that of the number of strings, supportive of our first hypothesis. Moreover, the ICCs are in within a wider range: 0.1 to 0.8 than the ICCs for the number of strings: 0.4 to 0.9, indicating there is a considerably large variation in the aggregated volume by various combinations of the tick size and the MTU. Further, no evidence of strong variation across securities is detected. To test the first hypothesis, similarly, we compute and report the ICCs by duration across trading days and across securities. Our evidence provides strong support for the hypothesis 1. The ICCs reported are in a range less than that of number of strings, suggesting a high level degree of variation in the durations of the completion of the series of trades in strings across trading days. Most majority ICCs are significant at the 0.01 level in panel A.

The variation across securities is mostly insignificant as shown in Panel B, similar to the results of the aggregated volume of strings. The higher degree of variation in duration of strings in Panel B as represented by smaller values in ICCs relative to that of in Panel A for the number of strings and the aggregated trading volume of strings is consistent with the univariate results illustrated in Table 16 and Table 17 respectively.

In Table 19, we report the correlation between the return volatility of strings (squared returns) and the aspects of the liquidity beyond the BBO. As can be seen in both panels for buy and sell side of market respectively, the return volatility of strings is

positively associated with all aspects of liquidity beyond the BBO. More specifically, there is a higher risk in the return of strings when there is higher number of price concession steps in the strings, when higher volume is demanded, and when longer duration is required to complete the series of trades in the string. Notably, the aspects of the liquidity beyond the BBO are positively correlated with each other at 0.01alpha level.

Indeed, the information content of large orders that can significantly affect the return of for large orders. How does the informativeness resided in the LOB affect the return and volatility of strings? We probe into this question by first examining the information content of strings using the beginning spread, the beginning price, the beginning volume of the first trade in the series as well as the duration of strings. We investigate their relation by regressing the return and return volatility of strings on the beginning price, the beginning volume, the beginning spread, and the duration of strings (measured in minutes). We also include 4 dummy coded variables in the regression representing string types from 2 to 5 by treating strings that have at least 6 trades in the series as the reference group. As revealed in Panel A of Table 20, for buy side market, the higher beginning price is associated with the lower return of strings, because for buyers the buying price is one of the key determinants of their goal of maximizing returns. On the contrary, the beginning price is positively related to the return of strings for the sell side market, i.e., the higher selling price to start with, the higher return of strings for sellers. The beginning spread, however, has completely opposite direction with the return of strings to that of the relationship between the beginning price and the return of strings. For the buy side, higher return of strings is significantly associated with wider beginning spread, while for the sell side, it is associated with narrower beginning spread. In other

words, the less information content in the beginning spread (Easley and O'Hara, 1987), the buyers have higher return. This is consistent with Hasbrouck's (1991) finding that wide spreads have larger price impacts. Both the volume and the duration of strings seem to be positively related with the return of strings for the buy side market and negatively related with the return of the strings for the sell sides of the markets. On the other hand, for the buy side market, strings that have more number of trades in the series have higher returns compared to strings have less number of trades in the series. This is the consistent with the effect of duration on string return. The effect is reversed for the sell side market. Collectively, the evidence shows that the return is higher when the traders sell the series of the trades more quickly and in a smaller number of trades.

The results for return volatility of the strings are displayed in the Panel B of Table 20. The directions of the control variable are consistent for both the buy and sell side market. In summary, the return volatility of strings is inversely related to the beginning price and beginning volume, however positively related to the beginning spread and the duration of the strings. In addition, the negative coefficients for string dummy variable indicate that strings with more than 6 trades in the series are more risky than other string types. Intuitively, it is because the longer the duration or the more trades in the strings incurs higher uncertainty of the price concessions and price steps.

Second, we use the slope of the beginning quote of strings as a proxy for informative-ness in the LOB. A gentle slope represents a wide dispersed belief of traders in security's valuation (Næs and Skjeltorp, 2006). Thus, it is believed that when traders have different private information about a security which leads to high level of

uncertainty of the value of the security, the slope of the LOB is more gentle than the slope when there is a homogeneous belief among traders. We report our results in the Table 21. As shown in columns (1) and (2), return is higher when slope is steeper, while return volatility increases as slope is more gentle, consistent with the findings of Næs and Skjeltorp (2006). We include the interaction term of slope and string in the regression to investigate the mediation effect of slope by string types and report the results in columns (3) and (4). Clearly, the linear line of return of strings by the number of trades in the series is steeper if the LOB slope increases one unit. That is the slope of the return on the number of trades increases as heterogeneous belief in securities valuation increases. Conversely, the slope of the return volatility on the number of trades decreases as heterogeneous belief in securities valuation increases. In columns (5) and column (6), we report the similar regression results by including interaction of slope by string dummy variables. The variables of interests are the interaction terms and the LOB slope. For instance, the interaction term slope*string 2 represents the return for the string 2 while the slope represents the return for the reference group, the string with more than 6 trades in the series. All the interaction terms are negative in the return regression and positive in the volatility of return regression. Thus, we conclude that the wider dispersed belief in traders' valuation on the securities the higher return for strings with more than 6 trades in the series relative to strings with fewer than 6 trades in the series. That is, for block trades that walk up/down the book, the return is higher when less private information in the order flow. This result is in line with the results for trades within the BBO. As can be seen in column (6), this effect is reversed for return volatility.

VII. Summary and Conclusions

By the end of 2008, according to the report of World Federation of Exchanges, the TSE ranked the second in terms of market capitalization around the world. Its fast-paced trading activities make our results applicable to most major exchanges and markets around the world. Using tick-by-tick trading data of the TSE in June of 2008, we first examine the existence and extent of liquidity beyond the BBO by identifying strings which by definition are a series of trades each of which is at a price that is greater than or equal to the previous price in the series. We are able to capture the co-variation of liquidity beyond the BBO without relying on the complete LOB. We show that ICC that is the measure of variability among the number of strings is prevalently close to unity across various combinations of tick size and MTU. As a result, we conclude that there is a systematic co-movement in liquidity beyond the BBO. In addition to the empirical evidences of common liquidity or common movement of strings beyond the BBO, we also examine the degrees of the co-variation of the depth and immediacy, the other two properties of liquidity beyond the BBO. We show that co-variation of the duration of strings, in contrast to that of the number of strings is relatively high and to a lesser degree the co-variation of the depth is moderate across trading days. Therefore, we conclude that there is extensive liquidity beyond the BBO, however, the related aspects of liquidity, i.e. the width, the depth and the immediacy beyond the BBOs have various variability across trading days.

Not surprisingly, each of three properties of liquidity beyond the BBO is positively correlated with string return and volatility of the string return. Further, our

analysis shows that the return of strings and return volatility of strings have direct relationship with the beginning prices, the beginning spread, the beginning volume, and the duration of strings. Specifically, the beginning spread, the beginning volume, and the duration of the strings has a positive relationship with the return of strings for buy side and an inverse relationship with the return of strings for sell side. On the contrary, the higher beginning price reduces the return of strings for the buy side while improves the return of strings for the sell side. The return volatility increases as the number of trades in the string series increases and when the beginning price decreases. Moreover, the return volatility is higher when the beginning spread is wider and the duration is longer. We also examine the effect of the slope on the return and return volatility of the strings. We conclude that when traders have heterogeneous belief in securities' valuation, it increases return and decreases the volatility of the string return for strings with more than 6 trades in the series relative to strings with less than 6 trades in the series. Slope by itself is negatively related to the return volatility and positive related to the return, which is consistent with the prior research.

Thus, we find conclusive evidence in supporting of our hypothesis that the information significant affect block trades' return and volatility by using the LOB slope and the state of the LOB as our proxies for the measure of the informative-ness in the LOB. To the best of our knowledge, we are the first to show that the private information has significant impact on the return of the block trades that walk up/down the LOB, which is consistent with the evidence for trades within the BBO.

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Table 16. Descriptive Statistics of Number of Trades in the Strings

We define the string based on number of price concession steps. For example, string 2 is a series of trades each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, two successively higher/lower prices. Similarly, string 3 is a series of trades each of which is at a price that is inferior to or equal to the previous price in the series and there are, among these trades, three successively higher/lower prices. Similarly, string 9 is a series of trades each of which is at a price that is inferior to or equal to the previous price in the series. There are, among these trades, a total of night successively higher/lower prices.

	Buy side				Sell side			
	Mean	STD	Skewness	Kurtosis	Mean	STD	Skewness	Kurtosis
String 2	5.16	6.37	19.92	1048.1	4.95	5.59	19.18	966.4
String 3	6.08	5.40	12.12	322.3	5.85	5.30	25.67	1729.5
String 4	7.00	4.86	10.72	219.8	6.90	4.82	11.00	216.3
String 5	7.93	4.36	8.35	126.1	7.88	5.56	20.79	819.1
String 6	8.81	3.94	7.79	111.5	8.83	4.17	7.68	99.61
String 7	9.88	5.10	18.22	614.2	9.81	5.28	12.79	250.7
String 8	10.65	3.65	8.85	149.2	10.47	2.77	4.24	29.84
String 9	11.49	3.00	4.78	36.1	11.39	3.51	13.02	299.8

Table 17. Frequencies and Descriptive Statistics of Number of Strings and Duration of Strings

Strings are classified into 5 different types depending on the number trades at successively higher/lower prices in the series. For example, string 2 is a series of trades each of which is at a price that is inferior to or equal to the previous price in the series and there are two trades, among the series of trades, at successively higher/lower prices. The "other" category includes strings of a series of 6, 7, 8, or 9 such trades. The LOBslope is the LOB slope computed using the immediate quotes before the first trade in the series. The frequency and the percentage (in parenthesis) are reported in the columns (1) and (2) for buy and sell sides respectively. The average duration of strings (in minutes) and the standard deviation (in parenthesis) are reported in the columns (4) and (5) for buy and sell sides respectively. Column (5) reports the average and standard deviation of the LOB slope.

String Type	Frequency of strings (%)		Average duration of strings (SD)		LOBSlope
	(1) Buy	(2) Sell	(3) Buy	(4) Sell	(5) All
String 2	714,789 (11.31)	602,009 (11.27)	0.78 (1.80)	0.93 (2.02)	2,797 (1,770)
String 3	66,931 (1.94)	105,053 (1.97)	1.18 (2.32)	1.37 (2.61)	3,056 (1,914)
String 4	18,432 (0.53)	28,708 (0.54)	1.45 (2.70)	1.65 (2.86)	3,159 (1,972)
String 5	5,595 (0.16)	9,161 (0.17)	1.62 (2.90)	1.86 (3.09)	3,217 (2,010)
String "Other"	3,333 (0.10)	5,782 (0.11)	1.39 (3.03)	1.66 (3.06)	3,074 (2,023)
All	484,660 (14.04)	750,713 (14.05)	1.28 (31.03)	1.40 (32.85)	2,853 (1,807)

Table 18. Descriptive Statistics of Duration and Aggregated Volume of Strings

Tick Size	MTU	String Type	Frequencies of Strings		Average Duration of Strings (SD)		Average Aggregated Volume (SD)	
			Buy	Sell	Buy	Sell	Buy	Sell
Panel A - Combination of Tick Size and MTU for String of Length 2								
1	1	2	2,071	2,188	0.25 (0.47)	0.24 (0.49)	88 (311)	99 (211)
1	10	2	1,221	2,642	0.43 (1.05)	0.43 (0.92)	521 (847)	735 (4347)
1	50	2	4,048	5,507	0.34 (0.89)	0.40 (0.96)	2318 (3216)	2338 (5981)
1	100	2	122,605	197,789	0.62 (1.56)	0.76 (1.75)	4980 (24149)	3791 (17245)
1	500	2	6,408	11,547	0.88 (1.79)	0.93 (1.84)	18462 (77047)	17372 (84325)
1	1000	2	148,962	242,096	0.90 (2.02)	1.08 (2.28)	15758 (61360)	15585 (55682)
5	50	2	196	411	1.30 (1.79)	1.82 (2.61)	403 (428)	490 (487)
5	100	2	18,755	28,495	1.04 (1.95)	1.23 (2.11)	3881 (9064)	3471 (7382)
5	1000	2	5,802	6,914	0.71 (1.21)	0.92 (1.61)	19109 (23305)	19878 (62976)
10	1	2	5,781	6,493	0.56 (1.52)	0.61 (1.54)	22 (52)	25 (88)
10	10	2	10,761	11,014	0.43 (0.87)	0.53 (1.06)	785 (1903)	714 (2443)
10	50	2	2,187	2,319	0.60 (1.31)	0.89 (1.76)	1837 (2456)	1615 (2986
10	100	2	29,644	47,403	0.84 (1.73)	0.98 (1.84)	5313 (42587)	5534 (28292)
10	500	2	132	268	1.93 (3.14)	2.80 (4.49)	6436 (7537)	21773 (256702)
10	1000	2	374	675	1.55 (3.14)	1.77 (2.91)	12289 (13356)	13092 (14544)
50	1	2	2,632	4,192	0.38 (0.90)	0.42 (1.17)	102 (238)	133 (271)
50	10	2	48	137	3.40 (5.02)	3.65 (5.03)	31 (16)	32 (18)
100	1	2	5,208	6,130	0.72 (1.60)	0.85 (1.98)	17 (21)	16 (23)
1000	1	2	23,454	25,680	0.84 (2.06)	0.98 (2.23)	61 (238)	54 (187)
10000	1	2	80	109	1.92 (3.33)	1.91 (3.17)	210 (267)	1.91 (3.17)
Panel B - Combination of Tick Size and MTU for String of Length 3								
1	1	3	473	575	0.40 (0.55)	0.36 (0.58)	174 (281)	210 (328)
1	10	3	246	661	0.51 (0.94)	0.64 (1.39)	1036 (1164)	1216 (1451)
1	50	3	972	1,376	0.48 (1.10)	0.60 (1.30)	4329 (4971)	4301 (5159)
1	100	3	27,219	45,728	1.05 (2.15)	1.21 (2.34)	6194 (26850)	5145 (18649)
1	500	3	863	1,557	1.37 (2.29)	1.52 (2.41)	13512 (26781)	19032 (68492)
1	1000	3	23,625	38,399	1.40 (2.61)	1.63 (2.95)	21450 (43174)	21095 (63715)
5	50	3	32	52	1.50 (1.57)	1.83 (2.03)	942 (574)	862 (592)
5	100	3	1,843	2,714	1.71 (3.08)	1.95 (2.94)	5175 (13096)	5075 (9336)
5	1000	3	422	442	1.19 (1.47)	1.40 (1.72)	40268 (32319)	42771 (49657)
10	1	3	1,646	1,872	0.82 (1.88)	0.78 (1.90)	38 (58)	41 (59)
10	10	3	2,015	1,982	0.47 (0.77)	0.67 (1.10)	1155 (2254)	949 (1650)
10	50	3	272	252	0.77 (1.38)	1.41 (2.68)	4720 (4540)	3951 (3647)
10	100	3	3,033	4,686	1.32 (2.30)	1.52 (2.63)	4570 (8168)	5884 (62617)
10	500	3	12	9	2.33 (2.87)	4.22 (3.67)	10375 (6169)	10944 (5276)
10	1000	3	27	19	1.56 (1.95)	3.32 (3.76)	34444 (22752)	19947 (14845)
50	1	3	499	673	0.77 (1.50)	0.82 (1.56)	167 (326)	134 (301)
50	10	3	9	37	4.33 (4.95)	5.16 (5.62)	50 (13)	69 (41)
100	1	3	922	1,210	1.09 (2.44)	1.41 (3.11)	40 (42)	31 (44)
1000	1	3	2,800	2,807	1.22 (2.31)	1.34 (3.08)	47 (182)	54 (190)
Panel C - Combination of Tick Size and MTU for String of Length 4								
1	1	4	138	194	0.43 (0.61)	0.44 (0.65)	222 (228)	337 (414)
1	10	4	101	203	0.60 (1.19)	0.45 (0.64)	1778 (2856)	1899 (2318)
1	50	4	332	426	0.49 (0.83)	0.79 (1.66)	6687 (7055)	6926 (8634)

1	100	4	8,171	13,787	1.34 (2.58)	1.51 (2.52)	8196 (31020)	7470 (68836)
1	500	4	217	379	1.44 (2.14)	1.69 (2.17)	15664 (36056)	33161 (194163)
1	1000	4	6,093	9,641	1.80 (3.14)	1.98 (3.31)	27613 (51601)	27040 (75922)
5	50	4	5	12	2.40 (1.95)	3.50 (4.64)	2130 (1526)	1112 (597)

Table 17. Descriptive Statistics of Duration of Strings and Aggregated Volume by Combination of Tick Size and MTU and by String Type (Cont.)

Tick Size	MTU	String Type	Frequencies of Strings		Average Duration of Strings (SD)		Average Aggregated Volume (SD)	
			Buy	Sell	Buy	Sell	Buy	Sell
5	100	4	336	521	1.93 (2.57)	2.46 (3.63)	6400 (12256)	6098 (18488)
5	1000	4	65	76	1.20 (1.62)	1.72 (2.22)	66154 (70372)	50237 (54794)
10	1	4	546	661	0.89 (1.68)	1.10 (2.85)	55 (75)	67 (96)
10	10	4	600	630	0.59 (0.76)	0.83 (1.32)	1274 (1848)	1391 (2335)
10	50	4	51	51	1.37 (2.42)	1.27 (1.47)	6079 (7948)	6288 (4485)
10	100	4	625	1,020	1.54 (2.57)	1.78 (2.83)	5128 (10705)	5339 (9150)
10	500	4	2	3	2.00 (1.41)	5.67 (5.69)	20250 (4596)	10000 (1500)
10	1000	4	4	1	2.00 (1.41)	Na	54750 (71369)	97667 (49541)
50	1	4	118	155	0.66 (1.36)	1.05 (1.85)	211 (580)	185 (448)
50	10	4	4	10	5.50 (10.34)	7.70 (14.02)	43 (29)	81 (21)
100	1	4	280	312	1.27 (2.77)	1.49 (2.63)	65 (75)	49 (94)
1000	1	4	744	624	1.38 (2.63)	1.54 (3.15)	48 (143)	54 (173)
Panel D- Combination of Tick Size and MTU for String of Length 5								
1	1	5	67	102	0.51 (0.61)	0.44 (0.65)	419 (417)	495 (530)
1	10	5	29	96	0.38 (0.56)	0.69 (1.27)	2825 (3016)	3314 (4351)
1	50	5	120	171	0.57 (0.92)	0.91 (1.56)	9623 (10593)	8440 (8280)
1	100	5	2,689	4,518	1.52 (2.86)	1.78 (2.87)	9876 (35669)	8596 (21845)
1	500	5	54	117	1.72 (2.66)	2.07 (2.65)	34926 (67161)	52611 (305814)
1	1000	5	1,668	2,937	2.04 (3.18)	2.31 (3.64)	33260 (59812)	36797 (154110)
5	100	5	78	124	2.82 (5.09)	2.72 (4.72)	5685 (7046)	7389 (13066)
5	1000	5	10	14	1.70 (2.06)	1.50 (2.35)	33400 (35994)	65571 (74728)
10	1	5	176	241	1.36 (2.14)	0.99 (1.47)	82 (200)	87 (98)
10	10	5	222	204	0.72 (1.07)	0.78 (1.01)	1719 (2171)	1375 (1165)
10	50	5	12	10	0.75 (0.75)	1.20 (1.40)	5521 (3651)	5960 (4579)
10	100	5	137	263	1.37 (2.08)	2.02 (3.25)	6482 (10395)	4665 (7405)
50	1	5	43	57	0.63 (0.79)	0.58 (0.82)	208 (449)	537 (1607)
50	10	5	2	3	1.50 (2.12)	2.33 (4.04)	100 (14)	167 (119)
100	1	5	82	110	1.71 (4.25)	1.50 (2.88)	82 (81)	76 (73)
1000	1	5	206	193	1.86 (2.78)	1.10 (1.70)	25 (36)	76 (392)
Panel E - Combination of Tick Size and MTU for String of Length Other								
1	1	Other	90	104	0.34 (0.52)	0.28 (0.49)	323 (526)	404 (537)
1	10	Other	43	89	0.35 (0.53)	0.44 (0.54)	1836 (2384)	2737 (3216)
1	50	Other	67	138	0.42 (0.70)	0.64 (1.16)	9996 (14468)	9624 (11311)
1	100	Other	1,563	2,891	1.30 (2.50)	1.66 (2.97)	11290 (28520)	9198 (23914)
1	500	Other	30	50	1.30 (1.91)	1.86 (2.35)	23633 (33127)	25130 (28711)
1	1000	Other	911	1,700	1.82 (3.46)	2.06 (3.49)	35527 (56433)	36941 (74811)
5	100	Other	26	56	1.62 (2.47)	2.98 (3.80)	5238 (7963)	6379 (9544)
5	1000	Other	1	6	4.00 (Na)	1.83 (1.17)	11000 (Na)	52500 (34274)
10	1	Other	160	212	1.48 (4.91)	0.96 (1.58)	85 (105)	108 (156)
10	10	Other	151	142	0.57 (0.81)	0.64 (0.96)	1657 (2702)	1465 (1618)
10	50	Other	6	4	0.83 (0.41)	0.50 (0.58)	12350 (9689)	8463 (5271)
10	100	Other	76	111	1.83 (2.12)	2.21 (4.90)	4784 (5069)	3999 (9272)
50	1	Other	23	46	1.13 (2.67)	0.54 (1.17)	364 (842)	182 (412)
100	1	Other	64	65	1.14 (2.96)	1.37 (3.00)	100 (156)	70 (104)
1000	1	Other	121	167	1.76 (5.85)	1.05 (2.64)	37 (124)	31 (68)

Table 19. Intra-class Correlation Coefficients

For the 21 trading days in June 2008, for each tick size MTU combination, for buys and sells, in turn, we report intra-class correlation coefficients (ICCs) and the associated F-value across days (Panel A) and across securities (Panel B). We report ICCs for number of strings in columns 3-6, for trading volume in columns 7-10, and for duration in columns 11-14. An ICC close to zero (one) indicates high (low) variability. We report the number of observations in column 15. * and † indicate that we reject the null hypothesis of equality of number of strings at the 0.01 and 0.05 levels, respectively.

Panel A- ICC across Trading Days

			Number of Strings				Trading volume				Duration			
Tick Size	MTU	N	ICC	F-Value	ICC	F-Value	ICC	F-Value	ICC	F-Value	ICC	F-Value	ICC	F-Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	
1	10	21	0.838*	119	0.875*	164	0.224*	7.44	0.258*	8.59	0.601*	30.6	0.382*	14.5
1	50	21	0.788*	81	0.719*	62.8	0.340†	11.8	0.319*	12.1	0.653*	39.7	0.714*	54.9
1	100	21	0.910*	222	0.862*	141	0.787*	78.9	0.384*	113	0.333*	11.8	0.403*	15.5
1	500	21	0.420*	19.0	0.710*	61.3	0.244*	8.31	0.296*	10.1	0.444*	19.2	0.533*	25.4
1	1000	21	0.808*	95.4	0.797*	90.1	0.589†	31.7	0.647*	40.1	0.385*	14.7	0.435*	17.5
5	100	21	0.826*	111	0.697*	52.8	0.572*	30.7	0.668*	44.7	0.392*	15.3	0.430*	17.3
5	1000	21	0.922*	284	0.779*	90.1	0.775*	80.6	0.591*	33.1	0.416*	16.3	0.538*	24.9
10	1	21	0.745*	66.1	0.670*	48.8	0.695*	48.9	0.553*	27.3	0.188*	5.8	0.370*	13.4
10	10	21	0.889*	183	0.825*	110	0.664*	44.7	0.654*	43.6	0.331*	12.7	0.452*	17.9
10	50	21	0.924*	225	0.870*	125	0.787*	76.7	0.794*	81.9	0.507*	22.9	0.646*	42.1
10	100	21	0.786*	83.9	0.826*	110	0.456*	18.7	0.684*	47.7	0.505*	22.8	0.483*	20.9
10	1000	21	0.445*	25.4	0.627*	39.0	0.130	4.12	0.201†	5.69	0.142	4.02	0.388*	13.6
50	1	21	0.849*	132	0.916*	230	0.688*	46.8	0.905*	206	0.528*	24.3	0.636*	35.2
100	1	21	0.724*	62.5	0.744*	64.9	0.534*	26.1	0.595*	33.0	0.369*	13.6	0.392*	14.2
1000	1	21	0.866*	146	0.877*	166	0.720*	56.1	0.826*	102	0.479*	21.2	0.430*	16.9
10000	1	21	0.539*	26.7	-0.024	0.38	0.149†	5.49	0.165†	5.56	-0.029	0.44	0.001	1.02

Panel B - ICC across Securities

			Number of Strings				Trading volume				Duration			
Tick Size	MTU	N	ICC	F-Value	ICC	F-Value	ICC	F-Value	ICC	F-Value	ICC	F-Value	ICC	F-Value
1	10	2	0.013	1.18	0.012	1.22	0.047	1.13	0.030	1.08	-0.027	0.87	0.021	1.07
1	50	4	0.016	1.42	0.040†	1.87	0.015	1.10	0.067	1.50	-0.083	0.57	-0.039	0.69
1	100	294	0.001*	8.26	0.003*	7.89	0.000	0.078	0.000	1.08	0.020*	9.53	0.022*	13.1
1	500	21	0.069*	4.73	0.042*	4.60	0.041†	2.25	0.025†	1.79	0.016†	1.69	0.009	1.44

1	1000	435	0.004*	10.3	0.007*	14.7	0.000	0.888	0.002*	2.53	0.059*	330	0.007*	6.44
5	100	61	0.004†	2.92	0.019*	5.25	0.017*	3.38	0.007*	2.42	0.023*	3.47	0.008†	1.99
5	1000	10	0.010*	2.57	0.037*	3.02	0.021†	2.13	0.021	1.55	0.011	1.21	-0.012	0.75
10	1	14	0.004	1.23	0.030*	2.54	-0.014	0.369	-0.002	0.94	0.015	1.32	0.025	1.51
10	10	11	0.008†	1.87	0.016†	2.04	0.017	1.59	0.024†	1.76	0.075*	2.38	-0.014	0.76
10	50	3	-0.010	0.648	-0.018	0.63	-0.006	0.922	0.003	1.05	0.008	1.05	0.024	1.22
10	100	84	0.173*	8.26	0.014*	8.77	0.000	1.03	0.008*	3.05	0.014*	3.39	0.003†	1.41
10	1000	2	0.227	1.91	0.026	1.15	-0.006	0.987	-0.102	0.77	-0.131	0.74	-0.036	0.89
50	1	4	0.007	1.27	0.000	1.02	-0.002	0.977	0.002	1.10	-0.013	0.90	-0.026	0.73
100	1	11	0.022†	2.25	0.011	1.51	0.028	1.81	0.014	1.40	0.040	1.69	-0.014	0.76
1000	1	57	0.037*	16.3	0.011*	6.52	-0.003	0.006	0.003†	1.80	0.066*	6.85	0.002†	1.19
10000	1	2	0.020	1.09	0.208	1.51	0.156	1.45	0.074	1.20	-0.66	0.88	-0.133	0.77

Table 20. Correlations Results

This table reports correlations between the liquidity aspects of strings and squared return (a measure of return volatility). Panel A (B) presents the Pearson correlation results for buy (sell) side. * and † indicate that we reject the null hypothesis of equality of number of strings at the 0.01 and 0.05 levels, respectively.

	Return Volatility	String Length	Aggregated Volume	Duration of strings (in Minutes)
Panel A: Buy Side				
Return Volatility	1			
String Length	0.022*	1		
Aggregated Volume	0.020*	0.033*	1	
Duration of strings (in Minutes)	0.035*	0.060*	0.051*	1
Panel B: Sell Side				
Return Volatility	1			
String Length	0.019*	1		
Aggregated Volume	0.016*	0.034*	1	
Duration of strings (in Minutes)	0.015*	0.066*	0.055*	1

Table 21. Regression Outcomes

This table reports regression outcomes for both buy side and sell side using string return and string return volatility as dependent variable in Panel A and panel B respectively. The beginning price, beginning volume, and beginning spread are the price, volume, and spread of the initial trade of the string. The duration of strings is the minutes consumed to complete the series of trades in the string. The t-statistics are bracketed and computed using heteroscedasticity consistent standard errors. * and † indicate that we reject the null hypothesis of equality of number of strings at the 0.01 and 0.05 levels, respectively.

	Panel A: String Return		Panel B: String Return Volatility	
	Buy Side	Sell Side	Buy Side	Sell Side
Constant	0.018*	-0.017*	0.0003*	0.0002*
	(74.7)	(-107.60)	(11.49)	(14.87)
Log of Beginning Price	-0.002*	0.002*	-0.00004*	-0.00002*
	(-63.8)	(91.89)	(-10.42)	(-12.62)
Log of Beginning Spread	0.002*	-0.002*	0.00003*	0.00002*
	(84.1)	(-116.47)	(11.98)	(14.29)
Log of Beginning Volume	0.00003*	-0.00004*	-0.0000*	-0.000*
	(6.6)	(-32.56)	(-4.98)	(-4.26)
Log of Duration	0.0002*	-0.0002*	0.000003*	0.0000*
	(23.19)	(-32.56)	(3.45)	(3.36)
String 2 Dummy	-0.005*	0.004*	-0.00005*	-0.00005*
	(-65.8)	(77.43)	(-25.91)	(-26.79)
String 3 Dummy	-0.003*	0.003*	-0.00004*	-0.00004*
	(-47.1)	(56.20)	(-21.07)	(-22.17)
String 4 Dummy	-0.002*	0.002*	-0.00003*	-0.00003*
	(-31.1)	(37.95)	(-15.62)	(-17.01)
String 5 Dummy	-0.001*	0.001*	-0.00002*	-0.000002*
	(-15.9)	(19.66)	(-9.07)	(-10.95)
No of observation	203,765	346,597	203,765	346,597
Adj. R-squared	0.43	0.46	0.03	0.03

Table 22. Effect of LOB Slope on String Return and String Return Volatility

This table reports regression outcomes using string returns as dependent variable. The LOBslope is the LOB slope computed using the immediate quotes before the first trade in the series. The beginning price, beginning volume, beginning spread are the respective price, volume, and spread of the initial trade of the string. The string with at least 6 trades in the series is treated as the reference group for the string dummy variables. The t-statistics are bracketed and computed using heteroscedasticity consistent standard errors. * and † indicate that we reject the null hypothesis of equality of number of strings at the 0.01 and 0.05 levels, respectively.

	(1) Return	(2) Volatility	(3) Return	(4) Volatility	(5) Return	(6) Volatility
Constant	-0.000***	0.000	-0.000	-0.000*	-0.002*	0.0001*
	(-6.57)	(0.98)	(-0.16)	(-7.10)	(-11.52)	(28.00)
LOBSlope*String			0.124*	-0.026*		
			(3.06)	(-9.12)		
String	-0.0002*	0.00001*	-0.0003*	0.00002*		
	(-33.39)	(24.81)	(-14.55)	(13.25)		
LOBSlope	0.726*	-0.040*	0.439*	0.021*	2.648*	-0.192*
	(42.97)	(-34.24)	(4.92)	(3.39)	(5.93)	(-22.23)
LOBSlope*String 2					-1.930*	0.159*
					(-4.32)	(18.18)
LOBSlope*String 3					-2.028*	0.148*
					(-4.52)	(17.09)
LOBSlope*String 4					-2.025*	0.099*
					(-4.34)	(4.83)
LOBSlope*String 5					-1.324*	0.077*
					(-2.58)	(8.28)
String 2 Dummy					0.002*	-0.0001*
					(8.85)	(-24.02)
String 3 Dummy					0.002*	-0.0001*
					(8.00)	(-21.93)
String 4 Dummy					0.002*	-0.0001*
					(6.89)	(-6.81)
String 5 Dummy					0.001*	-0.00004*
					(3.77)	(-10.38)
No of observation	1,198,070	1,198,070	1,198,070	1,198,070	1,198,070	1,198,070
Adj. R-squared	0.005	0.005	0.005	0.005	0.005	0.005