THREE ESSAYS ON BANK LENDING AND CORPORATE FINANCE

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Abstract

This thesis includes three essays on several important topics in empirical finance: Chief Executive Officer (CEO) risk-taking incentives, the cost and syndicate structure of bank loans and corporate investments with internal funds. This thesis contributes to these aspects of finance literature and the three essays are presented in Chapter 2, 3 and 4.

The first essay investigates how implicit contractual relationship between creditors and borrowers attenuates the conflict of interest between creditors and shareholders that arises from CEO compensation contracts when a corporation can be considered a nexus of explicit and implicit contractual relationships among stakeholders. We find that bank loans for firms with CEOs who are provided with risk-taking incentives have higher spreads and shorter maturities. A relationship between the lender and its borrower mitigates the influence of incentives for CEO risk-taking on loan spread and loan maturity. Such a relationship is especially beneficial for informationally opaque firms. The results are robust to the endogeneity of relationships and the simultaneous determination of loan spread, loan maturity and collateral requirements. Our results highlight the importance of the interaction between explicit and implicit contractual relationships to a firm's borrowing cost.

The second essay investigates the effects of a borrowing firm's CEO risk-taking incentives on the structure of the firm's syndicated loans. The conflict of

interest between creditors and shareholders arising from CEO risk-taking incentives is a major concern of borrower moral hazard for syndicate lenders, which require intensive monitoring by lead arrangers in a syndicate. When CEO risk-taking incentives are high, syndicates are structured to facilitate better due diligence and monitoring efforts. These syndicates have a smaller number of total lenders and are more concentrated, and lead arrangers retain a greater portion of the loan. Moreover, we examine the factors that affect the link between CEO risk-taking incentives and syndicate loan structure. CEO risk-taking incentives have a lesser effect on the syndicate structure when lead arrangers have a good reputation and have a prior lending relationship with a borrowing firm. By contrast, CEO risk-taking incentives have a greater influence on syndicate structure when borrowing firms are informationally opaque, are financially distressed or have low growth prospects.

The third essay studies corporate investments with internal funds when firms face real investment friction using a sample of U.S. oil companies from 2003 to 2011 before and after the 2008 financial crisis. We show that firms' capital expenditures are more sensitive to their lagged cash holdings than to their contemporaneous cash flows. By making investments with realized cash holdings, firms can avoid the investment adjustment costs that are incurred when investing with uncertain cash flows. We also show that cash flow policies are affected by liquidity constraints following the 2008 financial crisis: firms build up more cash reserves from cash flows, cut back payouts and raise more debt to maintain cash holdings.

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Chapter 1

Introduction

This thesis includes three essays that study CEO risk-taking incentives, relationship lending and the cost of bank loans, the effects of CEO risk-taking incentives on the syndicate structure of bank loans and corporate investments with internal funds. Each of these three essays is self-contained and presented in Chapters 2 through 4. In this chapter, I highlight the motivations, main results and contributions to literature of the three essays.

The first essay investigates how the implicit contractual relationship between creditors and borrowers attenuates the conflict of interest between creditors and shareholders that arises from CEO compensation contracts. One major conflict of interest between shareholders and creditors is the tension that arises from the risk-taking incentives for CEOs, which are designed by shareholders to align their interests with those of the CEO. Higher risk-taking CEO incentives can generate riskier policy choices (e.g., greater investment in research and development, less investment in capital expenditures, more focused and less diversified, and higher leverage) to mitigate risk-related agency problem because risk-averse CEO may forgo risky but positive net present value (NPV) projects (Coles et al. 2006). However, greater CEO risk-taking incentives might be perceived negatively by creditors because of the associated wealth transfer effects when CEOs take on risky projects (Jensen and Meckling 1976). Creditors will charge a higher cost of debt when borrowing firms offer aggressive risk-taking incentives to CEOs. Shareholders therefore find themselves in a dilemma in designing CEO compensation contracts; encouraging CEO risk-taking might reduce risk-related agency costs, but it could also increase borrowing costs. Because both agency costs and borrowing costs are ultimately borne by shareholders, aligning the interests of CEOs and shareholders is as important as aligning those of creditors and shareholders. However, little is known about the mechanisms that may resolve or attenuate the dilemma that shareholders face in designing CEO risk-taking incentives.

The purpose of the first essay is twofold. First, we investigate the conflict of interest between shareholders and banks (firms' primary creditors) that arises from CEO risk-taking incentives by examining whether and to what extent CEO risk-taking incentives affect the firm-level costs of borrowing from banks. The second and primary purpose of this paper is to show how the long-term commitments between firms and banks in lending relationships help to resolve the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives. Following the extant literature (e.g., Guay 1999, Coles et al. 2006, Core and Guay 2002), CEO risk-taking incentives are measured based on the sensitivity of the value of a CEO's portfolio to stock return volatility (*vega*) and stock price (*delta*). We find that bank loans for firms with CEOs who are provided with risk-taking incentives have higher spreads and shorter maturities. A relationship between the lender and its borrower mitigates the influence of incentives for CEO risk-taking on loan spread and loan maturity. Such a relationship is especially beneficial for informationally opaque firms.

This essay contributes to the literature on equity compensation design. The extant literature has examined how firm characteristics such as size, growth opportunities, and product competition influence the design of risk-taking incentives in CEO compensation contracts (e.g., Yermack (1995), Core and Guay (1999), Guay (1999), Coles et al. (2006)). Our study highlights the challenges faced by shareholders in the design of CEO compensation contracts; reducing risk-related agency costs by offering higher risk-taking incentives could leave a company with higher-cost bank loans. We argue that the implicit contractual relationship between banks and firms that is created by relationship lending helps to resolve this shareholder dilemma. Our analysis suggests that shareholders should consider their firm's long-term relationship with its creditors in designing CEO compensation contracts.

This essay also adds to the relationship lending literature by providing a specific channel through which relationship lending can increase the value of a firm. The extant literature has identified several benefits of lending relationships. For instance, relationship lending facilitates the value-enhancing exchange of information, increases the availability of credit and lowers borrowing costs (e.g., Petersen and Rajan, 1994, Berger and Udell, 1995, Bharath et al. 2011).

Relationship lending also allows for intertemporal smoothing of contract terms, which increases the availability of funds to “young” firms (Petersen and Rajan, 1994). In this study, we identify a subtle but important benefit of relationship lending: relationship lending attenuates the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives, which in turn allows shareholders to design CEO compensation contracts with less concern regarding raising the cost of debt.

The second essay investigates the effects of a borrowing firm’s CEO risk-taking incentives on the structure of the firm’s syndicated loans and the factors that affect the link between CEO risk-taking incentives and syndicate loan structure. Syndicated loans are made by multiple lenders, with one or more of the lenders (lead arrangers) playing the role of arranging, pricing and monitoring such loans. Lead arrangers analyze credit quality, negotiate key terms with borrowers before inviting a group of banks to participate and are responsible for allocating loan shares among participating banks (Lin et al. 2012). Although the lead arrangers perform the traditional role of due diligence as informed lenders, the loan amount itself is shared with one or more syndicate participant banks (Esty 2001). Given that lead arrangers in a syndicate hold less than 100% of the debt, other participant lenders can become concerned about the level of monitoring effort that is exerted by the lead arrangers. The reason is that lead arrangers do have an incentive to shirk their monitoring responsibilities when undertaking most of the monitoring costs and owning only part of the loan (Holmstrom and Tirole

1997; Sufi 2007). Therefore, the syndication process generates an additional element of moral hazard within a syndicate (syndicate moral hazard) between the lead arrangers and other participant syndicate members, in addition to the typical moral hazard problems arising between the borrowing firms and lenders in a lending relationship (borrower moral hazard). The concerns of participant banks regarding the potential for the lead arrangers to shirk their monitoring and due diligence duties are especially relevant in situations in which borrower moral hazard is high and borrowing firms require more intensive monitoring.

As argued earlier, one major conflict of interest between borrowing firms and lending banks is the conflict arising from CEOs' aggressive investment behaviors induced by the risk-taking incentives offered in their compensation contracts. With the increased credit risk from CEO risk-taking incentives, borrowing firms will encounter a more severe borrower moral hazard problem and require additional monitoring efforts and due diligence before loan origination. In addition to the borrower moral hazard resulting from CEO risk-taking incentives, the situation is complicated by the syndicate moral hazard because participant banks will have concerns regarding the incentives of lead arrangers to provide an optimal level of monitoring efforts (Ivashina 2009). To the extent that lead arrangers' ownership in a syndicate will serve as a signal of credible commitment and an indicator of the quality of borrowing firms, participant banks will often demand that a greater portion of syndicate loans be held by lead arrangers for incentive purposes if borrowing firms require greater due diligence and intensive monitoring (Sufi 2007). Therefore, the portion of a syndicate loan that is held by lead arrangers should increase with the CEO risk-taking incentives of a borrowing firm, and the syndicate loan should be more concentrated to mitigate the borrower moral hazard that is associated with CEO risk-taking incentives through effective monitoring.

With a merged sample of syndicate loan structure information, financial information from borrowing firms and CEO risk-taking incentives from 1992 to 2010, we obtain empirical results that are consistent with our hypotheses. Our results show that *vega* has a significant influence on the structure of a syndicate loan, whereas *delta* has no significant effect on the syndicate structure. Specifically, a syndicate loan will have a smaller number of total lenders, lead arrangers will hold a greater amount and percentage of the syndicate loan, and the syndicate ownership will be more concentrated as *vega* increases. The results suggest that syndicate lenders indeed consider CEO risk-taking incentives when they form a syndicate that is structured to ensure more efficient monitoring of borrower moral hazard. We also examine the factors that influence the relationship between *vega* and syndicate structure to investigate the possible channels through which the effects of *vega* on a syndicate loan structure can be mitigated or exacerbated. We find that if the lead arrangers have a good reputation or a prior lending relationship with the borrowing firms, then the effect of *vega* on the syndicate structure will be weaker. Our empirical results also show that the effect of *vega* on syndication structure is more pronounced if borrowing firms are informationally opaque, are financially distressed or have low growth prospects.

This essay attempts to combine two strands of the literature and offer the following contributions. The first strand of work investigates the borrower moral hazard arising from executive compensation and examines how this hazard is perceived by creditors (e.g., DeFusco et al. 1990; Oritz-Molina 2006; Vasvari 2008; Chen and Qiu 2012). These studies generally show that creditors react negatively to equity-related executive compensation because of the increased borrower moral hazard resulting from executive compensation.[1] We complement this strand of literature by showing that the CEO risk-taking incentives of a borrowing firm also have a significant influence on its syndicate loan structure, and we demonstrate that greater CEO risk-taking incentives are associated with a more concentrated syndicate structure and that lead arrangers retain a larger stake in such loans.

The second stream of work is related to a rapidly growing body of empirical studies on the structure of syndicate loans in the last decade. Sufi (2007) and Lee and Mullineaux (2004) show that syndicate loan structure is significantly related to the information opacity of borrowing firms. Firms with higher levels of information asymmetry require a more concentrated syndicate loan structure. Ball

[1] For example, DeFusco, Johnson and Zorn (1990) show that the bond price reacts negatively to the announcement of the adoption of managerial stock option plans in a sample of firms during the 1978-1982 period. Ortiz-Molina (2006) finds that the number of options held by a firm's top five managers increases the yield spread for new bond issue. Chen and Qiu (2012) find that bank loans that are lent to borrowing firms with greater CEO risk-taking incentives will carry higher loan spreads and shorter loan maturity.

et al. (2008) show that lead arrangers will hold a smaller portion of a syndicate if the accounting information of borrowing firms can capture credit quality in a timely fashion. Gopalan et al. (2011) find that lead arrangers will retain larger fractions of syndicate loans if their borrowing firms have previously filed large-scale bankruptcies. Although these studies examine the syndicate loan structure through moral hazards in monitoring, they do not identify a specific source of moral hazard between borrowing firms and lending banks that will affect the monitoring needs of lead arrangers in a syndicate.

This essay is most closely related to Lin et al. (2012), who investigate the effects of borrowing firm ownership structures on syndicate loan structure. Their key result is that the borrower moral hazard resulting from the divergence in cash flow rights and ownership rights of a dominant shareholder has a significant influence on syndicate structure. Our paper complements their study by showing that the borrower moral hazard resulting from CEO risk-taking incentives also has a great influence on syndicate structure. A syndicate loan will be structured in a way to ensure efficient monitoring by lead arrangers if borrowing firms offer excessive risk-taking incentives to CEOs in their compensation. This paper differs from their approach in that we focus on a wider conflict of interest between lenders and all shareholders rather than a single dominant shareholder. To the extent that the credit risk from CEO risk-taking incentives is a more common borrower moral hazard problem than cash flow-ownership divergence, the empirical results from this paper can be applied to a larger body of firms.

The third essay studies corporate investments with internal funds when firms face real investment friction and the related cash flow policies towards cash holdings, debt issuance and payouts to shareholders with a sample of U.S. oil companies before and after the 2008 financial crisis. In the Modigliani and Miller (1958) paradigm, corporate investments should only be affected by investment opportunities (i.e., access to positive NPV projects) when there is no financing friction. Once financing friction is introduced, corporate investments will depend on both investment opportunities and availability of internal funds because external funds are more expensive. Following this intuition, Fazzari, Hubbard and Petersen (1988) (FHP hereafter) developed an empirical approach to examine the impact of financing friction on the relation between investments and internal funds. Their key results are that, after controlling for a firm's investment opportunities as proxied for by Tobin's *Q*, internal funds (cash flows) have a significant positive impact on investment activities. This positive impact is interpreted as evidence for the presence of financing friction.[2] Although it is important to consider external financing friction when analyzing the investment behaviors of firms, the key results of FHP are also based on the assumption that real investment friction is not present, i.e., investments are reversible and have

[2] There is a large body of literature on cash flow-investment sensitivity. For a review of this literature, please see Hubbard (1998) and Stein (2003).

smooth adjustment costs (e.g. Hayashi 1982). If this assumption does not hold, then the effects of cash flows on investments are subject to missing variable bias because Tobin's *Q* is a poor proxy for investment opportunities when investment adjustment costs are not smooth.[3]

The extant literature has shown that real investment decisions are often subject to investment friction because investments can be indivisible and lumpy (e.g. Whited 2006), irreversible (e.g. Cooper and Haltiwanger 2006) with investment time lags and long investment horizons (e.g. Lamont 2000, Tsyplakov 2008, Tserlukevich 2008). The lumpiness of investment suggests that investments will be persistent, have inter-temporal features and have potentially high adjustment costs, especially if investment projects are irreversible. The time lag between when decisions to invest are made and when cash flows actually occur will also prevent firms from immediately making adjustments to investments when there are changes in cash flows. This is because cash flow levels for the coming year are uncertain when investment decisions are made, whereas required investment expenditures are clear because of investment persistence. Therefore, the investment of capital expenditures contingent on contemporaneous cash flows may cause investment projects to be frequently halted and restarted, which can be costly. In addition to cash flows, firms can rely on current cash holdings as

[3] A more accurate measure of investment opportunities is marginal *q*, which is defined as the market value of new *additional* investments divided by their replacement costs. Because marginal *q* is unobservable, empirical studies instead use average *q* (Tobin's *Q*, the ratio of the market value of *existing* capital to its replacement costs) to proxy for investment opportunities according to certain assumptions, i.e., frictionless capital markets and smooth adjustment costs. If these assumptions do not hold, average *q* will be a poor proxy for marginal *q*.

alternative sources of internal funds. Cash holdings can be particularly useful for firms facing real investment friction because cash holdings are a realized value at the time of investment decision making for the coming year. By making investments with cash holdings, firms can avoid potential adjustment costs associated with investing based on uncertain cash flows.

We focus on oil industry for two reasons. First, recent empirical studies (e.g. Tsyplakov 2008) have used the oil industry to examine the effect of investment friction because of the high adjustment costs and irreversible nature of investments in this industry, such as expensive geological surveys, long-term land leases, and drilling and exploration activities. Therefore, the oil industry represents an ideal context to study the investment decisions of firms facing real investment friction. Second, due to the 2008 financial crisis, the sample period from 2003 to 2011 includes two periods with opposite cash flow patterns: the cash flow windfall period from 2003 to 2007, during which oil prices grew by 25% per year on average, and the cash flow downfall period from 2009 to 2011, when the demand for oil declined due to the recession that took place after the 2008 financial crisis.[4] The financial crisis therefore serves as an exogenous shock to the financial status of oil companies and allows us to examine their investments with

[4] We exclude 2008 from our sample because of significant oil price volatility during this year ($92.97 in January, $133.88 in June and $41.12 in December). The inclusion of 2008 could lead to potentially biased results. We therefore split the sample into a pre-crisis sample period (2003-2007) and a post-crisis sample period (2009-2011). The average annual growth rate of oil prices is calculated based on the average monthly price of West Texas Intermediate grade for that year.

internal funds as well as their cash flow policies in response to positive and negative changes in cash flows.

We find that oil companies' capital expenditures are more sensitive to their lagged cash holdings than to their contemporaneous cash flows. The results suggest that the investments of firms are determined or planned based on realized cash holdings at the beginning of the year. Because firms are reluctant to change their investment plans due to adjustment costs, investments do not fluctuate with contemporaneous cash flows. The positive impact of lagged cash holdings on investments is in line with the notion that investment friction, such as investment time lags and investment persistence, will affect firms' choices relating to internal funds for investments.

In addition, we find oil companies' cash flow policies exhibit a "pecking order" in the use of cash flows to accommodate the relationship between corporate investments and internal funds. During the cash flow windfall period before the financial crisis from 2003 to 2007, oil companies use cash flows to build up cash reserves, pay back debts and buy back shares. During the cash flow downfall period after the financial crisis from 2009 to 2011, oil companies raise more debts and stop share repurchase to compensate cash flow declines and maintain cash holding level.

This essay is closely related to extant empirical studies that explore the effects of real investment friction on the relationship between corporate investments and internal funds. For example, a recent study by Gatchev et al. (2010) also investigates the impact of investment adjustment costs on the relation between investments and cash flows as well as related cash flow policies by examining cash flow sensitivities to investments and various cash flow outlays. After adding lagged investments as an explanatory variable, they show that cash flows virtually have no impact on investments and that lagged investments can explain a significant amount of current investments. They attribute the results to high investment adjustment costs and investment persistence. They also argue that the significant investment-cash flow sensitivities identified in previous studies are driven by missing variable bias because the inter-temporal nature of investment decisions is not accounted for. Our paper differs from their study in that we focus on investigating how firms invest with internal funds when investment persistence and adjustment costs are present by introducing lagged cash holdings as a new explanatory variable in the investment equation. We show that investments are highly sensitive to lagged cash holdings after considering investment persistence. Our results are intuitive in the context of investment planning time lags and investment persistence, showing that realized cash holdings are a more reliable internal source of funds for investment than uncertain cash flows when the investment decisions of firms are affected by real investment friction.

This essay is also related to empirical works that study cash flow windfalls. For example, Blanchard et al. (1994) investigate what happened to 11 firms when they won lawsuits or received cash settlements during the early 1980s. The authors find that cash flow windfalls were squandered by managers through unsuccessful diversification, debt-raising or compensation to ensure their self-interest and independence of firms with themselves at the helm. They attribute the empirical results to the agency cost of free cash flows (Jensen 1986). Apparently, the results of this study are not consistent with the managerial entrenchment of the free cash flows hypothesis. Instead, the findings are rather consistent with the financing resources irrelevance theory of Modigliani and Miller (1958) when financing friction is present, i.e., if there is a cash flow surplus, unconstrained firms will use cash flow windfalls to repay debts and make payouts to shareholders, whereas constrained firms will use cash flow windfalls to build up cash reserves and increase their financial flexibility.

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Chapter 2

Explicit and Implicit Contracts: CEO Risk-taking Incentives and the Cost of Corporate Borrowing

with Jiaping Qiu

2.1 Introduction

A corporation can be viewed as a nexus of contracts among various stakeholders, including shareholders, creditors and managers who provide assets (i.e., monetary capital or human capital) to the corporation in return for particular gains. The self-interest of one stakeholder often conflicts with that of another stakeholder, and the optimization of one contract is regularly conditional on that of the others. One major conflict of interest is the tension between shareholders and creditors that arises from the risk-taking incentives for chief executive officers (CEOs), which are designed by shareholders to align their interests with those of the CEO. A CEO's wealth tends to be more firm specific and under diversified than that of the firm's shareholders. A self-interested, risk-averse CEO may forgo risky but positive NPV projects. To reduce this risk-related agency problem, shareholders can provide compensation contracts (e.g., through stock options) that make a CEO's compensation an increasing function of the volatility of firm value. Empirically, CEO behavior has been found to be significantly affected by the risk-taking incentives offered in their compensation contracts.[5] In a recent important study, Coles et al. (2006) show that higher risk-taking incentives, measured by the sensitivity of CEO wealth to stock volatility, generate riskier policy choices such as greater investment in R&D, less investment in PPE, more focused and less diversified, and higher leverage.

However, greater CEO risk-taking incentives might be perceived negatively by creditors who implicitly hold a short put option on the firm's value. A 2007 Moody's Investor Service Special Comment states that "executive compensation is incorporated into Moody's credit analysis of rated issuers because compensation is a determinant of management behavior that affects indirectly credit quality (p.1)." DeFusco et al. (1990) show that bond price reacts negatively to the announcement of the adoption of managerial stock option plans in a sample of firms during 1978-1982. Ortiz-Molina (2006) finds that the number of options held by the firm's top five managers increases the yield spread for new bond issues.[6] Clearly, risk-taking incentives offered in executive compensation contracts significantly impact the behavior of both managers and creditors. Shareholders therefore find themselves in a dilemma in designing CEO

[5] Theoretically, the impact of convex payoffs on managerial risk-taking incentives depends on the managerial utility function and investment technology. It is possible that the concavity of the utility function for risk-averse managers will dominate the convexity of the payoff structure (Guay, 1999). Ross (2004) proves that no incentive schedule exists that will make all expected utility maximizers less risk averse. Ju et al. (2002) show that the impact of a call option contract on corporate risk-taking depends on managerial risk aversion as well as the underlying investment technology.

[6] Shaw (2007) found that the sensitivity of the CEO's stock and option portfolio to stock return volatility had little impact on the cost of 598 new bond issues by 274 firms during 1993-2004.

compensation contracts; encouraging CEO risk taking might reduce risk-related agency costs, but it could also increase borrowing costs. Because both agency costs and borrowing costs are ultimately borne by shareholders, aligning the interests of CEOs and shareholders is as important as aligning those of creditors and shareholders. However, little is known about the mechanisms that may resolve or attenuate the dilemma that shareholders face in designing CEO risk-taking incentives.

The purpose of this paper is twofold. First, we investigate the conflict of interest between shareholders and banks (firms' primary creditors) that arises from CEO risk-taking incentives. As discussed above, previous studies have focused on the public bond market. Bradley and Roberts (2004) show that since 1994, the private bank debt of corporations has been much greater than the public debt. Bank loans are generally senior to public bonds. This seniority allows banks to be less sensitive to CEO risk-taking incentives than public bond holders are because the more senior the claim is, the less sensitive its value will be to the potential loss of the total value of the firm. Therefore, banks might have weaker incentives to control CEO risk-taking incentives. However, compared to the investors in public bonds, who are more diffuse, the owners of bank debts are more concentrated, providing banks with more incentives to respond to CEO risk-taking incentives. Recent empirical studies have investigated the potential conflict of interest between shareholders and banks arising from other sources and its impact on the cost of bank loans. For example, Lin, Ma, Malatesta, and Xuan

(2011, 2012) found that bank loans for companies with a wider divergence between the largest shareholder's control and cash-flow rights are associated with higher spreads and more concentrated syndicates. Given the importance and uniqueness of bank debt, it is important to investigate whether and to what extent CEO risk-taking incentives affect the firm-level costs of borrowing from banks.

The second and primary purpose of this paper is to show how the long-term commitments between firms and banks in lending relationships help to resolve the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives. Boot (2000) defines relationship lending as having two major features: lenders invest in obtaining customer-specific, often proprietary information; and the profitability of lending is evaluated through multiple interactions. These two major features of relationship lending provide two effective mechanisms for resolving the conflict of interest surrounding CEO risk-taking incentives.

First, relationship lending reduces informational asymmetry between firms and banks, allowing banks to distinguish between value-enhancing and value-decreasing risk-taking incentives. Riskier corporate policies induced by greater risk-taking incentives are not always detrimental to creditors. Consider a simple example. A firm intends to raise $100 in capital with $50 from debt and $50 from equity. Two projects are available. Project A, with equal probabilities, will generate a cash flow of $110 in a good state and $40 in a bad state (with a cash flow standard deviation of $49.50). Project B, with equal probabilities, will generate a cash flow of $130 in a good state and $50 in a bad state (with a cash flow standard deviation of $56.57). For project A, the payoffs for creditors (shareholders) will be $50 ($60) and $40 ($0) in the good and bad states, respectively. For project B, the payoffs for creditors (shareholders) will be $50 ($80) and $50 ($0) in the good and bad states, respectively. Both creditors and shareholders are better off with project B despite its greater cash flow volatility. The shareholders would like to structure a compensation package that will encourage managers to undertake project B. Such greater risk-taking incentives will benefit creditors as well. However, if creditors have no information on the potential payoffs for the two projects, concern regarding risk-shifting behavior will lead creditors to charge higher prices if they observe that CEOs have greater risk-taking incentives. Therefore, the degree of information asymmetry between firms and creditors plays an important role in creditors' responses to CEO risk-taking incentives.

As private creditors, banks play a unique role in mitigating information asymmetry. Firms tend to avoid revealing proprietary information (e.g., the payoff of project B) to public creditors in the financial markets (e.g., bond holders) because that information could spill over to competitors (Bhattacharya and Chiesa, 1995). Public bondholders also have less of an incentive to invest in information production because the information can only be used for a particular transaction. In contrast, firms can reveal information to banks with less fear of information spillover (Diamond, 1984, Ramakrishnan and Thakor, 1984, Fama, 1985). This incentive is especially strong if a firm and a bank have a long-term lending relationship because the information disclosed by the firm can be reused by the bank in its future pricing (Boot, 2000). The reusability of information in relationship lending also provides additional incentives for banks to collect customer-specific information. As such, relationship banking mitigates the information asymmetry between firms and lenders, reducing the sensitivity of banks to CEO risk-taking incentives.

Second, the long-term commitment in relationship lending provides more of an incentive for banks to monitor potential risk-shifting activities induced by CEO risk-taking incentives. A typical issue in loan syndication is the free-rider problem: lenders do not have sufficient incentive to monitor the borrower because they do not obtain the full benefits of doing so. However, relationship lending can reduce this type of moral hazard problem because multiple transactions in relationship lending allow lenders to reap long-term benefits from monitoring efforts. In other words, relationship banks are better able to internalize the benefits of monitoring efforts than are non-relationship banks. Consequently, relationship banks have a lower average monitoring cost because of their multiple transactions with the same borrower. Some monitoring activities that are costly for banks without such relationships could be beneficial to those with these relationships. Relationship lending therefore encourages a firm’s commitment to monitoring CEO risk-taking behavior, thus decreasing the sensitivity of banks to CEO risk-taking incentives.

We start our analysis by investigating whether CEO risk-taking incentives affect the cost of bank loans. Following the extant literature (e.g. Guay 1999, Coles et al 2006, Core and Guay 2002), managerial risk-taking incentives are measured based on the sensitivity of the value of the CEO's portfolio to stock return volatility (*vega*) and stock price (*delta*). We focus primarily on *vega,* which is expected to be positively related to CEO risk-taking incentives because the higher *vega* is, the greater the increase in CEO compensation in tandem with stock return volatility. We are also interested in the impact of *delta*; however, the impact of *delta* on CEO risk-taking incentives is ambiguous. For example, using a two-period model, John and John (1993) show that the riskiness of an investment policy implemented by a manager increases with the degree of pay-performance sensitivity (i.e., *delta*) because the more aligned management incentives are with shareholder value (*delta*), the more risk-shifting incentives there are for managers. Conversely, Smith and Stulz (1985) argue that shareholders can structure compensation to influence the risk-taking incentives of a risk-averse manager with a concave utility function. Specifically, if compensation is structured as a linear function of stock price, it will force the manager's utility function to be a concave function of stock price, and the manager will reduce risk in utility maximizing. Thus, *delta* is expected to be negatively related to CEO risk-taking incentives because tying a CEO's wealth to stock prices will make a risk-averse CEO who is undiversified with respect to firm-specific risk less willing to increase the volatility of stock prices.[7] We find that *vega* (*delta*) is positively

[7] Lambert et al. (1991) also show that a risk-averse manager with a large proportion of compensation in the form of firm equity may actually avoid risk. Carpenter (2000) and Ross (2004)

(negatively) related to the costs of bank loans, measured using the all-in-spread in a loan contract, which includes the spread between the loan rate and the London Interbank Offered Rate and any other annual fee paid to the lender. The result indicates that CEO incentives that encourage risk taking increase the cost of bank loans whereas CEO incentives that discourage risk taking decrease the cost of bank loans. The results suggest that banks indeed consider CEO risk-taking incentives when pricing loans even though they are generally senior creditors and thus are less sensitive to firm risk.

Next, we investigate whether lending relationships influence the impact of CEO risk-taking incentives on the cost of bank loans. We find that *vega*'s positive effect on the loan spread is significantly lower if the borrower has a prior relationship with the lender. For loans borrowed from banks with which a firm does not have a prior relationship, an increase of one standard deviation in *vega* will increase the loan cost by 9.74 basis points. In contrast, for loans borrowed from banks with which the firm does have a prior relationship, an increase of one standard deviation in *vega* will only increase the loan cost by 1.95 basis point. One concern regarding OLS regressions is that unobservable factors that determine the formation of lending relationships might also affect the cost of bank loans. To address this potential endogeneity issue, we use physical proximity, i.e., the geographic distance between a bank and a borrowing firm, as the instrument

show that the same managerial risk aversion occurs when a manager's pay-performance sensitivity is high.

for the formation of lending relationships (e.g. Bharath et al. 2011, Dass and Massa 2011). The impact of relationship lending on the sensitivity of loan costs to CEO risk-taking incentives remains robust in the instrumental variable regression. The results are consistent with the argument that relationship lending is an effective mechanism in attenuating the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives.

We now explore the channels through which relationship lending impacts bank sensitivity to CEO risk-taking incentives. As discussed above, the first channel, the reduction in information asymmetry between borrowers and banks, allows relationship banks to better differentiate between value-enhancing and value-decreasing risk-taking incentives. If this is the case, we can expect that the effectiveness of relationship lending varies with the information opacity level of the borrower. Specifically, relationship lending is of less benefit for firms that are transparent with regard to information because there is less proprietary information to be produced (Bharath et al. 2011). For transparent firms, CEO risk-taking actions are easy for creditors to identify and monitor. Consequently, the benefits of relationship lending in attenuating the sensitivity of banks to CEO risk-taking incentives by reducing information asymmetry are lower. Indeed, we find that the impact of relationship lending on loan cost sensitivity to CEO risk-taking incentives is concentrated among firms that are not transparent in this respect – those that do not have public bond ratings, have less analyst coverage, or are not included in the S&P 500 index. Our findings are consistent with the results presented by Bharath et al. (2011), who show that relationship lending can more dramatically decrease the cost of bank loans for firms with a higher informational opacity level. Our findings complement those of Bharath et al.'s study by demonstrating a specific channel through which relationship lending lowers borrowing costs for firms.

To explore the second channel, the increase in monitoring intensity that occurs in relationship lending, we examine whether relationship banks shorten the time to debt maturity so as to increase monitoring intensity for firms with greater CEO risk-taking incentives. Our tests build on the insights presented in a recent study by Brockman et al. (2010), who find that the proportion of short term debt in a firm's balance sheet is positively (negatively) related to its CEO portfolio *vega* (*delta*). Moreover, short maturity debt mitigates the influence of *vega*- and *delta*-related incentives on public bond yields. These findings suggest that creditors use short-term debt to monitor CEO risk-taking behavior induced by *vega* and *delta*. Our results are also consistent with these findings; we find that bank loan maturities are positively (negatively) related to *delta* (*vega*), which suggests that banks shorten loan maturity to increase the monitoring frequency for firms with greater CEO risk-taking incentives. Moreover, we find that the effect is stronger for relationship loans than for non-relationship loans, which implies that the reduced monitoring costs from relationship lending will enable a lending bank to further shorten the loan maturity for firms with higher CEO risk-taking incentives to increase monitoring frequency. The evidence regarding the impact of

CEO risk-taking incentives on loan maturity and its interaction with relationship lending in this respect supports the argument that a firm's commitment to monitoring in relationship lending reduces the sensitivity of banks to CEO risk-taking incentives.

This paper contributes to the literature on equity compensation design. The extant literature has examined how firm characteristics such as size, growth opportunities, and product competition influence the design of risk-taking incentives in CEO compensation contracts (e.g., Yermack (1995), Core and Guay (1999), Guay (1999), Coles et al. (2006)). Our study highlights the challenges faced by shareholders in the design of CEO compensation contracts; reducing risk-related agency costs by offering higher risk-taking incentives could leave a company with higher-cost bank loans. We argue that the implicit contractual relationship between banks and firms that is created by relationship lending helps to resolve this shareholder dilemma. Our analysis suggests that shareholders should consider their firm's long-term relationship with its creditors in designing CEO compensation contracts.

This paper also adds to the relationship lending literature by providing a specific channel through which relationship lending can increase the value of a firm. The extant literature has identified several benefits of lending relationships. For instance, relationship lending facilitates the value-enhancing exchange of information, increases the availability of credit and lowers borrowing costs (e.g., Petersen and Rajan, 1994, Berger and Udell, 1995, Bharath et al. 2011).

Relationship lending also allows for intertemporal smoothing of contract terms, which increases the availability of funds to "young" firms (Petersen and Rajan, 1994). In this study, we identify a subtle but important benefit of relationship lending: relationship lending attenuates the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives, which in turn allows shareholders to design CEO compensation contracts with less concern regarding raising the cost of debt.

The remainder of the paper proceeds as follows. Section 2.2 discusses the sample construction, variable definitions and summary of descriptive statistics; section 2.3 presents the empirical results; section 2.4 discusses the robustness tests conducted in this study; and section 2.5 presents the conclusions generated by our findings.

2.2 Data

2.2.1 Sample construction

The information on bank loans comes from the Dealscan database in the Loan Pricing Corporation database, which contains detailed information on U.S. and foreign commercial loans made to corporations since 1989. Strahan (1999) and Chava and Robert (2008) provide thorough descriptions of the LPC Dealscan database. In our empirical analysis, the basic unit is a loan, also referred to as a facility or tranche in Dealscan. In measuring relationship lending, and particularly in instrumenting relationship lending by the physical proximity between the borrowing firm and the lender, we only consider loans made by U.S. financial institutions to U.S. firms. We also exclude financial service firms and utility firms.[8]

To calculate the sensitivity of CEO compensation to stock price and stock return volatility (i.e., *delta* and *vega*), we obtain company financial information from Compustat, stock return information from CRSP, and executive compensation information from Execucomp. After calculating *delta* and *vega*, we merge the CEO incentive information with the loan details, the company financial information, and the stock return information to create a final sample that contains 8449 loan facilities for 1524 firms from 1992 to 2007.

2.2.2 Variables

The primary outcome variable in our analysis is the cost of bank debt. Following the extant literature (e.g., Graham, Li and Qiu 2008; Bharath et al., 2011), we define the loan spread using the "All-in-Drawn" variable in the Loan Pricing Corporation's (LPC) DealScan database. "All-in-Drawn" measures the amount that the borrower pays in basis points over LIBOR for each dollar drawn down, and it also considers the spread of the loan with any annual (or facility) fee paid to the bank group.

Following Core and Guay (2002), the CEO risk-taking incentives, *vega*, are measured as the change in the value of a CEO's option portfolio that occurs given a 1% change in the annualized standard deviation of the firm's stock returns. The

[8] We also follow Bharath et al. (2011) and Qiu and Yu (2012) in adjusting DealScan data for merger and acquisition activities by lenders and borrowers during a sample year.

CEO's pay-performance sensitivity, *delta*, is measured as the change in the value of the CEO's options and stock portfolio that occurs given a 1% change in the value of a firm's common stock price. The partial derivatives of the option value with respect to stock return volatility and stock price are based on the Black-Scholes option pricing model adjusted for dividends by Merton (1973). The same method has been used to calculate *vega* and *delta* in recent empirical studies (e.g., Coles, 2006; Billet et al., 2010). The details regarding the calculation of *vega* and *delta* are provided in Appendix 2.A.

To measure a lending relationship, we use the method outlined in Bharath et al. (2011). For each loan, we search all of the previous loan transactions for the borrowing firm within the five-year window previous to the loan activation date to identify prior lending transactions with the same lead lender. Because more than 90% of the loans in Dealscan are syndicated, a lender is regarded as the lead lender if it is defined as the "lead arranger credit" in Dealscan or if it plays one of the following lender roles: agent, administrative agent, arranger, or lead bank.[9] We construct three alternative measures of the existence and the strength of relationship lending: *REL(Dummy)*, *REL(Number)*, *REL(Amount)*. *REL(Dummy)* is a dummy variable that is used to identify the existence of prior lending transactions with the same lender. It takes a value of 1 if the borrowing firm has conducted previous transactions with the same lead bank within the 5-year window or otherwise takes a value of zero. *REL(Number)* and *REL(Amount)* are

[9] Sufi (2007) and Bharath et al (2011) use the same definition of the lead lender.

continuous variables that measure the strength and intensity of lending relationships. For a loan in which firm i borrows from bank j, the first continuous measure of the lending relationship, *REL(Number),* is calculated as

$$REL(Number)_{ij} = \frac{\text{Number of loans by bank j to borrower i in the las 5 years}}{\text{Total number of loans by borrower i in the last 5 years}}.$$

For a loan that firm i borrows from bank j, the second continuous measure, *REL(Amount)*, is calculated as

$$REL(Amount)_{ij} = \frac{\text{\$ Amount of loans by bank j to borrower i in the las 5 years}}{\text{Total \$ amount of loans by borrower i in the last 5 years}}.$$

If there are multiple lead lenders for a loan, then we calculate *REL(Number)* and *REL(Amount)* for each lender and employ the highest values of *REL(Number)* and *REL(Amount)*.

2.2.3 Summary statistics

Table 2.1 presents summary statistics for CEO incentives, loan characteristics and firm characteristics. All of the variables are winsorized at 1% and 99%. The median values for the CEO incentive variables *vega* and *delta* (in thousands of dollars) are 70 and 262, respectively. These figures are comparable to those presented in earlier empirical studies. For example, the median values of *vega* and *delta* are 104 and 210 in Knopf et al. (2002) and 34 and 206 in Coles et al. (2006), respectively. The median loan spread is 100 basis points. The median maturity of the sample loans is 48 months, and the median loan amount in the sample is 250 million.

[Table 2.1 about here]

Panel A in Table 2.2 presents the distributions of the relationship and non-relationship loans during the sample period. A loan is defined as a relationship (non-relationship) loan if *REL(Dummy)* equals one (zero). The distribution of relationship lending is comparable to that of the related research; e.g., Bharath et al. (2011).[10] Panel B of Table 2.2 compares the differences in *loan spread*, *vega* and *delta* for the relationship and non-relationship loans. The mean values of *loan spread*, *vega* and *delta* are 121(165), 197(134) and 821(534) for relationship (non-relationship) loans, respectively. The results indicate that relationship loans are associated with higher values of *vega* and *delta* but that they have a lower *loan spread*. The mean comparison results are preliminary but are consistent with the view that relationship lending lowers the cost of borrowing and allows for greater managerial risk-taking incentives.

[Table 2.2 about here]

2.3 Empirical analysis

2.3.1 CEO incentives, relationship lending and loan spread

To investigate the impact of CEO risk-taking incentives and relationship lending on the cost of bank loans, we estimate the following regression model following

[10] Bharath et al. (2011) use a 5-year window because 75% of facilities have maturities that are equal to or less than 5 years. The maturity distribution follows a similar pattern in our sample as well; 75% of facilities have maturities that are less than 5 years. From 1992 to 2003, nearly 75% of facilities are relationship loans in our sample. This figure is comparable to the 70% figure presented in Bharath et al. (2011) for the same sample period.

the extant literature (e.g. Graham et al. 2008, Chava et al. 2009, and Lin et al. 2011):

$$Ln\left(Loan\ Spread_{lft}\right) = \alpha + \beta_1 \times Ln(vega)_{ft-1} + \beta_2 \times Ln(delta)_{ft-1} + \beta_3 \times REL_{lft} + \beta_4 \times REL_{lft} \times Ln(vega)_{ft-1} + \beta_5 \times REL_{lft} \times Ln(delta)_{ft-1} + \sum\gamma_i\left(Firm\ Characteristics_{ft-1}\right) + \sum\gamma_j\left(CEO\ Characteristics_{ft-1}\right) + \sum\gamma_k(Loan\ Characteristics_{lt}) + \sum\gamma_k\left(Controls_{lft}\right) + \epsilon_{lft} \quad \textbf{(2.1)}$$

where *l*, *f* and *t* represent loan *l*, firm *f* and year *t*; $Ln\left(Loan\ Spread_{lft}\right)$ is the natural logarithm of loan spread; $Ln(vega)$ is the natural logarithm of the sensitivity of the CEO option portfolio to stock return volatility; $Ln(delta)$ is the natural logarithm of the sensitivity of the CEO stock and option portfolios to stock price; and REL is the measure for relationship lending. We use $REL(Dummy)$ as our main measure of relationship lending and check the robustness of our results using $REL(Number)$ and $REL(Amount)$. Our main variables of interest are the interaction terms $REL(Dummy) \times Ln(vega)$ and $REL(Dummy) \times Ln\ (delta)$. Other explanatory variables include those for firm characteristics and loan characteristics as well as other control variables. In including other explanatory variables, we follow the previous literature on bank lending (e.g., Graham et al., 2008, Coles et al., 2006, Lin et al. 2011). The firm characteristics considered here include firm size, leverage, book-to-market ratio, profitability, interest coverage, Altman’s Z-score, stock return volatility and cash flow volatility. The CEO characteristics include CEO common share ownership and CEO tenure. The loan characteristics include loan amount, loan maturity, collateral, loan type and loan purpose.[11] Other controls include two-digit industry effects and year effects. The detailed definitions of all variables are provided in Appendix 2.B.

[Table 2.3 about here]

Table 2.3 reports the estimation results for Equation (2.1) with different specifications. Column (1) examines the effects of $Ln(vega)$ and $Ln(delta)$ without including $REL(Dummy)$, $REL(Dummy) \times Ln(vega)$ and $REL(Dummy) \times Ln(delta)$ as the explanatory variables. The coefficient for $Ln(vega)$ is positive and significant at the 5% level, whereas that of $Ln(delta)$ is negative and significant at the 1% level. The results indicate that the CEO risk-taking incentives embedded in their compensation contracts are indeed priced into bank loans. Column (2) includes only $REL(Dummy)$ and excludes $Ln(vega)$, $Ln(delta)$, and their interaction terms as explanatory variables. The coefficient for $REL(Dummy)$ is -0.050 and significant at 5%, suggesting that the loan spread for relationship loans is 5% lower on average than that of non-relationship loans. The results are consistent with the findings in Bharath et al. (2011). Column (3) includes $REL(Dummy)$, $Ln(vega)$, and $Ln(delta)$ but excludes their interaction terms. The coefficients for these three variables are all statistically significant, which suggests that relationship lending and CEO risk incentives have independent effects on the loan spread.

[11] Because approximately 30% of the observations in our sample from Dealscan have missing values for collateral, we treat all observations for missing values for collateral as "not secured" following Bharath et al. (2011). Our main results hold when we exclude the observations with missing values for collateral.

We now examine the interaction effect of relationship lending and CEO risk-taking incentives on the loan spread. Column (4) includes $Ln(vega)$, $Ln(delta)$, $REL(Dummy)$, $REL(Dummy) \times Ln(vega)$ and $REL(Dummy) \times Ln(delta)$ as explanatory variables. The coefficient for $Ln(vega)$ ($Ln(delta)$) is positive (negative) and significant at the 1% level, suggesting that a greater $Ln(vega)$ ($Ln(delta)$) increases (decreases) the costs of non-relationship loans ($REL(Dummy) = 0$). The coefficient for the interaction term $REL(Dummy) \times Ln(vega)$ is positive and significant at the 5% level. The coefficient for the interaction term $REL(Dummy) \times Ln(delta)$ is insignificant. The results indicate that relationship lending significantly reduces a bank's sensitivity to $Ln(vega)$ but not $Ln(delta)$. The insignificance of the coefficient on $REL(Dummy) \times Ln(delta)$ is unsurprising. Given that a higher $Ln(delta)$ reduces managerial risk incentives, it is less beneficial for relationship lenders in helping them to further monitor risky investments by CEOs. Thus, there is no difference between the effect of $Ln(delta)$ on the spread between relationship and no-relationship loans. However, the significant negative coefficient for $REL(Dummy) \times Ln(vega)$ indicates that the relationship loans are less sensitive to CEO risk-taking incentives than are the non-relationship loans. The results suggest that a lending relationship attenuates the influence of CEO compensation that encourages risk on the cost of bank loans.

These results have considerable economic significance. The estimated coefficients of $Ln(vega)$ and $REL(Dummy) \times Ln(vega)$ in Column (4) are

0.045 and -0.036, respectively, suggest that for non-relationship loans (i.e. $REL(Dummy) = 0$), an increase of one standard deviation in $Ln(vega)$ will cause an increase of 7.38% (1.64×0.045) in the loan spread. The mean value of the loan spread in our sample is 132 basis points. Therefore, a change of one standard deviation in $Ln(vega)$ could change the loan spread by 9.74 basis points (=132×7.38%), all other things being equal. However, this effect will be greatly mitigated for firms conducting relationship lending. The coefficients for $Ln(vega)$ and $REL(Dummy) \times Ln(vega)$ suggest that the effect of $Ln(vega)$ on relationship loans is equal to 0.009 (=0.045-0.036). A change of one standard deviation in $Ln(vega)$ will increase the spread for a relationship loan by only 1.95 basis points (0.009×1.64×132). Therefore, a change of one standard deviation in $Ln(vega)$ will have an impact of 7.79 (=9.74-1.95) on the loan spread between non-relationship loans and relationship loans. This impact is significant relative to the effects of other firm characteristics; for instance, the effect of a change of one standard deviation in leverage is 15.08 (=0.17×0.672×132) basis points, and the corresponding figure for interest coverage is 9.18 (=1.07×0.065×132). In sum, our results show that although CEO risk-encouraging incentives have a significant bearing on the costs of a bank loan, a lending relationship significantly attenuates this influence.

2.3.2 Endogeneity of relationship formation

One potential concern regarding the above analysis involves the endogeneity in the formation of lending relationships. A firm's decision to borrow from a lender with which it has a prior relationship or to switch to a new lender is affected by the firm's characteristics. It is possible that unobservable firm characteristics also affect the cost of a bank loan. To address this potential endogeneity problem, one solution is to find an instrument variable for relationship lending measure variables. The ideal instrument in this case will be correlated with the formation of a lending relationship but will only be indirectly correlated with the cost of a bank loan through its link to the lending relationship. Following Bharath et al. (2011) and Dass and Massa (2011), we use the geographical proximity of the borrowing firm to the lending bank as the instrument of lending relationships. As discussed in detail in Bharath et al. (2011), a shorter geographical distance lowers the cost of screening and monitoring, facilitating the formation of lending relationships. Therefore, the physical distance between the firm and the bank is expected to have an indirect effect on the cost of loans through its link to lending relationships but is not expected to have any other direct effects.

We use the zip codes of the headquarters to calculate the distance between borrowing firms and lending banks. A borrowing firm's location (i.e., its zip code) can be obtained from Compustat. For each lending bank, we obtain the location of the headquarters from the Dealscan company information database and the Federal Deposit Insurance Corporation's Institution Directory database. Having identified the zip codes for all of the borrowing firms and lending banks, we match the geographical coordinates (latitudes and longitudes) for each zip code using the U.S. Census Gazetteer Zips file.[12] We then calculate the distance between the location of each borrowing firm (subscript 1) and the location of its lending bank (subscript 2) for each loan using the following formula:

$$Dist_{1,2} = 3949.99 \times arcos[\sin(lat_1)\sin(lat_2) + \cos(lat_1)\cos(lat_2)\cos(long_1 - long_2)]$$

where 3949.99 is the radius of the Earth in miles; lat_1 and lat_2 are latitudes for the location 1 and location 2, respectively; and $long_1$ and $long_2$ are the longitudes for location 1 and location 2, respectively. This formula yields the distance between two locations in miles. To address the skewness in the distribution of distance, following Petersen and Rajan (2002), and Dass and Massa (2011), we use $Ln(1 + distance)$ as our instrumental variable for lending relationships.

[Table 2.4 about here]

Table 2.4 reports the results of the instrumental variable estimation. Column 1 reports the results of the first-stage probit regression with $Ln(1 + distance)$ and all other exogenous control variables used as independent variables. The coefficient for $Ln(1 + distance)$ is negative and significant at the 1% level, suggesting that the shorter the distance is between a borrowing firm and a lending bank, the more likely it is that the two organizations will form a lending relationship. The F-stat of the first-stage probit regression is 97.74, suggesting that the weak instruments problem is of less concern and that $Ln(1 + distance)$ is a viable instrument. The results of the second-stage regression are reported in

[12] Available online at http://www.census.gov/tiger/tms/gazetteer/zips.txt

Column 2. The coefficient for $Ln(vega)$ ($Ln(delta)$) is positive (negative) and significant at the 1% level. The coefficient of the interaction term for $Ln(vega)$ and the predicted value of the lending relationship, $Ln(vega) \times Predicted\ REL(Dummy)$, is positive and significant at the 5% level. Compared to the OLS results, the IV results are different only with regard to the increasing magnitude of the coefficients for the key variables when $REL(Dummy)$ is instrumented by $Ln(1 + distance)$ as in Bharath et al. (2011).[13] Overall, the results of the instrumental variable estimation are consistent with those of the OLS estimation.

2.3.3 Information opacity

The primary mechanism through which relationship lending mitigates the lender's sensitivity to CEO risk-taking incentives is the degree to which it decreases the information asymmetry between the firm and the lender. This decrease, in turn, increases the lender's ability to differentiate between value-enhancing and value-decreasing risk-taking incentives. The information produced through relationship lending is more valuable for firms that are informational opaque (relative to firms for which information is more publicly available). Therefore, we posit that the impact of relationship lending on the sensitivity of banks to CEO incentives varies based on the degree of information opacity of the borrowing firm. Specifically,

[13] The possible explanation for the increased magnitude of coefficients for *RL(Dummy)* and interaction terms is the attenuation bias from OLS regression because of measurement error in *RL(Dummy)*. Since *RL(Dummy)* is arbitrarily defined in practice, there could be measurement error between *RL(Dummy)* and the true value of relationship lending.

relationship lending should have a greater impact when the borrowing firm's level of information opacity is higher.

Following extant empirical studies (e.g. Lin et al. 2011), we employ three criteria to classify firms as high- or low–informational-opacity: the public bond market ratings, inclusion in the S&P 500 index and analyst coverage. Firms with public bond ratings are monitored by the financial markets and particularly by credit rating agencies. Faulkender and Petersen (2006) show that almost all firms with a positive amount of public debt are rated by rating agencies. We search the S&P senior secure debt rating for each borrowing firm. A firm is considered to be informational opaque (transparent) if it does not (does) have a public bond rating. Firms included in the S&P 500 index are extensively covered by the media and widely followed by investors. These firms are expected to be more transparent with regard to information. Thus, a firm is considered to be highly opaque in this regard if it is not included in the S&P 500 index. Analyst coverage is another proxy that is often used in empirical studies to determine a firm's level of information transparency. Firms that are followed by more analysts are expected to be more transparent. Using the I/B/E/S data on analyst following, we consider a firm to be highly opaque if the number of analysts following it is in the bottom quartile and highly transparent if the number is in the top quartile. Table 2.5 examines the impacts of relationship lending on the influence of CEO risk-taking incentives on the cost of bank loans for firms that are opaque and transparent with regard to information. The results are obtained from the second stage of 2SLS, with $REL(Dummy)$ instrumented by the physical distance between the borrowing firm and the lending bank.

[Table 2.5 about here]

The results in Table 2.5 show that the impact of relationship lending varies with the information opacity level of the borrowing firm. Specifically, for more transparent firms, we find that none of the coefficients of the interaction term $Ln(vega) \times Predicted\ REL(Dummy)$ are statistically significant. For firms that have a higher level of information opacity, the coefficients of the interaction terms are statistically significant and negative. The results indicate that the benefits of relationship lending in mitigating the sensitivity of loan cost to CEO risk-taking incentives exist only for firms that have a higher level of information opacity. These findings are consistent with the view that relationship lending facilitates information exchange between the firm and the bank, thereby allowing lenders to differentiate between value-enhance and value-decreasing risk-taking incentives, which in turn lowers their sensitivity to such incentives.

2.3.4 Loan maturity, relationship lending and CEO risk-taking incentives

Another reason why relationship lending attenuates lenders' sensitivity to CEO risk-taking incentives is that it increases monitoring efficiency, which constrains risk-shifting behavior after loans are awarded. One important tool for lenders to increase monitoring intensity is to reduce time to loan maturity. Brockman et al. (2010) show that *vega* (*delta*) is positively (negatively) associated with the proportion of short-term debt, suggesting that creditors shorten the duration of loans to increase monitoring frequency when CEOs are offered significant risk-taking incentives. Bharath et al. (2011) find that relationship loans are associated with shorter time to maturity, which implies that the reduced monitoring costs that result from prior lending relationships allow banks to increase monitoring frequency. Therefore, if relationship lending mitigates lenders' sensitivity through increased monitoring efficiency, we should expect that loan maturity for firms with greater CEO risk-taking incentives will be shorter given relationship lending. Thus, we posit that *vega* (*delta*) is negatively (positively) associated with bank loan maturity and that this association is stronger for relationship loans. To test this hypothesis, we estimate the following regression model:

$$
\begin{aligned}
Ln\left(Loan\ Maturity_{lft}\right) &= \alpha + \beta_1 \times Ln(vega)_{ft-1} + \beta_2 \times Ln(delta)_{ft-1} \\
&+ \beta_3 \times REL_{lft} + \beta_4 \times REL_{lft} \times Ln(vega)_{ft-1} + \beta_5 \times REL_{lft} \times Ln(delta)_{ft-1} \\
&+ \sum\gamma_i\left(Firm\ Characteristics_{ft-1}\right) + \sum\gamma_j\left(CEO\ Characteristics_{ft-1}\right) \\
&+ \sum\gamma_k(Loan\ Characteristics_{lt}) + \sum\gamma_m\left(Controls_{lft}\right) + \epsilon_{lft} \qquad \textbf{(2.2)}
\end{aligned}
$$

where $Ln\left(Loan\ Maturity_{lft}\right)$ is the natural logarithm of maturity for loan l that is borrowed by firm f in year t, measured in the number of months. The explanatory variables are the same as those in Equation (2.1).

[Table 2.6 about here]

Table 2.6 reports the regression results for Equation (2.2). Column 1 reports the OLS results, and Column 2 reports the IV results when *REL(Dummy)* is instrumented by the physical distance between the borrowing firm and the lending bank. Consistent with Brockman et al. (2010), the coefficients for $Ln(vega)$ ($Ln(delta)$) are negative (positive) and statistically significant, suggesting that banks shorten the time to loan maturity for firms with greater CEO risk-taking incentives in their compensation contracts. As also indicated by Bharath et al. (2011), the coefficient for *REL(Dummy)* is negative and statistically significant, suggesting that relationship loans have shorter maturities than non-relationship loans. The coefficients of the interaction terms for CEO risk-taking incentives and relationship lending, $REL(Dummy) \times Ln(vega)$ and $REL(Dummy) \times Ln(delta)$, are negative and positive, respectively, and are significant at the 5% level. In Column 2, we find similar results when the relationship lending measure is instrumented by using the physical distance between the borrowing firm and the lending bank. Overall, the results are consistent with the notion that relationship lending allows lenders to shorten the time to debt maturity and increase monitoring intensity, which allow banks to detect and correct potential risk-shifting by CEOs.

2.4 Robustness tests

2.4.1 Simultaneous estimation of loan contract terms

That banks structure both price and non-price terms to control their risk exposure could potentially bias our estimations, which separately analyze loan spread and maturity. To address this issue, we employ a simultaneous equation system for loan spread, maturity and collateral to control the potential joint determination of loan terms. Following Dennis et al. (2000) and Bharath et al. (2011), we assume that there is a unidirectional relationship between the price (loan spreads) and non-price (maturity and security) terms and that a bidirectional channel exists between the non-price terms, maturity and security. As argued in Bharath et al. (2011), these assumptions are based on the industry practice within loan syndication: generally, the non-price terms are determined before the interest rate. The structural model is as follows:

$$Ln\left(Loan\ Spread_{lft}\right) = \alpha_1 + \beta_{11} \times Ln(vega)_{ft-1} + \beta_{12} \times Ln(delta)_{ft-1} + \beta_{13} \times REL_{lft} + \beta_{14} \times REL_{lft} \times Ln(vega)_{ft-1} + \beta_{15} \times REL_{lft} \times Ln(delta)_{ft-1} + \beta_{16} \times Ln(maturity)_{lft} + \beta_{17} \times Collateral_{lft} + X_f'\gamma_1 + \epsilon_{lft}^1 \quad \textbf{(2.3)}$$

$$Ln\left(Loan\ Maturity_{lft}\right) = \alpha_2 + \beta_{21} \times Ln(vega)_{ft-1} + \beta_{22} \times Ln(delta)_{ft-1} + \beta_{23} \times REL_{lft} + \beta_{24} \times REL_{lft} \times Ln(vega)_{ft-1} + \beta_{25} \times REL_{lft} \times Ln(delta)_{ft-1} + \beta_{26} \times Collateral_{lft} + X_f'\gamma_2 + \epsilon_{lft}^2 \quad \textbf{(2.4)}$$

$$Collateral_{lft} = \alpha_3 + \beta_{31} \times Ln(vega)_{ft-1} + \beta_{32} \times Ln(delta)_{ft-1} + \beta_{33} \times REL_{lft} + \beta_{34} \times REL_{lft} \times Ln(vega)_{ft-1} + \beta_{35} \times REL_{lft} \times Ln(delta)_{ft-1} + \beta_{36} \times Ln\left(Loan\ Maturity_{lft}\right) + X_f'\gamma_3 + \epsilon_{lft}^3 \quad \textbf{(2.5)}$$

where X_f' contains all of the exogenous variables that affect the corresponding loan term *i*. We use the IV regression framework (Bharath et al., 2011) to estimate the structural equations. Asset maturity is used as the instrument for loan maturity because firms tend to calibrate the time to debt maturity to the economic life of the assets (e.g., Hart and Moore 1994; Graham et al. 2008). The loan concentration (defined as loan amount / (value of existing debt + loan amount)) is used as the instrument for collateral because the larger the amount of the current loan is relative to the size of the total debt, the more likely it is that a lender will ask for collateral (Berger and Udell 1990; Bharath et al. 2010).

[Table 2.7 about here]

Table 2.7 reports the impact of relationship lending on the sensitivity of loan contract terms to CEO risk-taking incentives, controlling for the joint determination of loan contract terms. Columns (1) and (2) report the results for the loan spread equation. The coefficient for $REL \times Ln(vega)$ is negative and statistically significant, which suggests that relationship lending can mitigate the sensitivity of loan spreads to CEO risk-taking incentives (*vega*). Columns (3) and (4) report the results for the loan maturity equation. The coefficients for the interaction term $REL \times Ln(delta)$ and $REL \times Ln(vega)$ are positive and negative respectively and significant, suggesting that relationship lending allows firms to increase monitoring intensity by offering shorter-loan terms to firms with higher CEO risk-taking incentives. Columns (5) and (6) report the results for the collateral equation. The results show that relationship loans are less likely to post collateral than are non-relationship loans; this finding is consistent with that of Bharath et al (2011). $Ln(vega)$ is positively related to the likelihood of collateralization, which implies that a lending bank is more likely to require collateral from firms with greater CEO risk-taking incentives. However, the interaction terms for relationship lending and CEO risk-taking incentives are not statistically significant, which implies that relationship lending does not have a significant impact on the sensitivity of collateral choice to CEO risk-taking incentives. We also provide several relevance and validity test statistics to support our empirical results. For example, we obtain the Durbin-Wu-Hausman (DWH) chi-square of 124.30 from the loan spread regression with the potentially endogenous regressors maturity and collateral. This result suggests that maturity and collateral are indeed endogenous and validates the IV approach. The first-stage F-statistic for maturity regression is 199.93, which suggests that loan concentration is a relevant instrument for collateral in maturity regression. We also find a DWH chi-square of 276.40 in the maturity regression, which suggests that collateral is indeed endogenous in the maturity regression and validates the IV approach. In the collateral regression, we obtain a Wald chi-square of 20.90, which suggests that maturity is endogenous to collateral. Overall, the results in presented in Table 2.7 show that relationship lending affects the sensitivity of lending banks to CEO risk-taking incentives.

2.4.2 Alternative measures of relationship lending

[Table 2.8 about here]

Our previous analysis is based on the relationship lending measure *REL(Dummy)*, which identifies the existence of relationship lending. We check the robustness of the results using two alternative measures, *REL(Number)* and *REL(Amount)*, which reflect the relative importance and intensity of the relationship loans (Schenone 2010). Table 2.8 reports the impact of lending relationships on the sensitivity of loan spreads and loan maturity to CEO risk-taking incentives using these two alternative measures and the IV results when they are instrumented by the physical distance between the borrowing firm and the lending bank. In the loan spread regressions, the coefficients of the interaction terms $REL(Number) \times$

$Ln(vega)$ and $REL\ (Amount) \times Ln(vega)$ are significantly negative in both the OLS and the IV estimations. In the loan maturity regressions, the coefficients of the interaction terms $REL(Number) \times Ln(vega)$ and $REL\ (Amount) \times Ln(vega)$ are significantly negative in both the OLS and the IV estimations. The coefficients of the interaction terms $REL(Number) \times Ln(delta)$ and $REL\ (Amount) \times Ln(delta)$ are significantly positive in both the OLS and the IV estimations. The results are consistent with those obtained using *REL(Dummy)* as the measure of relationship lending. In un-tabulated results, we find that the differential impacts of relationship lending on firms that are informational transparent versus those that are informational opaque also remain robust to the use of these two alternative measures of relationship lending. In summary, the effect of a lending relationship on the sensitivity of lenders to CEO risk-taking incentives is robust to the use of simultaneous determinants of the loan contract terms and to the use of different measures of lending relationships.

2.5 Conclusions

A corporation includes different stakeholders who interact through a complex set of contractual relationships. The contractual relationships between shareholders, creditors and the CEO are among the most important, as they have a significant bearing on firm value. A well-designed CEO incentive contract should provide the CEO with stronger incentives to increase shareholders' value. However, such an incentive contract could potentially be perceived negatively by creditors, thus increasing the cost of debt, which would reduce shareholder value. Therefore, it is important to understand the conflict of interest that is inherent in the provision of CEO incentives and to examine potential mechanisms through which this conflict of interest can be resolved or attenuated.

This paper investigates how CEO risk-taking incentives affect the cost of bank loans and, more importantly, how lending relationships provide an effective mechanism for attenuating the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives. We find that firms with greater CEO risk-taking incentives have higher cost of bank loans. The results suggest that banks indeed consider CEO risk-taking incentives when pricing loans. We also show that the impact of CEO risk-taking incentives on loan cost is significantly lower for relationship loans than for non-relationship loans, which suggests that relationship lending attenuates bank sensitivity to CEO risk-taking incentives. In addition, our results suggest two channels through which relationship lending influences the impact of CEO risk-taking incentives on the cost of loans: it reduces the information asymmetry between lenders and borrowers and increases monitoring intensity. The former allows banks to differentiate between value-enhancing and value-decreasing risk-taking incentives before loans are made. The latter can be used to limit the risk-shifting behavior that may occur after loans are made. We find the impact of relationship lending on bank sensitivities to CEO risk-taking incentives to be significant only for firms that are more informational opaque. In addition, relationship banks shorten the time to maturity to increase monitoring intensity for firms with greater CEO risk-taking incentives. Our results are robust to the endogeneity of lending relationship formation, simultaneous determinants of loan contract terms, and alternative measures of lending relationships.

In summary, this paper presents new empirical evidence of the influence of CEO risk-taking incentives on loan contract terms. It also provides new insight into the importance of relationship lending by providing a channel through which relationship lending can benefit a borrowing firm and showing how these benefits can be translated into valuable gains for all firm stakeholders, including shareholders, creditors, and firm executives. Altogether, the results of this study can help us to better understand the interactions between the different contractual relationships within a firm and how best to optimize one contract when it is conditional on others.

Appendix 2.A: Calculation of CEO portfolio sensitivities

Following the methodology outlined by Core and Guay (2002), we define the sensitivity of CEO portfolio to stock price (*delta*) as the change in the value of a CEO's stock and option portfolio due to a 1% change in the price of a firm's common stock. The sensitivity of CEO portfolio to stock return volatility (*vega*) is defined as the change in the value of a CEO's option portfolio due to a 1% change in the annualized standard deviation of a firm's stock returns. Partial derivatives of the option price with respect to stock price (Δ) and stock return volatility (υ) are based on the Black and Scholes option-pricing model, adjusted for dividends by Merton (1973) as follows:

$$\Delta = e^{-dt} N(Z)$$

$$v = e^{-df} N'(Z) S\sqrt{T}$$

$$Z = \frac{\ln(s/x) + T(r - d + \sigma^2/2}{\sigma\sqrt{T}}$$

where

N is the cumulative probability function for the normal distribution;
$N`$ is the density function for the normal distribution;
S is the price of the underlying stock;
X is the exercise price of the option;
σ is the expected stock return volatility;
r is the natural logarithm of the risk-free interest rate;
T is the time to maturity of the option in years;
d is the natural logarithm of the expected dividend yield.

We use Core and Guay (2002) one year approximation method to compute *delta* and *vega*. We calculate *delta* and *vega* as follows:

$$Delta = S / 100(\Delta_{ng} N_{ng} + \Delta_{pgex} N_{pgex} + \Delta_{pgunex} N_{pgunex} + N_{stock})$$

$$Vega = 1 / 100(\upsilon_{ng} N_{ng} + \upsilon_{pgex} N_{pgex} + \upsilon_{pgunex} N_{pgunex})$$

Where *S* represents the stock price and N represents the number of options or stocks in hundreds of thousands. The subscripts *ng*, *pgex*, *pgunex* and *stock* stand for new grants, previously granted exercisable options, previously granted unexercisable options and stock holdings respectively.

Appendix 2.B: Variable definitions

Variable	Definition
Altman Z-score	defined as (1.2*working capital+1.4*retained earnings + 3.3*EBIT +0.999*sales)/total assets.
Asset Maturity	Log (act/(act + ppent))*(act/cogs)+(ppent/(act + ppent)*ppent/dp)
Cash Flow Volatility	defined as the standard deviation of quarterly cash flows over past 4 years scaled by total asset.
Collateral	Dummy variable takes value of 1 if the loan is secured or 0 otherwise.
Interest Coverage	defined as log (1+ EBITDA/interest expenses).
Loan type	4 dummy variables. Loantype1 takes value of 1 if the loan type is "Revolver/Line >= 1 Yr." and 0 otherwise. Loantype2 takes value of 1 if the loan type is "Term Loan" or "Term Loan A through H" and 0 otherwise. Loantype3 takes value of 1 if the loan type is "Revolver/Line < 1 Yr." and 0 otherwise. Loantype4 takes value of 1 if the loan type is "364-Day Facility" and 0 otherwise. These 4 loan types account for over 95% in our sample.
Loan purpose	5 dummy variables. Loanpurpose1 takes value of 1 if loan purpose is "Corp. purposes" and 0 otherwise. Loanpurpose2 takes value of 1 if loan purpose is "Work. cap." and 0 otherwise. Loanpurpose3 takes value of 1 if loan purpose is "Debt Repay." and 0 otherwise. Loanpurpose4 takes value of 1 if loan purpose is "Takeover" and 0 otherwise. Loanpurpose5 takes value of 1 if loan purpose is "CP backup" and 0 otherwise. These 5 loan purposes account for over 90% in our sample.
Loan concentration	Loan amount/(value of existing debt + loan amount)
Leverage	defined as (long term debt + debt in current liabilities)/total assets.
Log (amount)	defined as log term of loan facility amount.
Log (asset)	defined as log term of firm's total assets.
Log (maturity)	defined as the log of loan facility maturity.
Ln(*delta*)	log term of *delta*
Ln(*vega*)	log term of *vega*
Market to Book	defined as (market value of equity + book value of debt)/total assets

Ownership	defined as the CEO stock ownership deflated by firm outstanding common shares.
Delta	defined as the change of CEO stock and option portfolio to 1% change of stock price.
Profitability	defined as EBITDA/total assets.
Return Volatility	defined as standard deviation of annualized monthly stock returns over past 60 months.
REL(Dummy)	defined as dummy variable takes value of 1 if the borrowing firm of the loan facility had transactions with lender before in 4 year look back window period before current loan and 0 otherwise
REL(Number)	defined as the ratio of number of loans with the lender to the number of total loans by borrowing firm in 4 year window period before current loan.
REL(Amount)	defined as the ratio of dollar value of the loans with the lender to the total dollar value of loans borrowed by the firm in the last 4 year before current loan.
Tenure	defined as natural log of number of years CEO in position, equals the difference between the year of observation and the year when the CEO in position
Vega	defined as the change of CEO option portfolio for 1% change of standard deviation of annualized stock return.

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Table 2.1 Summary statistics

The table presents summary statistics for CEO incentives, loan contract terms and firm characteristics for the sample of 8449 loan facilities of 1524 firms over 1992-2007. *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price. *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return. *Total asset* is (AT) in Compustat. *Leverage* is defined as (long term debt + debt in current liabilities)/total assets. *Book to Market* is defined as (total assets-total liabilities)/common share outstanding *fiscal year end stock closing price. *Interest coverage* is defined as log (1+ EBITDA/interest expenses). *Altman Z-score* is defined as (1.2×working capital + 1.4×retained earnings + 3.3×EBIT + 0.999×sales) / total assets. *Loan spread* is basis points charged over LIBOR or LIBOR equivalent. *Loan maturity* is the maturity of loan facility in months. *Loan amount* is the amount of loan facility in million dollars.

Variable	Mean	Std Dev	25th	Median	75th
delta ($ thousand)	750	1551	103	262	678
vega ($ thousand)	181	297	25	70	194
Total Asset ($M)	6806	18228	671	1802	6103
Leverage	0.27	0.17	0.16	0.26	0.37
Altman Z-score	1.96	1.15	1.25	1.9	2.61
Book-to-Market	0.48	0.44	0.25	0.41	0.62
Interest coverage	2.02	1.07	1.36	1.87	2.51
Loan Spread (in basis point)	132	115	42	100	200
Loan Maturity (Month)	43	23	12	48	60
Loan Amount ($M)	529	1047	100	250	550

Table 2.2 Relationship lending from 1992-2007

This table presents relationship lending distribution from 1992-2007. Panel A presents the distribution of relationship lending over 1992-2007. For a particular facility, if the borrowing firm borrows from the same lead bank in the past 5 years, then this facility is considered to be relationship loan (REL(Dummy)=1). Panel B presents the mean comparison of CEO incentive variables and the cost of bank loans for relationship loans and non-relationship loans. Significance level at 10%, 5% and 1% is indicated by *, ** and *** respectively.

Panel A

Year	Non Relationship REL (Dummy)=0	Relationship REL (Dummy)=1	Total
1992	18	32	50
1993	63	176	239
1994	97	267	364
1995	123	307	430
1996	127	413	540
1997	129	418	547
1998	165	427	592
1999	175	464	639
2000	179	538	717
2001	180	555	735
2002	118	516	634
2003	121	545	666
2004	148	511	659
2005	161	488	649
2006	144	417	561
2007	145	282	427
Total	2093	6356	8449

Panel B

Variables	Non Relationship	Relationship	Difference
Delta ($ thousands)	534	821	287***
Vega ($ thousands)	134	197	63***
Loan Spread (in basis points)	165	121	44***

Table 2.3 Relationship lending's impact on CEO incentives-cost of bank loan relationship

The table presents the results of Equation (2.1): relationship lending's effect on CEO incentives and cost of bank loan relationship with different specifications. The dependent variables are natural log of loan spread in basis point. *REL (Dummy)* is a dummy variable taking value of 1 if the borrowing firm of a loan facility had transactions with the same lead lending bank in 5 year look back window period before current loan. *Ln (vega)* is the natural log term of *vega*. *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return. *Ln (delta)* is the natural log term of *delta*. *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price. *Ln (assets)* is the natural log of firm total assets. *Leverage* is defined as (long term debt + debt in current liabilities)/total assets. *Book to Market* is defined as (total assets-total liabilities)/common share outstanding × fiscal year end stock closing price. *Interest coverage* is defined as Ln (1+ EBITDA/interest expenses). *Altman Z-score* is defined as (1.2×working capital + 1.4×retained earnings + 3.3×EBIT + 0.999×sales)/total assets. *Return volatility* is defined as standard deviation of annualized monthly stock returns over past 60 months. *Cash flow volatility* is defined as the standard deviation of quarterly cash flows over past 4 years scaled by total asset. *Ownership* is the CEO stock ownership deflated by firm outstanding common shares. *Tenure* is defined as natural log of CEO tenure, equals the difference between observation year and the year CEO in position. *Ln (maturity)* is the natural log of loan facility maturity. *Ln (amount)* is the natural log of loan facility amount. *Collateral* is defined as a dummy variable taking value of 1 if the loan is secured and 0 otherwise. Column 1 estimates equation (1) without relationship lending related variables. Column 2 estimates equation (1) without CEO incentive related variables. Column 3 estimates equation (1) without the interaction terms between relationship lending measure and CEO incentives. Column 4 estimates equation (1) with complete specification. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	(1)	(2)	(3)	(4)
Ln(*delta*)	-0.050***		-0.049***	-0.060***
	(-3.76)		(-3.67)	(-3.28)
Ln(*Vega*)	0.019**		0.018**	0.045***
	(2.01)		(1.98)	(3.00)
REL(Dummy)		-0.050**	-0.050**	0.034
		(-2.28)	(-2.18)	(0.46)
Ln(*delta*) x REL(Dummy)				0.013
				(0.79)
Ln(*Vega*) x REL(Dummy)				-0.036**
				(-2.35)
Firm Characteristics				

Ln(Assets)	-0.153***	-0.174***	-0.152***	-0.151***
	(-9.33)	(-11.67)	(-9.27)	(-9.23)
Leverage	0.666***	0.692***	0.673***	0.672***
	(6.41)	(6.70)	(6.48)	(6.48)
Book to Market	0.222***	0.235***	0.222***	0.220***
	(7.57)	(8.27)	(7.52)	(7.53)
Interest Coverage	-0.064***	-0.070***	-0.065***	-0.065***
	(-3.51)	(-3.93)	(-3.58)	(-3.52)
Profitability	-1.063***	-1.174***	-1.063***	-1.074***
	(-4.68)	(-5.29)	(-4.69)	(-4.74)
Altman Z-score	-0.041***	-0.036**	-0.040***	-0.040***
	(-2.66)	(-2.40)	(-2.61)	(-2.63)
Return Volatility	0.741***	0.746***	0.735***	0.733***
	(8.83)	(9.19)	(8.78)	(8.79)
Cash Flow Volatility	1.371***	1.281***	1.387***	1.390***
	(3.68)	(3.45)	(3.71)	(3.71)
CEO Characteristics				
Ownership	0.001***	-	0.001***	0.001***
	(3.85)	-	(3.81)	(3.85)
Tenure	0.003*	-	0.003*	0.002*
	(1.76)	-	(1.74)	(1.77)
Loan Characteristics				
Ln(Amount)	-0.062***	-0.062***	-0.061***	-0.062***
	(-5.06)	(-5.06)	(-4.95)	(-5.03)
Ln(Maturity)	-0.045**	-0.052**	-0.046**	-0.045**
	(-2.16)	(-2.45)	(-2.20)	(-2.15)
Collateral	0.509***	0.506***	0.507***	0.507***
	(20.51)	(20.57)	(20.43)	(20.50)
N	6912	7086	6912	6912
R-square	0.714	0.710	0.714	0.715

Table 2.4 2SLS of relationship lending formation

This table presents the results of 2SLS regression with instrument variable for relationship lending formation. Column 1 is the probit regression results of instrument variable Ln (1+ distance) and all variables in the second stage regressed on *REL (Dummy)*. Column 2 reports the second stage results of a 2SLS regression with *REL (Dummy)* instrumented by Ln (1+Distance). Wooldridge (2002) has shown that this approach yields consistent coefficients, as well as correct standard errors. Dependent variable in Column 2 is natural log of bank loan spread in basis point. *Distance* is the geographical distance of a borrowing firm and a lending bank in miles. Other independent variables are defined as same in Table 2.3. In Column 1, Heteroscedasticity corrected standard errors are in parentheses. In Column 2, year dummies, 2 digits SIC industry dummies, loan purpose and type dummies are included in all estimations. Heteroscedasticity robust t-statistics are in parentheses and standard errors are clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

First Stage Probit		IV	
	(1)		(2)
Ln (1+ Distance)	-0.050*** (0.011)	Predicted REL(Dummy)	0.356 (1.03)
Ln (Assets)	0.083*** (0.025)	Ln(*Delta*)	-0.060*** (-3.18)
Leverage	0.658*** (0.170)	Ln(*Vega*)	0.110** (2.57)
Book to Market	-0.006 (0.051)	Predicted REL(Dummy) × Ln(*Delta*)	0.122 (0.99)
Profitability	-0.139 (0.394)	Predicted REL (Dummy) × Ln(*Vega*)	-0.129** (-2.33)
Altman Z-score	0.058** (0.027)	**Firm Characteristics**	
		Ln(Assets)	-0.131*** (-6.88)
Return Volatility	-0.483*** (0.138)	Leverage	0.790*** (6.72)
Cash Flow Volatility	1.761*** (0.614)	Book to Market	0.210*** (7.07)
Log (Amount)	0.083*** (0.023)	Interest Coverage	-0.096*** (-4.37)
Log (Maturity)	-0.055 (0.042)	Profitability	-1.085*** (-4.79)
Collateral	-0.165*** (0.045)	Altman Z-score	-0.027 (-1.61)
Interest Coverage	-0.116*** (0.029)	Return Volatility	0.636*** (6.61)
Ln(*Delta*)	0.074*** (0.024)	Cash Flow Volatility	1.692***

Ln(*Vega*)	-0.023		(4.18)
	(0.018)	**CEO Characteristics**	
Ownership	-0.001*	Ownership	0.001***
	(0.001)		(2.92)
Tenure	-0.002	Tenure	0.002
	(0.003)		(1.50)
N	6912	**Loan Characteristics**	
Pseudo R-square	0.102	Ln(Amount)	-0.041***
			(-2.91)
		Ln(Maturity)	-0.062***
			(-2.91)
		Collateral	0.469***
			(16.16)
		N	6912
		R-square	0.717
		First stage F-stat	97.74

Table 2.5 Relationship lending, CEO incentives and firm information opacity

The table presents the results of Equation (2.1), relationship lending's effect on CEO incentives and the cost of bank loan with low versus high firm information opacity level. The dependent variables are natural log of loan spread in basis point. Independent variables are defined same in table 3. The results are obtained from second stage of 2SLS with *REL (Dummy)* instrumented by the physical distance between a borrowing firm and a lending bank. Column 1 through 3 estimates equation (1) for firms with low information opacity. Column 4 through 6 estimates equation (3) for firms with high information opacity. Year dummies, 2 digits SIC industry dummies, loan purpose and type dummies are included in all estimations. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Low Information Opacity			High Information Opacity		
Method: IV	With Bond Rating	S&P 500 Inclusion	High Analyst Coverage	Without Bond Rating	No S&P 500 Inclusion	Low Analyst Coverage
	(1)	(2)	(3)	(4)	(5)	(6)
REL	0.202	0.316	0.868	0.083	0.166	0.218
	(0.30)	(0.32)	(0.77)	(0.20)	(0.41)	(0.53)
Ln(*Delta*)	-0.196	-0.141	-0.197	-0.072	-0.101	-0.078
	(-1.53)	(-1.00)	(1.08)	(-1.07)	(-1.53)	(-1.05)
Ln(*Vega*)	0.031	0.007	0.154	0.118***	0.101**	0.110**
	(0.30)	(0.07)	(1.13)	(2.75)	(2.35)	(2.19)
REL × Ln(*Delta*)	0.139	0.113	0.122	0.026	0.048	0.034
	(1.27)	(0.95)	(1.60)	(0.49)	(0.89)	(0.54)
REL × Ln(*Vega*)	-0.067	0.003	-0.170	-0.148***	-0.126**	-0.148**
	(-0.29)	(0.03)	(-0.87)	(-2.60)	(-2.20)	(-2.17)
Firm Characteristics						
Ln(Assets)	-0.108***	-0.159***	-0.116***	-0.139***	-0.066***	-0.141***
	(-3.82)	(-5.16)	(-4.24)	(-6.85)	(-3.37)	(-6.57)
Leverage	0.634***	0.917***	0.866***	0.880***	0.818***	0.750***
	(3.16)	(3.74)	(5.23)	(7.38)	(6.75)	(5.43)
Book to Market	0.223***	0.549***	0.301***	0.199***	0.139***	0.174***
	(4.71)	(5.61)	(6.44)	(6.26)	(5.32)	(5.48)
Interest Coverage	-0.180***	-0.079**	-0.089***	-0.075***	-0.083***	-0.097***
	(-4.71)	(-2.00)	(-3.02)	(-3.13)	(-3.61)	(-3.70)
Profitability	-0.113***	-0.817*	-1.051***	-1.008***	-0.906***	-1.167***
	(-3.17)	(-1.84)	(-3.07)	(-3.73)	(-3.91)	(-4.28)

Altman Z-score	-0.032	-0.040	-0.036	-0.015	-0.012	-0.015
	(-1.11)	(-1.09)	(-1.55)	(-0.80)	(-0.74)	(-0.76)
Return Volatility	0.593***	0.757***	0.556***	0.671***	0.513***	0.704***
	(3.78)	(3.64)	(4.33)	(6.24)	(5.23)	(5.98)
Cash Flow Volatility	2.666***	2.602***	2.637***	1.330***	1.588***	1.151**
	(4.10)	(3.37)	(4.33)	(3.09)	(3.94)	(2.53)
CEO Characteristics						
Ownership	0.001	0.001	0.001	0.001**	0.001**	0.001***
	(1.31)	(1.44)	(0.25)	(2.51)	(2.44)	(3.04)
Tenure	0.003	0.003	0.005**	0.002	0.002	-0.001
	(1.06)	(1.04)	(2.22)	(1.05)	(1.06)	(-0.01)
Loan Characteristics						
Ln(Amount)	-0.059***	-0.071**	-0.046**	-0.028*	-0.046***	-0.029*
	(-2.95)	(-2.54)	(-2.22)	(-1.67)	(-3.08)	(-1.74)
Ln(Maturity)	-0.058	-0.010	-0.112***	-0.080***	-0.071***	-0.030
	(-1.63)	(-0.23)	(-3.34)	(-2.89)	(-3.12)	(-1.17)
Collateral	0.577***	0.561***	0.477***	0.394***	0.423***	0.456***
	(11.14)	(8.37)	(10.80)	(12.39)	(14.69)	(13.12)
N	2803	2259	1552	4109	4653	1567
R-square	0.762	0.688	0.746	0.694	0.659	0.707

Table 2.6 Relationship lending, CEO incentives and loan maturity

The table presents the results of Equation (2.2), relationship lending's effect on CEO incentives and loan maturity relationship. The dependent variables are natural log of loan maturity in months. *Assets maturity* is defined as Ln (act/(act + ppent)) × (act/cogs) + (ppent/(act + ppent) × ppent/dp). Other independent variables are defined same in table 3. REL measure is *REL(Dummy)*. Column 1 estimates equation (2) by OLS. Column 2 reports the results obtained from the second stage of 2SLS with *REL (Dummy)* instrumented by the physical distance between a borrowing firm and a lending bank. Year dummies, 2 digits SIC industry dummies and loan purpose dummies are included in all estimations. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Methods	OLS	IV
	(1)	(2)
REL	-0.165**	-1.937***
	(-2.46)	(-6.44)
Ln(*Delta*)	0.029**	0.241***
	(1.98)	(5.06)
Ln(*Vega*)	-0.030**	-0.150***
	(-2.02)	(3.33)
REL × Ln(*Delta*)	0.032**	0.155**
	(2.17)	(2.58)
REL × Ln(*Vega*)	-0.025**	-0.274***
	(-2.15)	(-4.61)
Firm Characteristics		
Ln (Assets)	-0.166***	-0.035*
	(-10.32)	(-1.93)
Leverage	0.313***	1.014***
	(3.23)	(10.29)
Book to Market	0.049	0.015
	(1.52)	(0.48)
Interest Coverage	0.013	-0.141***
	(0.80)	(-8.55)
Profitability	-0.250	-0.264
	(-1.17)	(-1.26)
Altman Z-score	0.017	0.085***
	(1.19)	(6.00)
Return Volatility	-0.185**	-0.657***
	(-2.10)	(-7.58)

Cash Flow Volatility	-0.131	-1.368***
	(-0.41)	(-4.29)
Asset Maturity	0.041**	0.022
	(2.16)	(1.24)
CEO Characteristics		
Ownership	-0.001	-0.001***
	(-1.50)	(-5.35)
Tenure	0.001	-0.001
	(0.07)	(-1.31)
Loan Characteristics		
Ln(Amount)	0.129***	0.193***
	-9.09	(14.88)
Collateral	0.278***	-0.003
	-12.33	(-0.15)
N	6912	6912
R-square	0.233	0.321

Table 2.7 Simultaneous equations: loan spread, maturity and collateral

The table presents the results of simultaneous equations of a three-equation system. The dependent variables are natural log of loan spread, natural log of loan maturity in months and dummy variable of collateral taking value of 1 if the loan is secured or 0 otherwise. *Assets maturity* is defined as ln (act/(act + ppent)) × (act/cogs) + (ppent/(act + ppent) × ppent/dp). *Loan concentration* is defined as loan amount / (existing debt + loan amount). Other independent variables are defined same in table 3. Year dummies, 2 digits SIC industry dummies and loan purpose dummy are included in all estimations. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level in loan spread and loan maturity regressions. Bootstrapped standard errors are in parentheses for collateral regressions. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Ln(Loan Spread)		Ln (Maturity)		Collateral	
	OLS (1)	IV (2)	OLS (3)	IV (4)	Probit (5)	IV Probit (6)
REL	0.034	0.375	-0.165**	-0.210***	-0.215**	-0.082***
	(0.46)	(0.75)	(-2.46)	(-2.78)	(0.09)	(0.02)
Ln(*Delta*)	-0.060***	-0.105***	0.029**	0.039**	-0.025	-0.042
	(-3.28)	(-5.69)	(1.98)	(2.37)	(0.04)	(0.03)
Ln(*Vega*)	0.045***	0.062***	-0.030**	-0.026**	0.04**	0.015
	(3.00)	(4.11)	(-2.02)	(-2.11)	(0.02)	(0.03)
REL × Ln(*Delta*)	0.013	0.048	0.032**	0.060**	-0.068*	-0.024
	(0.79)	(0.88)	(2.17)	(2.07)	(0.04)	(0.04)
REL × Ln(*Vega*)	-0.036**	-0.063**	-0.025**	-0.063**	0.02	0.017
	(-2.35)	(-2.41)	(-2.15)	(-2.43)	(0.04)	(0.03)
Firm Characteristics						
Log(Assets)	-0.151***	-0.163***	-0.166***	0.031	-0.182***	-0.170***
	(-9.23)	(-6.30)	(-10.32)	(0.45)	(0.04)	(0.04)

Leverage	0.672***	0.082	0.313***	-0.421	1.445***	1.257***
	(6.48)	(0.73)	(3.23)	(-1.59)	(0.23)	(0.43)
Book to Market	0.220***	0.121***	0.049	-0.053	0.133**	0.006
	(7.53)	(3.97)	(1.52)	(-1.04)	(0.05)	(0.09)
Interest Coverage	-0.065***	-0.094***	0.013	0.061**	-0.154***	-0.046
	(-3.52)	(-5.02)	(0.80)	(2.22)	(0.03)	(0.05)
Profitability	-1.074***	-0.654***	-0.250	0.542	-1.498***	-1.185***
	(-4.74)	(-2.85)	(-1.17)	(1.41)	(0.43)	(0.44)
Altman Z-score	-0.040***	-0.057***	0.017	0.049**	-0.026	-0.020
	(-2.63)	(-3.67)	(1.19)	(2.13)	(0.03)	(0.02)
Return Volatility	0.733***	1.166***	-0.185**	-1.237***	1.745***	0.722
	(8.79)	(11.31)	(-2.10)	(-3.57)	(0.15)	(0.66)
Cash Flow Volatility	1.390***	1.994***	-0.131	-1.984***	2.722***	0.608
	(3.71)	(5.13)	(-0.41)	(-2.77)	(0.65)	(1.13)
CEO Characteristics						
Ownership	0.001***	0.002***	-0.001	-0.002***	-0.002***	-0.001
	(3.85)	(7.28)	(-1.50)	(-3.02)	(0.00)	(0.00)
Tenure	0.002*	0.002	0.001	0.001	0.003	-0.001
	(1.77)	(1.13)	(0.07)	(0.55)	(0.00)	(0.00)
Loan Characteristics						
Log(Amount)	-0.062***	-0.293***	0.129***	0.075***	-0.091**	0.040
	(-5.03)	(-17.55)	(9.09)	(3.26)	(0.04)	(0.06)
Log(Maturity)	-0.045**	-0.248**			0.237***	1.114***
	(-2.15)	(-2.22)			(0.04)	(0.19)
Collateral	0.507***	1.780***	0.278***	2.333***		
	(20.50)	(19.74)	(12.33)	(3.74)		

Instrument Variables					
Asset Maturity		0.041**	0.611***		
		(2.16)	(2.46)		
Loan Concentration				0.636***	0.513**
				(0.21)	(0.22)
Durbin-Wu-Hausman's Chi-square test	124.30		276.40		
p-value	0.00		0.00		
Wald Chi-square test					20.90
p-value					0.00
First-stage F statistics			199.93		

Table 2.8 Alternative relationship lending measure with *REL (Number) and REL (Amount)*

The table presents the results using alternative relationship lending measures *REL (Number)* and *REL (Amount). REL (Number)* is defined as the ratio of the number of loans with the same lead bank borrowed by a firm to the total number of loans borrowed by the firm in the last five years before current loan. *REL (Amount) is* defined as the ratio of the dollar value of loans with the same lead bank borrowed by a firm to the total dollar value of loans borrowed by the firm in the last five years before current loan. For a loan with multiple lead banks, the highest values of *REL (Number)* and *REL (Amount)* among all lead banks are used. Dependent variables are natural log of loan spread in basis points and natural log of loan maturity in months. The IV results are obtained from the second stage of 2SLS with *REL (Number)* and *REL (Amount)* instrumented by the physical distance between a borrowing firm and a lending bank. Independent variables are defined the same as before. Year dummies, 2 digits SIC industry dummies, loan purpose dummies are included in all estimations. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

REL Measures	*REL(Number)*				*REL(Amount)*			
Dependent variables	*Ln(loan Spread)*		*Ln(Loan Maturity)*		*Ln(loan Spread)*		*Ln(Loan Maturity)*	
Methods	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
REL	0.012	0.345	-0.245***	-4.233***	0.004	0.433	-0.204**	-4.407***
	(0.16)	(0.47)	(-2.71)	(-10.53)	(0.07)	(0.59)	(-2.37)	(-11.90)
Ln(*Delta*)	-0.063***	-0.145***	0.021**	0.137***	-0.064***	-0.135***	0.024**	0.132***
	(-3.80)	(-3.32)	(2.09)	(3.03)	(-3.70)	(-3.47)	(2.20)	(3.00)
Ln(*Vega*)	0.052***	0.119***	-0.035***	0.125***	0.049***	0.111***	-0.032**	0.141***
	(3.74)	(2.85)	(-2.77)	(3.61)	(3.45)	(2.62)	(-2.63)	(3.02)
REL × Ln(*Delta*)	0.025	0.083	0.024**	0.315**	0.024	0.115	0.020**	0.247**
	(1.43)	(1.19)	(2.14)	(2.43)	(1.34)	(1.16)	(2.29)	(2.36)
REL × Ln(*Vega*)	-0.060***	-0.192***	-0.029**	-0.202**	-0.053***	-0.168***	-0.019**	-0.204**

	(-3.61)	(-2.94)	(-2.25)	(-2.04)	(-3.19)	(-2.62)	(-2.05)	(-2.31)
Firm Characteristics								
Ln(Assets)	-0.156***	-0.180***	-0.148***	-0.286***	-0.155***	-0.177***	-0.148***	-0.281***
	(-9.59)	(-6.84)	(-8.85)	(-17.27)	(-9.49)	(-7.11)	(-8.88)	(-17.40)
Leverage	0.670***	0.725***	0.197**	0.683***	0.672***	0.758***	0.202**	0.921***
	(6.48)	(6.56)	(2.09)	(7.59)	(6.51)	(6.08)	(2.13)	(10.22)
Book to Market	0.219***	0.209***	0.026	0.027	0.220***	0.215***	0.027	0.070**
	(7.52)	(6.88)	(0.90)	(0.93)	(7.54)	(7.06)	(0.90)	(2.43)
Interest Coverage	-0.065***	-0.084***	0.012	-0.101***	-0.065***	-0.084***	0.013	-0.105***
	(-3.59)	(-3.49)	(0.79)	(-6.84)	(-3.57)	(-3.48)	(0.80)	(-7.25)
Profitability	-1.063***	-0.959***	-0.153	0.220	-1.068***	-0.976***	-0.154	0.138
	(-4.74)	(-4.04)	(-0.74)	(1.06)	(-4.75)	(-4.18)	(-0.74)	(0.67)
Altman Z-score	-0.040***	-0.033**	0.019	0.060***	-0.040***	-0.033**	0.019	0.064***
	(-2.64)	(-2.04)	(1.30)	(4.53)	(-2.64)	(-2.03)	(1.31)	(4.84)
Return Volatility	0.730***	0.593***	-0.235***	-1.187***	0.729***	0.591***	-0.235***	-1.221***
	(8.81)	(3.33)	(-2.75)	(-13.70)	(8.78)	(3.30)	(-2.73)	(-14.43)
Cash Flow Volatility	1.352***	1.245***	-0.395	-0.431	1.360***	1.309***	-0.391	-0.052
	(3.59)	(3.38)	(-1.24)	(-1.46)	(3.60)	(3.58)	(-1.23)	(-0.18)
Asset Maturity			0.040**	0.028*			0.040**	0.027*
			(2.10)	(1.65)			(2.11)	(1.66)
CEO Characteristics								
Ownership	0.001***	0.001**	-0.001	-0.001	0.001***	0.001***	-0.001	-0.002
	(3.75)	(2.27)	(-1.45)	(-0.80)	(3.79)	(2.63)	(-1.45)	(-0.89)
Tenure	0.003*	0.003**	0.001	0.001	0.003*	0.003**	0.001	0.001
	(1.78)	(1.98)	(0.20)	(0.60)	(1.80)	(2.04)	(0.21)	(0.96)

Loan Characteristics								
Ln(Amount)	-0.060***	-0.034	0.128***	0.233***	-0.059***	-0.025	0.129***	0.290***
	(-4.87)	(-1.56)	(8.97)	(17.48)	(-4.80)	(-0.90)	(9.03)	(20.94)
Ln(Maturity)	-0.045**	-0.067**	-	-	-0.046**	-0.074**	-	-
	(-2.17)	(-2.51)	-	-	(-2.22)	(-2.48)	-	-
Collateral	0.505***	0.467***	0.281***	0.087***	0.506***	0.466***	0.281***	0.114***
	(20.43)	(11.43)	(11.76)	(3.45)	(20.35)	(10.86)	(11.74)	(4.59)
N	6912	6912	6912	6912	6912	6912	6912	6912
R-square	0.717	0.716	0.273	0.335	0.716	0.717	0.272	0.345

Chapter 3

CEO Risk-taking Incentives and Bank Loan Syndicate Structure

3.1 Introduction

Over the past 20 years, syndicated loans have become a dominant form of bank lending in the global corporate financing market, with originations in 2009 surpassing $1.8 trillion (Loan Pricing Corporation). Syndicated loans are made by multiple lenders, with one or more of the lenders (lead arrangers) playing the role of arranging, pricing and monitoring such loans. Lead arrangers analyze credit quality, negotiate key terms with borrowers before inviting a group of banks to participate and are responsible for allocating loan shares among participating banks (Lin et al. 2012). Although the lead arrangers perform the traditional role of due diligence as informed lenders, the loan amount itself is shared with one or more syndicate participant banks (Esty 2001). Given that lead arrangers in a syndicate hold less than 100% of the debt, other participant lenders can become concerned about the level of monitoring effort that is exerted by the lead arrangers. The reason is that lead arrangers do have an incentive to shirk their monitoring responsibilities when undertaking most of the monitoring costs and owning only part of the loan (Holmstrom and Tirole 1997; Sufi 2007). Therefore, the syndication process generates an additional element of moral hazard within a syndicate (syndicate moral hazard) between the lead arrangers and other participant syndicate members, in addition to the typical moral hazard problems arising between the borrowing firms and lenders in a lending relationship (borrower moral hazard). The concerns of participant banks regarding the potential for the lead arrangers to shirk their monitoring and due diligence duties are especially relevant in situations in which borrower moral hazard is high and borrowing firms require more intensive monitoring.

In this chapter, we focus on the managerial risk-taking incentives of chief executive officers (CEOs) at borrowing firms to investigate how CEO risk-taking incentives influence the syndicate loan structure. One major conflict of interest between borrowing firms and lending banks is the conflict arising from the aggressive investment behaviors of CEOs as a result of the risk-taking incentives that are offered in their compensation contracts. To encourage less diversified and risk-averse CEOs to take on risky but positive net present value (NPV) projects, shareholders provide CEOs with incentive compensation to encourage risky investment behaviors (Coles et al. 2006). Such compensation contracts provide a better incentive alignment between shareholders and CEOs; however, creditors may perceive such compensation negatively because it will encourage CEOs to engage in asset substitution activities and reduce debt value (e.g., Jensen and Meckling 1976). With the increased credit risk from CEO risk-taking incentives, such borrowing firms will encounter a more severe borrower moral hazard problem and require additional monitoring efforts and due diligence before loan origination. Moreover, in addition to the borrower moral hazard resulting from

CEO risk-taking incentives, the situation is complicated by the syndicate moral hazard because participant banks will have concerns regarding the incentives of lead arrangers to provide an optimal level of monitoring efforts (Ivashina 2009). To the extent that lead arrangers' ownership in a syndicate serves as a signal of credible commitment and an indicator of the quality of borrowing firms, participant banks often demand that a greater portion of syndicate loans be held by lead arrangers for incentive purposes if borrowing firms require greater due diligence and intensive monitoring (Sufi 2007). Therefore, the portion of a syndicate loan that is held by lead arrangers should increase with the CEO risk-taking incentives of a borrowing firm, and the ownership of syndicate loan should be more concentrated to mitigate the borrower moral hazard that is associated with CEO risk-taking incentives through effective monitoring.

However, some counter-factors could result in a more diffused syndicate structure as CEO risk-taking incentives increase. For example, as credit risk increases with CEO risk-taking incentives, lenders have diversification incentives to form a more diffused syndicate to reduce credit risks (Esty and Megginson 2003). Moreover, a more diffused syndicate structure increases the difficulty of renegotiation because any resolution related to the renegotiation or amendment of a syndicated loan must be approved by the entire lending group (Lee and Mullineaux 2004). Therefore, a diffused syndicate structure can be used by lenders as a mechanism to discourage the strategic default incentives of borrowing firms (Lin et al. 2012; Bolton and Scharfstein 1996). Consequently, a diffused syndicate structure is preferred by lenders who are concerned with a strategic default by borrowing firms because of excessive CEO risk-taking incentives, which suggests that CEO risk-taking incentives negatively influence the syndicate concentration level. Because of the competing theories, the overall effect of CEO risk-taking incentives on syndicate structure is an empirical question that constitutes the purpose of this study.

We begin our analysis by investigating whether CEO risk-taking incentives affect syndicate structure and, if so, to what extent. Following the current literature (e.g., Guay 1999, Coles et al. 2006, Core and Guay 2002), CEO risk-taking incentives are measured based on the sensitivity of the value of a CEO's portfolio to stock return volatility (*vega*) and stock price (*delta*). The influence of *delta* on CEO risk-taking incentives is ambiguous. Using a two-period model, John and John (1993) show that the riskiness of an investment policy implemented by a manager increases with the degree of pay-performance sensitivity (i.e., *delta*) because greater alignment between management incentives and shareholder value (*delta*) is associated with more risk-shifting incentives for managers. Conversely, Smith and Stulz (1985) argue that shareholders can structure compensation to influence the risk-taking incentives of a risk-averse manager with a concave utility function. Specifically, if compensation is structured as a linear function of stock price, then this structure will force the manager's utility function to be a concave function of stock price, and the manager will reduce risk in maximizing utility. Thus, *delta* is expected to be negatively related to CEO risk-taking incentives because linking a CEO's wealth to stock prices will cause a risk-averse CEO who is undiversified with respect to firm-specific risk to become less willing to increase the volatility of stock prices.[14] In this study, we focus primarily on *vega*, which is expected to be positively related to CEO risk-taking incentives because a higher *vega* value is associated with a greater increase in CEO compensation in tandem with stock return volatility. Following extant empirical studies (e.g., Lee and Mullineaux 2004; Sufi 2007; Lin et al. 2012), we employ four different measures of syndicate loan structure: the total number of lenders in a syndicate, the amount of the loan held by lead arrangers, the percentage of the loan held by lead arrangers and a Herfindahl index of lenders' shares. In addition, we also use the average amount of the loan held by lead arrangers, the average percentage of the loan held by lead arrangers and the ratio of the number of lead arrangers to the number of total lenders as alternative measures in an additional robustness check.

We also examine the factors that influence the relationship between *vega* and syndicate structure to investigate the possible channels through which the effects of *vega* on a syndicate loan structure can be mitigated or exacerbated. We focus on the factors that will affect syndicate moral hazards or borrower moral hazards and how they interact with the relationship between *vega* and syndicate structure. For example, the concerns of lead arrangers with regard to maintaining their

[14] Lambert et al. (1991) also show that a risk-averse manager with a large proportion of compensation in the form of firm equity may actually avoid risk. Carpenter (2000) and Ross (2004) show that the same managerial risk aversion occurs when a manager's pay-performance sensitivity is high.

reputation can mitigate various moral hazard problems, such as shirking in monitoring (Chemmanur and Fulghieri 1994). Moreover, a prior lending relationship can reduce information asymmetry between a lender and a borrower and act as a signal to participant banks that lead arrangers have the ability and advantage to engage in effective monitoring (Boot 2000). Therefore, we postulate that the effect of *vega* on the syndicate structure will be weaker if lead arrangers have a good reputation or a prior lending relationship with the borrowing firms to mitigate syndicate moral hazard.

Informationally opaque firms, such as small firms with low analyst coverage and no credit rating, have a higher degree of information asymmetry with lenders, and it is thus difficult for lenders to evaluate the true risk level of their investments. As a result, lending banks will be more sensitive to credit risks associated with CEO risk-taking incentives if the borrowing firms are informationally opaque (Chen and Qiu 2012). The equity of financially distressed firms can be viewed as a deep out-of-the-money call option on firm assets; thus, the credit risks from CEO risk-taking incentives will increase greatly if shareholders encourage the CEOs of financially distressed firms to assume greater risks. Similarly, offering high risk-taking incentives to the CEOs of firms with low investment opportunities will encourage unnecessary risk-seeking behaviors and investments in negative NPV projects, which will also increase credit risks from CEO risk-taking incentives. Therefore, we postulate that the effect of *vega* on the syndicate structure will be strengthened if borrowing firms are informationally opaque, financially distressed or with low growth prospects. It follows that such firms will have greater borrower moral hazards arising from CEO risk-taking incentives and thus require more intensive monitoring from lead arrangers, and the syndicate structure should be shaped accordingly to address this issue.

With a merged sample of syndicate loan structure information, financial information from borrowing firms and CEO risk-taking incentives from 1992 to 2010, we obtain empirical results that are consistent with our hypotheses. Our results show that *vega* has a significant influence on the structure of a syndicate loan, whereas *delta* has no significant effect on the syndicate structure. Specifically, a syndicate loan will have a smaller number of total lenders, lead arrangers will hold a greater amount and percentage of the syndicate loan, and the syndicate ownership will be more concentrated as *vega* increases. The estimated effects of *vega* on syndicate structure are both statistically and economically significant. Ceteris paribus, an increase of one standard deviation in *vega* will increase the amount of the loan held by lead arrangers by approximately 37%, increase the percentage of the loan held by lead arrangers by 5.6% and increase the Herfindahl loan concentration index by 9.7%. The insignificant effect of *delta* on the syndicate structure is consistent with the notion of the ambiguous effect of *delta* on a CEO's appetite for risk. The results suggest that syndicate lenders indeed consider CEO risk-taking incentives when they form a syndicate that is structured to ensure more efficient monitoring of borrower moral hazard.

Our empirical results also show that there are more lenders in a syndicate, a smaller amount and percentage of the loan is held by lead arrangers and the shares of lenders is less concentrated if lead arrangers have a good reputation or a prior lending relationship with a borrowing firm. Moreover, we find that the effect of *vega* on syndication structure is more pronounced if borrowing firms are informationally opaque, are financially distressed or have low growth prospects. Specifically, there will be fewer lenders in a syndicate, lead arrangers will retain a large amount (percentage) of the loan and the shares of lenders will be more concentrated if borrowing firms are informationally opaque, are financially distressed or have low growth prospects. The results are consistent with our hypotheses and suggest that these factors are the channels through which the relationship between CEO risk-taking incentives and syndicate structure is mitigated or exacerbated.

One potential concern for our empirical analysis is the issue of endogeneity. Although the syndicate structure of a loan is unlikely to be a direct determinant of the CEO risk-taking incentives of the borrowing firm, our empirical results may be driven by the possibility that some unaccounted-for firm characteristics could jointly determine CEO risk-taking incentives and syndicate structure. We address this endogenous issue in the following ways. First, for all of the variables relating to firm and CEO characteristics, we use lagged values rather than contemporaneous values in all empirical specifications. The use of lagged values can mitigate endogenous concerns from the missing variable bias and reverse causality. Second, we use an instrumental variable approach to address the possible endogeneity of CEO risk-taking incentives. Following extant empirical studies (e.g., Liu and Mauer 2011), we instrument CEO risk-taking incentives with CEO and firm characteristics, such as firm age, CEO age and CEO tenure. Our empirical results continue to hold when CEO risk-taking incentives are instrumented with instrumental variables. Third, as argued by Lin et al. (2012), the interaction tests of the factors that affect the relationship between CEO risk-taking incentives and syndicate structure also help to alleviate missing variable bias because an omitted variable is less likely to be correlated with interaction terms than with linear terms (Raddatz 2006).

This paper attempts to combine two strands of the literature and offer the following contributions. The first strand of work investigates the borrower moral hazard arising from executive compensation and examines how this hazard is perceived by creditors (e.g., DeFusco et al. 1990; Oritz-Molina 2006; Vasvari 2008; Chen and Qiu 2012). These studies generally show that creditors react negatively to equity-related executive compensation because of the increased borrower moral hazard resulting from executive compensation.[15] We complement this strand of literature by showing that the CEO risk-taking incentives of a borrowing firm also have a significant influence on its syndicate loan structure,

[15] For example, DeFusco et al. (1990) show that the bond price reacts negatively to the announcement of the adoption of managerial stock option plans in a sample of firms during the 1978-1982 period. Ortiz-Molina (2006) finds that the number of options held by a firm's top five managers increases the yield spread for new bond issue. Chen and Qiu (2012) find that bank loans that are lent to borrowing firms with greater CEO risk-taking incentives will carry higher loan spreads and shorter loan maturity.

and we demonstrate that greater CEO risk-taking incentives are associated with a more concentrated syndicate structure and that lead arrangers retain a larger stake in such loans.

The second stream of work is related to a rapidly growing body of empirical studies on the structure of syndicate loans in the last decade. Sufi (2007) and Lee and Mullineaux (2004) show that syndicate loan structure is significantly related to the information opacity of borrowing firms. Firms with higher levels of information asymmetry require a more concentrated syndicate loan structure. Ball et al. (2008) show that lead arrangers will hold a smaller portion of a syndicate if the accounting information of borrowing firms can capture credit quality in a timely fashion. Gopalan et al. (2011) find that lead arrangers will retain larger fractions of syndicate loans if their borrowing firms have previously filed large-scale bankruptcies.[16] Although these studies examine the syndicate loan structure through moral hazards in monitoring, they do not identify a specific source of moral hazard between borrowing firms and lending banks that will affect the monitoring needs of lead arrangers in a syndicate.

This paper is most closely related to Lin et al. (2012), who investigate the effects of borrowing firm ownership structures on syndicate loan structure. Their

[16] Bharath et al. (2011a) find that syndicate structures will be less concentrated as shareholder rights are reduced with a natural experiment of the passage of second generation antitakeover laws in the U.S. Vasvari (2008) find that both *delta* and *vega* are positively related to lead arrangers' ownership. However, the relationship between CEO risk-taking incentives and syndicate loan structure is not the main focus of the paper, and the paper does not explore the channels through which borrower moral hazard and syndicate moral hazard will affect such a relationship.

key result is that the borrower moral hazard resulting from the divergence in cash flow rights and ownership rights of a dominant shareholder has a significant influence on syndicate structure. Our paper complements their study by showing that the borrower moral hazard resulting from CEO risk-taking incentives also has a great influence on syndicate structure. A syndicate loan will be structured to ensure efficient monitoring by lead arrangers if borrowing firms offer excessive risk-taking incentives to CEOs in their compensation. This paper differs from their approach in that we focus on a wider conflict of interest between lenders and all shareholders rather than a single dominant shareholder. To the extent that the credit risk from CEO risk-taking incentives is a more common borrower moral hazard problem than cash flow-ownership divergence, the empirical results from this paper can be applied to a larger body of firms.

The remainder of the paper is organized as follows. Section 3.2 describes the sample construction and provides definitions of the variables. Section 3.3 presents the empirical results, and Section 3.4 concludes the paper.

3.2 Sample and variables

3.2.1 Sample construction

We construct our sample from four major sources of data to test our hypotheses in this paper. These sources are the DealScan database of bank loans from the Loan Pricing Corporation (LPC), borrowing firms' financial and accounting information from Compustat, executive compensation information from

Execucomp and borrowing firms' stock price information from CRSP. The basic observation in this study is a loan facility, the term given in DealScan to represent a syndicate loan. The sample construction process is described as follows. We first obtain syndicate loan information, such as the syndicate lender number and shares, the names of borrowing firms, the loan amount and maturity, from DealScan. We then match the borrowing firms with the financial and accounting information of the borrowing firms from Compustat according to the method outlined by Chava and Robert (2008). The next step is to match the CEO risk-taking incentives of each borrowing firm. To calculate CEO risk-taking incentives, the sensitivity of CEO compensation to stock prices and stock return volatility (i.e., *delta* and *vega*), we obtain company financial information from Compustat, stock return information from CRSP and executive compensation information from Execucomp. After calculating *delta* and *vega*, we merge them with the syndicate structure, the loan details and the company financial information. We exclude borrowing firms in the financial and utility industries following common practice because these firms are usually regulated. Our final sample contains 10,417 loan facilities for 1,890 firms from 1992 to 2010.

3.2.2 CEO risk-taking incentives

Following Core and Guay (2002), we measure *vega* as the change in the value of a CEO's option portfolio given a 1% change in the annualized standard deviation of a firm's stock returns. *Delta* is measured as the change in the value of a CEO's options and stock portfolio given a 1% change in the value of a firm's common stock price. The partial derivatives of the option value with respect to stock return volatility and stock price are based on the Black-Scholes option pricing model adjusted for dividends by Merton (1973). The same method is used to calculate *vega* and *delta* in recent empirical studies (e.g., Coles et al. 2006; Billet et al. 2010). The details regarding the calculation of *vega* and *delta* are provided in Appendix 3.A.

3.2.3 Bank loan syndicate structure

During the last decade, DealScan from LPC has become the primary data source for studies of bank loan syndicate structures. Sufi (2007), Ivashina (2009) and Lin et al. (2012) provide thorough descriptions of the syndicate loan mechanism. A typical syndicate loan agreement includes extensive disclaimers of the responsibilities of lead arrangers. Lead arrangers owe no fiduciary duties to any participant banks. If a borrower defaults, participant banks have no recourse against lead arrangers (Gopalan et al. 2011). Therefore, once participant banks purchase their portions of a loan, lead arrangers will consider that all of the responsibilities related to the portions of the loan have been effectively transferred to participant banks. Consequently, credit risk sharing among syndicate members is based on each lender's share in a loan.

In this study, we follow Sufi (2007) and Lin et al. (2012) to define syndicate loan structure as the syndicate concentration of lead arrangers because retaining a large portion of a loan provides a credible signal of lead arrangers' commitment to participant banks. Specifically, we employ the following four measures of syndicate structure: the total number of lenders, the dollar amount and percentage of the loan retained by lead arrangers, and the Herfindahl index based on the shares of lenders.[17] When a loan has more than one lead arranger, we examine the total dollar amount and percentage of the loan held by all lead arrangers. The Herfindahl index is defined as the sum of the squares of each lender's share in a loan. By definition, this index ranges from 0 to 1, with a higher value indicating a higher degree of concentration of loan ownership within a syndicate. In addition, we use the average amount and percentage of the loan held by the lead arrangers and the ratio of the number of lead arrangers to the total number of lenders as alternative syndicate structure measures in a robustness check.

3.2.4 Control variables

In addition to the key variables of CEO risk-taking incentives and the loan syndicate structure, we use a large set of control variables of firm characteristics, loan characteristics and CEO characteristics to capture their possible effects on the loan syndicate structure and to mitigate the missing variable bias. For borrowing firm characteristics, we account for firm size, Tobin's Q, Altman Z-score, tangibility, profitability, stock return volatility and leverage. For loan characteristics, we control for loan size, loan maturity, loan purpose, loan type, whether the loan includes contingent performance-based pricing and whether the

[17] Because of missing values of lender shares in DealScan, the dollar amount and percentage of the loan held by lead arrangers and the Herfindahl index of all lender shares will have fewer observations than the total number of lenders.

loan is collateralized.[18] For CEO characteristics, we control for salary, bonus and the number of common shares held by each CEO. In addition, we also include year dummies and industry dummies with two-digit SIC codes to control for year and industry fixed effects. The detailed definitions of these variables and other key variables used in this study are reported in Appendix 3.B.

3.2.5 Summary statistics

Table 3.1 presents summary statistics for the CEO risk-taking incentives variables, the syndicate structure variables, some firm characteristics and the loan characteristic variables that are used in this study. All variables are winsorized at 1% and 99%. The median values for the CEO risk-taking incentive variables *vega* and *delta* (in $M) are 0.076 and 0.276, respectively. These figures are comparable to those presented in earlier empirical studies. For example, the median values of *vega* and *delta* are 0.104 and 0.210 in the Knopf et al. (2002) and 0.034 and 0.206 in the Coles et al. (2006), respectively. For the four syndicate structure variables, the summary statistics are also comparable to extant empirical studies. For example, Lin et al. (2012) report a mean value of 8 for the total number of lenders. Lee and Mullineaux (2004) find that lead arrangers retain an average of 32.232% of the loan and report a mean value of 0.227 for the Herfindahl index.

[Table 3.1 about here]

3.3 Empirical results

3.3.1 The impact of CEO risk-taking incentives on syndicate structure

[18] We follow extant empirical studies (e.g., Bharath et al. 2011b) and consider facilities with missing value in collateral to be uncollateralized.

In this section, we investigate the effects of the CEO risk-taking incentives of a borrowing firm on its syndicate loan structure. Specifically, we follow extant empirical studies (e.g., Sufi 2007; Lin et al. 2012) to estimate the following empirical model using ordinary least squares (OLS) regressions:

$$Syndicate\ strucutre =$$
$$f(CEO\ risk - taking\ incentives, Borrowing\ firm\ characteristics,$$
$$Loan\ characteristics, CEO\ characteristics, Industry\ effect, Year\ effect) \quad \textbf{(3.1)}$$

In the regression, each observation is a single loan or a facility as termed by DealScan. The dependent variables are the different measures of syndicate structure as discussed in Section 3.2.3. The key independent variables of interest are the CEO risk-taking variables *vega* and *delta*. In the regression, we also control for the characteristics of borrowing firms, loans and CEOs as well as industry and year effects. Following the empirical literature on bank loan and executive compensation (e.g., Graham et al. 2008, Coles et al. 2006), these control variables include leverage, Tobin's Q, tangibility, profitability, Altman Z-score, return volatility, CEO ownership and salary, loan amount and maturity and loan collateral. To mitigate the endogeneity concern related to CEO risk-taking incentives and reverse causality, we use lagged values of CEO- and firm-related variables throughout this study. All standard errors are corrected for heteroskedasticity and are clustered at the borrowing firm level.

[Table 3.2 about here]

Table 3.2 presents the baseline regression results of estimating Equation (3.1). For Columns 1 through 4, the dependent variables are different measures of loan syndicate structure: the total number of lenders (Column 1), the dollar amount of the loan retained by lead arrangers (Column 2), the percentage of the loan retained by lead arrangers (Column 3) and the Herfindahl index of lender shares in the loan (Column 4). In Column 1, the coefficient of *vega* is -0.796 and is significant at the 5% level, suggesting that the number of lenders in a syndicate decreases as *vega* increases. For Columns 2 through 4, the coefficients of *vega* are positive and significant at the 1% level, which suggests that lead arrangers retain a greater amount and portion of the loan and that the syndicate is more concentrated as *vega* increases. For all four specifications with different syndicate structure measures as dependent variables, all of the coefficients of *delta* are statistically insignificant and negligible in magnitude compared with the coefficients of *vega*. The results suggest that *delta* does not have a significant influence on the syndicate structure. This finding is consistent with the notion that the influence of *delta* on CEO risk-taking incentives is ambiguous, as argued earlier. The effect of *vega* on the syndicate structure is not only statistically significant but also economically significant. On average, all else being equal, an increase of one standard deviation in *vega* corresponds to a 37% increase in the amount of the loan held by lead arrangers, a 5.6% increase in the percentage of the loan held by lead arrangers and a 9.7% increase in the Herfindahl loan concentration index.

Overall, the results from the baseline model of the multivariate regression analyses suggest that CEO risk-taking incentives (*vega*) have a significant effect on the syndicate structure of a firm's bank loans. Specifically, syndicate loans made to borrowing firms with higher *vega* will have a smaller number of lenders in the syndicates, a greater amount and portion of the loan held by lead arrangers and more concentrated lender shares. These results are consistent with the hypothesis that borrower moral hazard from excessive CEO risk-taking incentives increases the credit risks encountered by lending banks and thus require more intensive monitoring by lead arrangers. Consequently, a syndicate is structured to conduct better due diligence and efficient monitoring. These syndicates typically have fewer lenders and are more concentrated, with lead arrangers retaining a larger portion of the loan than the syndicates that are lending to borrowing firms with less aggressive CEO risk-taking incentives.

3.3.2 Endogeneity of CEO risk-taking incentives

Although we use a large number of control variables and lagged values of CEO risk-taking incentives and firm financial variables to mitigate the endogenous and reverse causality concerns, we still encounter the potential missing variable bias in our baseline results that could cause some unaccounted-for firm characteristics to jointly determine CEO risk-taking incentives and syndicate structure. In this section, we will attempt to address this issue with an additional test by employing an instrumental variable approach and then re-estimating the baseline model results with two-stage least squares (2SLS). The ideal instrument in this case is correlated with *vega* but is only indirectly correlated with the syndicate structure through its link to *vega*. Following extant empirical studies (e.g., Liu and Mauer 2011), we use CEO age and tenure as the instrumental variables for *vega*, and we use firm age as the instrumental variable for *delta*. In the first stage (untabulated), we regress *vega* (*delta*) on all independent variables, in addition to the instrumental variables CEO age and tenure (firm age). The F-statistics in the first-stage regression are 20.59 and 32.44 for the *vega* and *delta* regressions, respectively, and thus confirming the statistical significance of the instruments. Because there are three instrumental variables and two endogenous independent variables, we perform the Sargan test for over-identification restrictions to confirm the validity of the additional instrument. The statistics for the Sargan test is 0.38 with a p-value of 0.54. Therefore, the results fail to reject the null hypothesis that the surplus instrumental variable is valid. In the second stage, we replace *vega* and *delta* with the predicted values from the first-stage regression, and we re-estimate Equation (3.1) with the predicted values. The results from the second stage are reported in Table 3.3.

[Table 3.3 about here]

Similar to Table 3.2, the dependent variables from Columns 1 through 4 in Table 3.3 are different measures of loan syndicate concentration: the total number of lenders (Column 1), the dollar amount of the loan retained by lead arrangers (Column 2), the percentage of the loan retained by lead arrangers (Column 3) and the Herfindahl index of lender shares in the loan (Column 4). Consistent with the

OLS results in Table 3.2, the coefficient of *vega_predicted* is negative and statistically significant at the 5% level in Column 1, and the coefficients of *vega_predicted* are positive and statistically significant at the 1% level for Columns 2 through 4. Similar to the OLS results, none of the coefficients of *delta_predicted* are significant in a statistical sense or in magnitude compared with the coefficients of *vega_predicted.*[19]

Overall, the results from the instrumental variable approach are consistent with the results from the OLS approach, suggesting that syndicate loans made to borrowing firms with greater CEO risk-taking incentives (*vega*) have a smaller number of lenders, are more concentrated and have a higher portion of the loan held by lead arrangers. The effect of *vega* on the bank loan syndicate structure remains statistically significant when employing the instrumental variable approach, which can help to alleviate concerns regarding endogeneity. The coefficients of *vega* in the instrumental variable approach are several times larger in absolute magnitude than the corresponding coefficients from the OLS approach, which is similar to the results of related empirical studies (e.g., Liu and Mauer 2011). In the following sections, the reported regression results are obtained from the second stage of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age).

[19] Because *delta* has no significant effect on syndicate structure in either the OLS or instrumental variable approach, we focus primarily on *vega* in the following analysis and treat *delta* as a control variable.

3.3.3 Factors that influence the relationship between CEO risk-taking incentives and syndicate structure

In this section, we examine the potential factors influencing the relationship between the CEO risk-taking incentives of borrowing firms and the syndicate structure of loans that are made to borrowing firms. The motivation for this section is to investigate the channels through which the link between CEO risk-taking incentives and syndicate structure are mitigated or exacerbated. We identify factors that affect borrower moral hazards or syndicate moral hazards and examine how they interact with the relationship between CEO risk-taking incentives and syndicate structure. Specifically, we examine the following factors: the reputations of lead arrangers, the prior lending relationships between lead arrangers and borrowing firms, the information opacity level of borrowing firms, the financial distress levels of borrowing firms and the growth opportunities of borrowing firms. In particular, we postulate that the influence of CEO risk-taking incentives on syndicate concentration and on the lead arrangers' portion of a loan will be accentuated (attenuated) by factors that exacerbate (mitigate) the syndicate moral hazard problem or borrower moral hazard problem. We test this hypothesis in the following sections.

3.3.3.1 The reputation of lead arrangers

The extant literature suggests the importance of a lender's reputation in lending behaviors and mitigating moral hazard problems in syndication (e.g., Pichler and Wilhelm 2001). The concerns of lead arrangers with regard to maintaining their reputations can alleviate shirking in due diligence and monitoring (Chemmanur and Fulghieri 1994). As a result, reputable lead arrangers can sell off larger portions of the loans that they syndicate (Dennis and Mullineaux 2000). Moreover, the reputations of lead arrangers serve as a signal in the credit market for their ability to select, manage and monitor the loans that they syndicate (Demiroglu and James 2010). If borrowing firms default on their liability or file bankruptcy, then such actions will damage the reputations of lead arrangers in the credit market and signal the failure to perform due diligence and monitoring. Lead arrangers will be penalized in subsequent syndication activities by having to retain larger fractions of the loans that they syndicate, being less likely to syndicate loans and being less likely to sell loans to participant banks (Gopalan et al. 2011). Therefore, we expect that the effects of CEO risk-taking incentives on the syndicate structure will be attenuated if lead arrangers have a good reputation because reputable lead arrangers are more likely to perform better due diligence and efficient monitoring and therefore reduce moral hazard in monitoring.

To test this hypothesis empirically, we construct a dummy variable *Reputation* to measure the reputations of lead arrangers. Following Lin et al. (2012), *Reputation* is equal to 1 if the lead arranger is one of the top ten lenders in the syndicate loan market during the sample period in terms of the total amount of loan transactions and 0 otherwise. We then include *Reputation* and its interaction terms with *vega* and *delta* in the baseline model Equation (3.1). The results are reported in Table 3.4.[20]

[Table 3.4 about here]

The dependent variables in Table 3.4 are the same four syndicate structure variables as used previously. The key independent variables of interest are *vega*, *Reputation* and their interaction term. First, the coefficients of *vega* maintain the same sign and significance level as the baseline model results. Second, as the table shows, the reputation of lead arrangers has a significant influence on syndicate structure. A good lead arranger reputation is related to an increase in the total number of lenders, a decrease in the amount and percentage of the loan held by lead arrangers, and a decrease in the syndicate concentration as measured by the Herfindahl index, consistent with the extant studies discussed earlier. Moreover, the coefficients of the interaction term between *vega* and *Reputation* are statistically significant and have the opposite signs of the corresponding coefficients on *vega* in different model specifications. Consistent with our hypothesis, this result suggests that *vega* will have a lesser influence on syndicate structure if a loan is syndicated by reputable lead arrangers. Specifically, for a given value of *vega*, a syndicate will have more lenders and be less concentrated, and lead arrangers will retain a smaller amount and portion of the loan if the syndicate has reputable lead arrangers.

[20] Although we show that *delta* has no significant effect on the syndicate structure and is treated as a control variable, we include the interaction term of *delta* and the indicator variables in this section and the following sections to ensure robustness.

3.3.3.2 The lending relationship of lead arrangers with borrowing firms

Extant studies also suggest that the past lending relationships of lead arrangers may also affect the ability and willingness of lead arrangers to monitor firms efficiently. For example, Boot (2000) suggests that the past lending relationships of lead arrangers with borrowing firms can not only mitigate information asymmetry between lenders and borrowers but also provide a good signal to participant banks that lead arrangers have the ability and experience to monitor borrowing firms. By reducing information asymmetry between lenders and borrowers, borrower moral hazard can be mitigated because of the proprietary information of borrowing firms that is generated through relationship lending. Moreover, as suggested by Bharath et al. (2011b), repetitive transactions from relationship lending can lower monitoring costs for lead arrangers. Therefore, past lending relationships can be viewed as lead arrangers' commitment and advantage in engaging in efficient monitoring and can thus alleviate syndicate moral hazard problems. As a result, we expect that a prior lending relationship between borrowing firms and lead arrangers will attenuate the relationship between *vega* and syndicate structure.

To empirically test this hypothesis, we construct a measure of the lending relationship variable for each loan facility following extant empirical studies (e.g., Bharath et al. 2011b; Chen and Qiu 2012). For each loan, we search all of the previous loan transactions for a borrowing firm within a five-year window period before the loan activation date to identify prior lending transactions with the same lead arranger. We then create a dummy variable *Relationship* for each loan facility to measure the existence of prior lending relationships with the same lead arranger. The variable takes a value of 1 if the borrowing firm has had previous transactions with the same lead arranger within the five-year window period and 0 otherwise.[21] We then re-estimate the baseline model Equation (3.1), including the relationship lending variable *Relationship* and its interaction terms with *vega* and *delta*. The results are reported in Table 3.5.

[Table 3.5 about here]

The dependent variables in Table 3.5 are the same four syndicate structure variables as used previously. The key independent variables of interest are *vega*, *Relationship* and their interaction term. The coefficients of *vega* maintain the same sign and significance level as the previous baseline model results. The coefficients of *Relationship* are statistically significant in all model specifications, suggesting that the existence of a prior lending relationship between lead arrangers and a borrowing firm has a significant influence on syndicate structure. Specifically, a prior lending relationship is related to an increase in the total number of lenders, a decrease in the amount and percentage of the loan held by lead arrangers, and a decrease in the syndicate concentration as measured by the Herfindahl index. More importantly, in all four model specification, the coefficients of the interaction terms between *vega* and *Relationship* are

[21] If there are multiple lead arrangers in a syndicate, then we search previous lending transactions in a five-year look-back window for each lead arranger. *Relationship* takes a value of 1 if any of the lead arrangers have had transactions with the borrowing firm before current loan facility and 0 otherwise.

statistically significant and bear the opposite signs of the corresponding coefficients on *vega*. Thus, consistent with our hypothesis, the results suggest that *vega* will have a smaller effect on syndicate structure if a loan is syndicated by lead arrangers with a prior lending relationship with the borrowing firm. The results imply that the existence of a prior lending relationship between a borrowing firm and lead arrangers can mitigate possible borrower moral hazards and syndicate moral hazards and therefore attenuate the effects of *vega* on syndicate structure.

3.3.3.3 Information opacity of borrowing firms

The information opacity levels of borrowing firms reflect the degree to which a financial institution must investigate and monitor a borrowing firm as a result of the level of information asymmetry between the financial institution and firm (Sufi 2007). In this sense, because informationally opaque firms have a smaller amount of publicly available information, financial institutions must spend extra time and resources to investigate these firms. Thus, these firms are more difficult and costly to monitor than informationally transparent firms. As a result, lending banks are more sensitive to the credit risk from CEO risk-taking incentives for informationally opaque firms than for more transparent firms because of the more severe borrower moral hazard in such firms (Chen and Qiu 2012). Therefore, syndicate loans that are lent to such firms should have a concentrated structure to enable better monitoring. We postulate that the influence of *vega* on syndicate structure will be strengthened as the information opacity levels of borrowing firms increase.

To empirically test this hypothesis, we include several information opacity measures and their interaction terms with *vega* and *delta* in Equation (3.1). Following extant empirical studies (e.g., Lin et al. 2012; Bharath et al. 2011b), we use firm size, the analyst coverage and the long-term debt rating as the measures of borrowing firms' information opacity levels. In general, larger firms with credit ratings and better analyst coverage tend to have a lower degree of information opacity; therefore, *vega* is expected to have a smaller effect on the syndicate structure for such firms. The regression results are reported in Table 3.6.[22]

[Table 3.6 about here]

In Table 3.6, the dependent variables are the percentage of the loan held by lead arrangers in Columns 1 through 3 and the Herfindahl index of lender shares in Columns 4 through 6. The interaction terms between *vega* (*delta*) and the three information opacity degree measures are included in the different model specifications. *No rating* is a dummy variable taking a value of 1 if a borrowing firm does not have S&P long-term debt rating and a value of 0 otherwise. *Num. of analysts* measures the total number of analysts covering a borrowing firm. The key variables of interest are the interaction terms of *vega* and three information opacity degree measures: *Log (assets)*, *No rating* and *Num. of analyst*. All of the

[22] For the sake of the brevity, this table includes only the percentage of the loan held by lead arrangers and the Herfindahl index of lender shares as independent variables of the syndicate structure. All results are robust to the use of the total number of lenders and the amount of the loan held by lead arrangers as a syndicate structure independent variable.

coefficients of the interaction terms between *Log (assets)* (*Num. of analyst*) and *vega* are negative and significant in the respective specifications, suggesting that *vega*'s effects on syndicate structure are mitigated for larger borrowing firms and firms with greater analyst coverage. Similarly, all of the coefficients of the interaction terms between *No rating* and *vega* are positive and significant in the respective specifications, suggesting that *vega*'s effects on syndicate structure are strengthened for borrowing firms without a credit rating. In addition, the coefficients of the information opacity measures are also significant with expected signs. For example, the coefficients of *No rating* are positive, and the coefficients of *Num. of analyst* are negative; thus, the results suggest that the information opacity of borrowing firms is positively related to syndication concentration and informationally opaque firms will have a more concentrated syndicate structure. Consistent with our hypothesis, the overall results from this section suggest that the percentage of a loan held by lead arrangers and the degree of syndicate concentration will increase as *vega* increases and that the relationship will be stronger for informationally opaque borrowing firms.

3.3.3.4 The financial distress level of borrowing firms

The financial distress level of borrowing firms is can also expected to influence the syndicate structure. For example, financially distressed firms are more likely to default and therefore require the syndicate be structured for better monitoring. More importantly, because equity can be viewed as a call option on a firm's assets, shareholders have strong incentives to offer CEOs a high value of *vega* to increase equity value but decrease debt value (Chen and Qiu 2012). Such incentives could be strengthened if borrowing firms encounter financial distress because the equity can be viewed as a deep out-of-the-money call option (Bharath et al. 2011a). Thus, lending to such firms will have higher credit risks arising from *vega* and will require more intensive monitoring. Therefore, the effect of *vega* on syndicate structure will be accentuated for more financially distressed borrowing firms. We investigate the effects of the financial distress levels of borrowing firms on the link between *vega* and syndicate structure by including the interaction terms between the financial distress measure (Altman *Z-score*) and *vega* (*delta*) in Equation (3.1). The regression results are reported in Table 3.7.

[Table 3.7 about here]

The dependent variables in Table 3.7 are the same four syndicate structure variables as used previously. The key variables of interest are the interaction terms between *vega* and the Altman *Z-score*. Among the four specifications, the coefficients of the *Z-score* × *vega* are negative and significant in three models (Columns 2 through 4). Because lower (higher) Altman *Z-scores* indicate that borrowing firms are more (less) financially distressed, the significant and negative coefficients of *Z-score* × *vega* suggest that the effect of *vega* on syndicate structure will be accentuated (attenuated) if borrowing firms are more (less) financially distressed, consistent with our expectation. Specifically, for a given *vega*, our results indicate that a larger amount (higher percentage) of loan will be held by lead arrangers and that the syndicated structure will be more concentrated for more financially distressed borrowing firms. In addition, the coefficients of the Altman *Z-score* are negative, as expected; this result is consistent with the notion that lead arrangers will retain a larger portion of loan and that the syndicate structure will be more concentrated if borrowing firms are financially distressed and thus require more intensive monitoring.[23]

3.3.3.5 The growth opportunities of borrowing firms

Extant empirical studies (e.g., Smith and Watts 1992; Baber et al. 1996) show that a firm's investment opportunity set has a significant influence on its executive compensation design. In particular, firms with greater investment opportunities will offer CEOs higher compensation, greater use of stock options and compensation with greater sensitivity to firm performance. The intuition is that firms with greater investment opportunities have greater access to positive NPV projects. Shareholders in such firms will offer CEOs incentive compensation to encourage risk-averse CEOs to undertake all positive NPV projects, despite the potential risks involved. However, if a firm has bleak growth prospects (i.e., difficulty in accessing positive NPV projects), then offering excessive risk-taking incentives to the firm's CEO will encourage the CEO to undertake risky and most likely negative NPV projects. Consequently, such action is more likely to result in asset substitution activity and decreased debt value. As a result, lenders will be more sensitive to CEO risk-taking incentives if borrowing firms have low investment opportunities because the borrower moral hazard resulting from CEO

[23] Bharath et al. (2011) report similar results; financially distressed firms are associated with a more concentrated syndicate structure if a borrowing firm has high shareholder rights.

risk-taking incentives will be more severe in these firms. Therefore, we hypothesize that the effect of *vega* on syndicate structure will be accentuated as the investment opportunities of borrowing firms decrease. We test this hypothesis by including the interaction terms between *vega* (*delta*) and *Tobin's Q* in baseline Equation (3.1). The results are reported in Table 3.8.

[Table 3.8 about here]

The dependent variables in Table 3.8 are the same four syndicate structure variables as used in the previous sections. The key variables of interest are the interaction terms between *vega* and *Tobin's Q*. Among the four specifications, the coefficients of *Tobin's Q* × *vega* are negative and significant in three models (Column 2 through Column 4). The negative and significant coefficients of the interaction terms between *vega* and *Tobin's Q* suggest that for a given amount of *vega*, the influence of *vega* on syndicate structure will increase as the investment opportunities of borrowing firms decline. Specifically, all else being equal, lead arrangers will retain a larger amount (portion) of a loan, and the syndicate will be more concentrated if borrowing firms have fewer growth opportunities. Consistent with our hypothesis, the results from this section suggest that offering excessive CEO risk-taking incentives to borrowing firms with low growth prospects will exacerbate the borrower moral hazard resulting from CEO risk-taking incentives and thus require more intensive monitoring. As a result, the effects of CEO risk-taking incentives on syndicate structure will be strengthened as the investment opportunities of borrowing firms decrease.

3.3.4 Additional robustness check

The use of lagged values for CEO risk-taking incentives and borrowing firms' financial information variables and the instrumental variable approach for CEO risk-taking incentives can help to mitigate concerns regarding potential endogeneity and reverse causality. Moreover, by investigating the factors that affect the relationship between CEO risk-taking incentives and syndicate structure, we further alleviate endogenous and causality concern by including various interaction terms in the baseline model as interaction terms are less likely to be subject to endogenous concerns. In this section, we perform an additional robustness check with alternative measures of syndicate structure to estimate Equation (3.1). The results are presented in Table 3.9.

[Table 3.9 about here]

The three alternative measures of syndicate structure are the average amount of the loan held by lead arrangers (Column 1), the average percentage of the loan held by lead arrangers (Column 2) and the ratio of the number of lead arrangers to the number of total lenders in a syndicate (Column 3). The results are obtained from the second stage of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age). Similar to the baseline model results, *vega* has a significant influence on three alternative measures of syndicate structure. Specifically, *vega* is positively related to the average amount (percentage) of the syndicate loan held by lead arrangers, and there will be more lead arrangers in a syndicate if borrowing firms offer their CEOs a higher value of *vega*. Overall, the results from the alternative syndicate structure measures are consistent with the results from the baseline model, suggesting that lead arrangers will undertake more stakes in a loan when borrowing firms have greater CEO risk-taking incentives.

3.4 Conclusions

In this paper, we explore how the CEO risk-taking incentives of borrowing firms affect the syndicate structure for their syndicated loans. Excessive CEO risk-taking incentives are likely associated with asset substitution activities by shareholders and decreased debt value, which in turn necessitate more intensive monitoring by lenders. Therefore, we hypothesize that syndicate loans will have a concentrated structure and that lead arrangers will be required to hold large stakes in a syndicate when borrowing firms offer excessive risk-taking incentives to their CEOs.

Using a sample of syndicated loans from 1992 to 2010, we find strong evidence that the CEO risk-taking incentives (*vega*) of a borrowing firm will significantly affect the structure of its syndicated loans. Specifically, there will be fewer lenders and greater lender concentration, and lead arrangers will retain a greater portion of the loan if the CEO risk-taking incentives of the borrowing firm increase, all else being equal. Moreover, we investigate the channels through which the link between CEO risk-taking incentives and syndicate structure will be mitigated or exacerbated by identifying the factors that affect borrower moral hazard or syndicate moral hazard. CEO risk-taking incentives will have a smaller influence on syndicate structure if lead arrangers have a good reputation or a prior lending relationship with the borrowing firm. By contrast, CEO risk-taking incentives will have a greater influence on syndicate structure if the borrowing firm is informationally opaque, is experiencing financial distress or has low growth prospects. In summary, this paper contributes to our understanding of how CEO risk-taking incentives and the associated credit risk affect the structure of a syndicate loan when effective monitoring by financial institutions is required.

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Appendix 3.A: Calculation of CEO risk-taking incentives

Following the methodology outlined by Core and Guay (2002), we define the sensitivity of CEO portfolio to stock price (*delta*) as the change in the value of a CEO's stock and option portfolio due to a 1% change in the price of a firm's common stock. The sensitivity of CEO portfolio to stock return volatility (*vega*) is defined as the change in the value of a CEO's option portfolio due to a 1% change in the annualized standard deviation of a firm's stock returns. Partial derivatives of the option price with respect to stock price (Δ) and stock return volatility (υ) are based on the Black and Scholes option-pricing model, adjusted for dividends by Merton (1973) as follows:

$$\Delta = e^{-dt} N(Z)$$

$$v = e^{-df} N'(Z) S\sqrt{T}$$

$$Z = \frac{\ln(s/x) + T(r - d + \sigma^2/2}{\sigma\sqrt{T}}$$

where

N is the cumulative probability function for the normal distribution;
$N`$ is the density function for the normal distribution;
S is the price of the underlying stock;
X is the exercise price of the option;
σ is the expected stock return volatility;
r is the natural logarithm of the risk-free interest rate;
T is the time to maturity of the option in years;
d is the natural logarithm of the expected dividend yield.

We use Core and Guay (2002) one year approximation method to compute *delta* and *vega*. We calculate *delta* and *vega* as follows:

$$Delta = S / 100(\Delta_{ng} N_{ng} + \Delta_{pgex} N_{pgex} + \Delta_{pgunex} N_{pgunex} + N_{stock})$$

$$Vega = 1 / 100(\upsilon_{ng} N_{ng} + \upsilon_{pgex} N_{pgex} + \upsilon_{pgunex} N_{pgunex})$$

Where *S* represents the stock price and N represents the number of options or stocks in hundreds of thousands. The subscripts *ng, pgex*, *pgunex* and *stock* stand for new grants, previously granted exercisable options, previously granted unexercisable options and stock holdings respectively.

Appendix 3.B: Variable Definition

Variable	Definition
Total number of lenders	The total number of lenders in a syndicate.
Amount of loan kept by lead arrangers	The dollar amount of the loan kept by lead arrangers. ($M)
Percentage of loan kept by lead arrangers	The percentage of the loan kept by lead arrangers.
Herfindahl index of lenders' shares	Computed as the sum of the squares of each lender's share in a loan.
Average amount of loan held by lead arrangers	The dollar amount of the loan kept by lead arrangers divided by the number of lead arrangers.
Average percentage of loan held by lead arrangers	The percentage of the loan kept by lead arrangers divided by number of lead arrangers.
Ratio of num. of lead arrangers to num. of total lenders	The ratio of the number of lead arrangers to the number of total lenders.
Delta	The dollar amount change of CEO stock and option portfolio to 1% change of stock price. ($M)
Vega	The dollar amount change of CEO option portfolio for 1% change of standard deviation of annualized stock return. ($M)
Altman Z-score	(1.2×working capital+1.4×retained earnings + 3.3×EBIT +0.999×sales)/total assets.
Tobin's Q	The sum of market value of equity plus book value of debt scaled by total asset.
Leverage	The sum of long term debt and debt in current liabilities scaled by total assets
Log (asset)	The natural log of total assets in $M.
Profitability	EBIT/total assets.
Return Volatility	The standard deviation of annualized monthly stock returns over past 60 months.
Tangibility	Net property, plant and equipment/total assets
Ownership	CEO's common shares ownership scaled by total number of outstanding common shares

Salary	The natural log of total salary plus bonus.
Log (amount)	The natural log of loan facility amount in $M.
Log (maturity)	The natural log of loan facility maturity in months.
Collateral	A dummy variable takes value of 1 if a loan is secured and 0 otherwise
Performance	A dummy variable takes value of 1 if a loan uses performance pricing and 0 otherwise
Loan type	4 dummy variables. Loantype1 takes value of 1 if the loan type is "Revolver/Line >= 1 Yr." and 0 otherwise. Loantype2 takes value of 1 if the loan type is "Term Loan" or "Term Loan A through H" and 0 otherwise. Loantype3 takes value of 1 if the loan type is "Revolver/Line < 1 Yr." and 0 otherwise. Loantype4 takes value of 1 if the loan type is "364-Day Facility" and 0 otherwise. These 4 loan types account for over 95% in our sample.
Loan purpose	5 dummy variables. Loanpurpose1 takes value of 1 if loan purpose is "Corp. purposes" and 0 otherwise. Loanpurpose2 takes value of 1 if loan purpose is "Work. cap." and 0 otherwise. Loanpurpose3 takes value of 1 if loan purpose is "Debt Repay." and 0 otherwise. Loanpurpose4 takes value of 1 if loan purpose is "Takeover" and 0 otherwise. Loanpurpose5 takes value of 1 if loan purpose is "CP backup" and 0 otherwise. These 5 loan purposes account for over 90% in our sample.
Reputation	A dummy variable takes value of 1 if lead arrangers are one of the top 10 lender lenders in syndicate loan market during sample period (in dollar amount) and 0 otherwise
Relationship	A dummy variable takes value of 1 if the borrowing firm of a loan facility had transactions with lead arrangers within 5 years window period before current loan origination date, and 0 otherwise
No rating	A dummy variable takes value of 1 if a borrowing firm does not have S&P long term debt rating, and 0 otherwise
Num. of Analyst	The total number of analysts that covering a borrowing firm

Table 3.1 Summary Statistics

The table presents summary statistics for CEO risk-taking incentive variables, syndicate structure variables, firm characteristics and loan characteristics variables for the sample of 10417 loan facilities of 1890 firms over 1992-2010. *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price. *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return. Herfindahl index of lenders' shares is defined as the sum of square of each lender's share in a syndicate in percentage points. *Total asset* is (AT) in Compustat. *Leverage* is defined as (long term debt + debt in current liabilities)/total assets. *Tobin's Q* is defined as the market value of the firm divided by the book value of the firm. *Tangibility* is defined as net property, plant and equipment value divided by total assets. *Profitability* is defined as EBIT divided by total assets. *Altman Z-score* is defined as (1.2×working capital+1.4×retained earnings+3.3×EBIT+0.999×sales)/total assets. *Loan maturity* is the maturity of loan facility in months. *Loan amount* is the amount of loan facility in million dollars

Variable	Mean	Std Dev	25^{th}	Median	75^{th}
Delta ($M)	1.012	2.591	0.106	0.276	0.711
Vega ($M)	0.208	0.433	0.027	0.076	0.213
Total number of lenders	9.334	8.877	3	7	13
Amount of loan kept by lead arrangers ($M)	91.724	154.581	22.5	41.621	90
Percentage of loan kept by lead arrangers (%)	38.977	26.944	19.091	30.683	50
Herfindahl Index of lenders' shares (0 ~ 1)	0.228	0.264	0.071	0.121	0.250
Total Asset ($M)	8964	21198	805	2229	7762
Leverage	0.298	0.175	0.179	0.286	0.397
Altman Z-score	1.882	1.071	1.182	1.808	2.496
Tobin's Q	1.743	0.955	1.155	1.456	1.972
Tangibility	0.321	0.221	0.149	0.264	0.452
Profitability	0.139	0.078	0.094	0.133	0.178
Loan Maturity (Month)	46	26	20	50	60
Loan Amount ($M)	486	1012	90	200	500

Table 3.2 The impact of CEO risk-taking incentives on syndicate structure

This table presents the OLS regression results of Equation (3.1): effects of CEO risk-taking incentives on syndicate structure. The dependent variables are total number of lenders (Column 1), amount of loan held by lead arrangers ($M) (Column 2), percentage points of loan held by lead arrangers (Column 3) and Herfindahl index of lenders' shares (Column 4). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). Herfindahl index of lenders' shares is defined as the sum of square of each lender's share in a syndicate. *Log* (*assets)* is defined as the nature logarithm of total assets. *Leverage* is defined as (long term debt + debt in current liabilities)/total assets. *Tobin's Q* is defined as the market value of firm divided by book value of the firm. *Tangibility* is defined as net property, plant and equipment value divided by total assets. *Profitability* is defined as EBIT divided by total assets. *Altman Z-score* is defined as (1.2×working capital + 1.4×retained earnings + 3.3×EBIT + 0.999× sales)/total assets. *Return volatility* is the stock return volatility of borrowing firms in past 60 months. *Ownership* is the number of common shares held by CEOs divided by total common shares outstanding. *Salary* is the nature logarithm of CEO's salary plus bonus. *Log (maturity)* is the natural logarithm of the maturity of loan facility in months. *Log* (*amount*) is the natural logarithm of the amount of loan facility in million dollars. *Collateral* is a dummy variable takes value of 1 if a loan is collateralized and 0 otherwise. *Performance* is a dummy variable takes value of 1 if a loan uses performance pricing term and 0 otherwise. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Total number of lenders	Amount of loan held by lead arrangers	Pct of loan held by lead arrangers	Herfindahl Index of lenders' shares
	(1)	(2)	(3)	(4)
Vega	-0.796**	78.988***	5.128***	0.051***
	(-2.43)	(3.79)	(3.80)	(3.82)
Delta	-0.003	0.183	-0.011	0.001
	(-0.14)	(0.60)	(-0.40)	(0.38)
Log(Assets)	1.560***	16.853***	-1.799**	-0.028***
	(10.47)	(4.05)	(-2.25)	(-3.48)
Leverage	3.802***	-8.794	-7.708**	-0.088**
	(4.88)	(-0.45)	(-1.99)	(-2.35)
Tobin's Q	-0.254*	-3.408	-0.038	0.002
	(-1.73)	(-1.13)	(-0.05)	(0.28)
Tangibility	-0.588	-36.228**	-6.955**	-0.035

	(-0.89)	(-2.06)	(-2.44)	(-1.27)
Profitability	0.202	114.597**	11.964	0.075
	(0.10)	(2.35)	(1.29)	(0.82)
Altman Z-score	0.003	-7.783**	-2.425***	-0.024***
	(0.02)	(-2.21)	(-3.44)	(-3.48)
Return Volatility	-0.550	27.081*	8.086*	0.035
	(-1.01)	(1.73)	(1.89)	(0.99)
Ownership	0.025	0.101	0.173	-0.001
	(0.39)	(0.07)	(0.59)	(-0.03)
Salary	0.339**	-7.755*	-1.189*	-0.012**
	(2.22)	(-1.91)	(-1.82)	(-2.07)
Log(Amount)	2.027***	55.910***	-7.058***	-0.069***
	(14.67)	(13.20)	(-9.70)	(-8.55)
Log(Maturity)	0.729***	-48.954***	-8.876***	-0.065***
	(4.73)	(-7.31)	(-7.08)	(-6.09)
Collateral	0.873***	6.253	-0.214	-0.001
	(3.08)	(1.22)	(-0.19)	(-0.02)
Performance	4.086***	-19.954***	-6.069***	-0.074***
	(16.23)	(-2.90)	(-5.05)	(-6.73)
Loan purpose	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
N	10417	6373	6373	6373
R-square	0.36	0.52	0.39	0.44

Table 3.3 Instrument variables estimation for *delta* and *vega*

This table presents the second stage results of 2SLS with instrument variables estimation of Equation (3.1): effects of CEO risk-taking incentives on syndicate structure. The dependent variables are total number of lenders (Column 1), amount of loan held by lead arrangers ($M) (Column 2), percentage points of loan held by lead arrangers (Column 3) and Herfindahl index of lenders' shares (Column 4). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). The instrument variables for *vega* are CEO age and tenure. The instrument variable for *delta* is firm age. *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Total number of lenders	Amount of loan held by lead arrangers	Pct of loan held by lead arrangers	Herfindahl Index of lenders' shares
	(1)	(2)	(3)	(4)
*Vega*_predicted	-2.593**	224.123***	14.816***	0.147***
	(-2.52)	(4.03)	(3.94)	(3.99)
*Delta*_predicted	-0.013	1.179	0.007	0.001
	(-0.17)	(1.27)	(0.08)	(0.76)
Log(Assets)	1.559***	17.242***	-1.716**	-0.027***
	(10.50)	(4.12)	(-2.18)	(-3.46)
Leverage	3.796***	-8.670	-7.695**	-0.088**
	(4.87)	(-0.45)	(-1.98)	(-2.35)
Tobin's Q	-0.253*	-3.529	-0.046	0.002
	(-1.72)	(-1.17)	(-0.06)	(0.27)
Tangibility	-0.585	-37.574**	-7.034**	-0.036
	(-0.89)	(-2.14)	(-2.47)	(-1.29)
Profitability	0.205	95.864**	11.927	0.075
	(0.10)	(2.34)	(1.28)	(0.81)
Altman Z-score	0.003	-7.956**	-2.434***	-0.024***
	(0.02)	(-2.24)	(-3.45)	(-3.49)
Return	-0.549	25.631*	8.022*	0.034

Volatility	(-1.01)	(1.64)	(1.87)	(0.96)
Ownership	0.025	0.075	0.168	-0.001
	(0.39)	(0.05)	(0.57)	(-0.04)
Salary	0.338**	-7.276*	-1.161*	-0.012**
	(2.22)	(-1.91)	(-1.79)	(-2.04)
Log(Amount)	2.028***	56.033***	-7.051***	-0.069***
	(14.67)	(13.16)	(-9.70)	(-8.56)
Log(Maturity)	0.732***	-49.124***	-8.887***	-0.065***
	(4.75)	(-7.31)	(-7.08)	(-6.10)
Collateral	0.875***	5.969	-0.234	0.001
	(3.09)	(1.17)	(-0.21)	(0.13)
Performance	4.088***	-20.359***	-6.095***	-0.075***
	(16.23)	(-2.95)	(-5.07)	(-6.75)
Loan purpose	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
N	10417	6373	6373	6373
R-square	0.35	0.51	0.38	0.43

Table 3.4 Lead arrangers' reputation

This table presents the regression results on the effect of lead arrangers' reputation in syndicate loan market on the relation between CEO risk-taking incentives and syndicate structure. The dependent variables are total number of lenders (Column 1), amount of loan held by lead arrangers ($M) (Column 2), percentage points of loan held by lead arrangers (Column 3) and Herfindahl index of lenders' shares (Column 4). The results are obtained from second stage regression of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. *Reputation* is a dummy variable that takes value of 1 if the lead arranger is one of the top 10 lenders in the sample. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Total number of lenders	Amount of loan held by lead arrangers	Pct of loan held by lead arrangers	Herfindahl Index of lenders' shares
	(1)	(2)	(3)	(4)
*Vega*_predicted	-2.527**	271.589***	13.387***	0.168***
	(-2.14)	(3.00)	(2.69)	(3.01)
Reputation	0.562**	-18.541***	-2.493**	-0.014***
	(1.98)	(-3.56)	(-2.55)	(-2.67)
Reputation× *vega*_predicted	0.229**	-52.401**	-2.333**	-0.104**
	(2.41)	(-2.49)	(-2.28)	(-2.53)
*Delta*_predicted	-0.113	1.237	0.055	0.002
	(-1.54)	(0.76)	(0.32)	(1.52)
Reputation× *Delta*_predicted	0.016	-2.067	-0.143	-0.002
	(0.09)	(-1.25)	(-0.77)	(-0.87)
Log(Assets)	1.379***	13.773***	-1.561**	-0.026***
	(10.01)	(3.74)	(-2.10)	(-3.50)
Leverage	3.219***	-9.223	-7.749**	-0.090**
	(4.31)	(-0.48)	(-2.01)	(-2.43)
Tobin's Q	-0.256*	-3.683	-0.034	0.002

	(-1.74)	(-1.21)	(-0.04)	(0.32)
Tangibility	-0.636	-39.697**	-6.999**	-0.036
	(-0.96)	(-2.27)	(-2.47)	(-1.31)
Profitability	0.282	101.251**	12.099	0.078
	(0.14)	(2.45)	(1.30)	(0.84)
Altman Z-score	-0.013	-8.661**	-2.419***	-0.024***
	(-0.08)	(-2.42)	(-3.46)	(-3.50)
Return Volatility	-0.535	22.413	6.439	0.032
	(-0.98)	(1.45)	(1.53)	(0.91)
Ownership	0.034	0.339	0.171	-0.001
	(0.53)	(0.24)	(0.58)	(-0.02)
Salary	0.314**	-7.526*	-1.119*	-0.012**
	(2.07)	(-1.91)	(-1.72)	(-2.00)
Log(Amount)	2.001***	57.781***	-6.929***	-0.069***
	(14.45)	(13.31)	(-9.54)	(-8.63)
Log(Maturity)	0.742***	-50.056***	-8.896***	-0.066***
	(4.79)	(-7.50)	(-7.05)	(-6.12)
Collateral	0.872***	6.283	-0.214	0.001
	(3.07)	(1.22)	(-0.19)	(0.12)
Performance	4.081***	-20.195***	-6.010***	-0.075***
	(16.21)	(-2.91)	(-5.00)	(-6.74)
Loan purpose	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
N	10417	6373	6373	6373
R-square	0.36	0.52	0.39	0.44

Table 3.5 Lead arrangers' lending relationship with borrowing firms

This table presents the regression results on the effects of lead arrangers' lending relationship with borrowing firms on the relation between CEO risk-taking incentives and syndicate structure. The dependent variables are total number of lenders (Column 1), amount of loan held by lead arrangers ($M) (Column 2), percentage points of loan held by lead arrangers (Column 3) and Herfindahl index of lenders' shares (Column 4). The results are obtained from second stage regression of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. *Relationship* is a dummy variable that takes value of 1 if a borrowing firm has conducted previous transactions with the same lead arranger within the 5-year look-back window or otherwise takes a value of zero. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Total number of lenders	Amount of loan held by lead arrangers	Pct of loan held by lead arrangers	Herfindahl Index of lenders' shares
	(1)	(2)	(3)	(4)
*Vega*_predicted	-3.454***	352.575***	14.624***	0.086**
	(-2.74)	(4.72)	(3.30)	(2.39)
Relationship	1.049***	-23.53***	-7.749***	-0.046***
	(4.12)	(-4.54)	(-3.18)	(-4.32)
Relationship × *Vega*_predicted	2.030***	-324.885***	-3.760**	-0.035**
	(2.85)	(-3.88)	(-2.60)	(2.34)
*Delta*_predicted	-0.082	-2.838	-0.132	0.001
	(1.01)	(-1.38)	(-1.16)	(0.32)
Relationship × *Delta*_predicted	0.079	9.156	0.328	-0.001
	(0.83)	(1.19)	(1.21)	(-0.16)
Log(Assets)	1.472***	10.673***	-2.053***	-0.029***
	(10.15)	(2.90)	(-2.84)	(-3.93)
Leverage	3.219***	-5.750	-7.513*	-0.089**
	(4.23)	(-0.30)	(1.93)	(-2.40)
Tobin's Q	-0.317**	-1.914	0.090	0.004
	(-2.19)	(-0.67)	(0.12)	(0.63)
Tangibility	-0.758	-31.975*	-5.773**	-0.039
	(-1.15)	(-1.87)	(-2.10)	(-1.51)

Profitability	0.335	88.712**	10.538	0.081
	(0.16)	(2.10)	(1.14)	(0.87)
Altman Z-score	-0.131	-6.859*	-2.213***	-0.023***
	(-0.79)	(-1.91)	(-3.03)	(-3.23)
Return Volatility	-0.578	23.048	6.497	0.039
	(-1.04)	(1.52)	(1.53)	(1.13)
Ownership	0.021	-0.261	0.138	0.001
	(0.33)	(-0.19)	(0.49)	(0.15)
Salary	0.314**	-6.652*	-1.147*	-0.012*
	(2.02)	(-1.84)	(-1.83)	(-1.95)
Log(Amount)	1.965***	59.202***	-6.573***	-0.063***
	(13.80)	(13.94)	(-9.15)	(-7.81)
Log(Maturity)	1.030***	-50.352***	-9.162***	-0.077***
	(5.98)	(-7.60)	(-7.38)	(-6.77)
Collateral	0.770***	5.023	-0.436	-0.002
	(2.73)	(0.99)	(-0.39)	(-0.21)
Performance	4.046***	-19.175***	-5.779***	-0.064***
	(16.15)	(-2.80)	(-4.96)	(-6.02)
Loan purpose	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
N	10417	6373	6373	6373
R-square	0.36	0.53	0.41	0.43

Table 3.6 Borrowing firms' informational opacity

This table presents the regression results on the effects of borrowing firms' informational opacity on the relation between CEO risk-taking incentives and syndicate structure. The dependent variables are percentage points of loan held by lead arrangers (Column1-3) and Herfindahl index of lenders' shares (Column 4-6). The results are obtained from second stage regression of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. *No rating* is a dummy variable that takes value of 1 if a borrowing firm does not have S&P long term debt rating or otherwise takes a value of zero. *Num. of Analyst* is the total number of analysts covering the firm. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Percentage of loan held by lead arrangers			Herfindahl Index of lenders' shares		
	(1)	(2)	(3)	(4)	(5)	(6)
*Vega*_predicted	62.113***	56.864***	19.759***	0.769***	0.574***	0.177***
	(3.24)	(2.93)	(3.27)	(2.84)	(3.28)	(3.14)
Log (assets) × *Vega*_predicted	-7.57**			-0.091***		
	(-2.48)			(-3.32)		
No rating × *Vega*_predicted		17.075**			0.207**	
		(2.17)			(2.50)	
Num. of Analysts × *Vega*_predicted			-3.058**			-0.018**
			(-2.13)			(-2.18)

*Delta*_predicted	2.737	-2.172	-0.071	0.028	-0.008	0.001
	(0.82)	(-1.11)	(-0.14)	(1.28)	(-0.33)	(0.34)
Log (assets) × *Delta*_predicted	-0.267			-0.003		
	(-0.86)			(-1.19)		
No rating × *Delta*_predicted		2.165			0.008	
		(1.11)			(0.36)	
Num. of Analysts × *Delta*_predicted			0.004			-0.001
			(0.29)			(-0.09)
No rating		3.241**			0.043***	
		(2.28)			(3.02)	
Num. of Analysts			-0.124**			-0.001**
			(-2.23)			(-2.56)
Log(Assets)	-1.896**	-1.571**	-1.987***	-0.031***	-0.026***	-0.030***
	(-2.53)	(-2.00)	(-2.74)	(-3.98)	(-3.29)	(-4.05)
Leverage	-5.661**	-6.142**	-5.215**	-0.085**	-0.083**	-0.083**
	(-2.12)	(-2.25)	(-2.41)	(-2.31)	(-2.25)	(-2.27)
Tobin's Q	0.072	0.405	-0.245	0.004	0.005	0.004
	(0.09)	(0.54)	(-0.32)	(0.06)	(0.04)	(0.02)
Tangibility	-6.872**	-7.753***	-7.436**	-0.034	-0.044	-0.039
	(-2.44)	(-2.77)	(-2.58)	(-1.25)	(-1.63)	(-1.40)
Profitability	12.067	17.291*	10.229	0.079	0.097	0.062
	(1.30)	(1.87)	(1.05)	(0.85)	(1.05)	(0.66)

Altman Z-score	-2.423***	-2.353***	-2.405***	-0.024***	-0.022***	-0.024***
	(-3.47)	(-3.49)	(-3.39)	(-3.51)	(-3.21)	(-3.42)
Return Volatility	5.948	6.938*	6.125	0.028	0.038	0.031
	(1.41)	(1.65)	(1.46)	(0.78)	(1.07)	(0.87)
Ownership	0.129	0.142	0.171	-0.001	-0.001	-0.001
	(0.44)	(0.48)	(0.58)	(-0.17)	(-0.28)	(-0.07)
Salary	-0.947	-1.021	-1.167*	-0.010*	-0.011*	-0.013**
	(-1.48)	(-1.57)	(1.80)	(-1.67)	(-1.81)	(-2.08)
Log(Amount)	-7.068***	-7.522***	-7.051***	-0.069***	-0.069***	-0.070***
	(-9.73)	(-11.64)	(-9.67)	(-8.57)	(-8.44)	(-8.52)
Log(Maturity)	-8.779***	-8.433***	-8.904***	-0.065***	-0.064***	-0.066***
	(-6.99)	(-6.76)	(-7.09)	(-6.06)	(-5.95)	(-6.11)
Collateral	-0.389	-0.359	-0.159	-0.001	0.001	0.002
	(-0.34)	(-0.32)	(-0.14)	(-0.04)	(0.05)	(0.18)
Performance	-5.982***	-6.011***	-6.117***	-0.073***	-0.075***	-0.075***
	(-5.01)	(-5.10)	(-5.11)	(-6.67)	(-6.88)	(-6.77)
Loan purpose	Yes	Yes	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
N	6373	6373	6373	6373	6373	6373
R-square	0.39	0.39	0.39	0.44	0.44	0.44

Table 3.7 Borrowing firms' financial distress

This table presents the regression results on the effects of borrowing firms' financial distress level on the relation between CEO risk-taking incentives and syndicate structure. The dependent variables are total number of lenders (Column 1), amount of loan held by lead arrangers ($M) (Column 2), percentage points of loan held by lead arrangers (Column 3) and Herfindahl index of lenders' shares (Column 4). The results are obtained from second stage regression of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. *Altman Z-score* is defined as (1.2*working capital+1.4*retained earnings+3.3*EBIT+0.999*sales)/total assets. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Total number of lenders	Amount of loan held by lead arrangers	Pct of loan held by lead arrangers	Herfindahl Index of lenders' shares
	(1)	(2)	(3)	(4)
*Vega*_predicted	-3.004**	362.939***	17.418***	0.139***
	(-2.56)	(3.90)	(3.33)	(2.61)
Z-score × *Vega*_predicted	0.378	-91.987**	-1.788**	-0.05**
	(0.43)	(-2.54)	(-2.57)	(-2.18)
*Delta*_predicted	0.029	1.053	0.161	0.003
	(0.23)	(0.34)	(0.37)	(1.06)
Z-score × *Delta*_predicted	-0.024	0.351	-0.074	-0.001
	(-0.38)	(0.24)	(-0.35)	(-0.93)
Log(Assets)	1.390***	13.714***	-1.651**	-0.028***
	(10.25)	(3.74)	(-2.24)	(-3.64)
Leverage	3.177***	-9.904	-7.577*	-0.090**
	(4.24)	(-0.56)	(-1.95)	(-2.42)
Tobin's Q	-0.256*	-1.654	0.011	0.002
	(-1.74)	(-0.56)	(0.01)	(0.30)
Tangibility	-0.670	-33.253*	-6.841**	-0.036

	(-1.01)	(-1.91)	(-2.40)	(-1.28)
Profitability	0.296	94.506**	11.786	0.076
	(0.14)	(2.23)	(1.26)	(0.82)
Altman Z-score	-0.025	-3.358**	-2.293***	-0.023***
	(-0.15)	(-2.29)	(-3.12)	(-3.17)
Return Volatility	-0.556	22.906	6.586	0.035
	(-1.00)	(1.49)	(1.56)	(0.97)
Ownership	0.034	0.193	0.165	-0.001
	(0.52)	(0.14)	(0.56)	(-0.03)
Salary	0.315**	-6.323	-1.130*	-0.13**
	(2..06)	(-1.62)	(-1.74)	(-2.06)
Log(Amount)	2.031***	56.253***	-7.058***	-0.070***
	(14.73)	(13.24)	(-9.68)	(-8.53)
Log(Maturity)	0.716***	-49.698***	-8.876***	-0.065***
	(4.63)	(-7.40)	(-7.06)	(-6.11)
Collateral	0.853***	6.385	-0.220	0.001
	(3.00)	(1.25)	(-0.19)	(0.13)
Performance	4.092***	-21.303***	-6.101***	-0.075***
	(16.29)	(-3.04)	(-5.09)	(-6.75)
Loan purpose	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
N	10417	6373	6373	6373
R-square	0.36	0.52	0.39	0.44

Table 3.8 Borrowing firms' growth opportunity

This table presents the regression results on the effects of borrowing firms' growth opportunity on the relation between CEO risk-taking incentives and syndicate structure. The dependent variables are total number of lenders (Column 1), amount of loan held by lead arrangers ($M) (Column 2), percentage points of loan held by lead arrangers (Column 3) and Herfindahl index of lenders' shares (Column 4). The results are obtained from second stage regression of 2SLS with *vega* (*delta*) instrumented by CEO age and tenure (firm age). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Total number of lenders	Amount of loan held by lead arrangers	Pct of loan held by lead arrangers	Herfindahl Index of lenders' shares
	(1)	(2)	(3)	(4)
*Vega*_predicted	-2.526**	358.924***	25.972***	0.244***
	(-2.49)	(3.56)	(3.80)	(3.56)
Tobin's Q × *Vega*_predicted	0.111	-65.353**	-5.539***	-0.047**
	(0.13)	(-2.46)	(-2.66)	(-2.51)
*Delta*_predicted	0.271	-4.387	-0.156	0.001
	(0.35)	(-1.39)	(-0.39)	(0.09)
Tobin's Q × *Delta*_predicted	-0.096	2.090	0.084	0.001
	(-0.30)	(1.18)	(0.83)	(0.57)
Log(Assets)	1.456***	15.889***	-1.781**	-0.029***
	(9.25)	(3.61)	(-2.23)	(-3.61)
Leverage	3.330***	-6.955	-7.546*	-0.095**
	(3.98)	(-0.37)	(-1.96)	(-2.48)
Tobin's Q	-0.222	0.416	0.333	0.005
	(-1.53)	(0.13)	(0.42)	(0.72)
Tangibility	-0.281	-41.128**	-7.327**	-0.038
	(-0.41)	(-2.32)	(-2.46)	(-1.31)

Profitability	0.905	109.394**	9.558	0.027
	(0.41)	(2.42)	(0.91)	(0.25)
Altman Z-score	0.024	-7.839**	-2.352***	-0.024***
	(0.13)	(-2.17)	(-3.28)	(-3.30)
Return Volatility	-0.381	34.483**	8.051*	0.040
	(-0.66)	(2.11)	(1.88)	(1.08)
Ownership	0.024	0.673	0.181	-0.001
	(0.35)	(0.44)	(0.60)	(-0.30)
Salary	0.324**	-6.813*	-1.069	-0.012*
	(2.02)	(-1.71)	(-1.62)	(-1.91)
Log(Amount)	2.091***	57.395***	-7.117***	-0.069***
	(13.78)	(12.59)	(-9.87)	(-8.19)
Log(Maturity)	0.657***	-48.689***	-8.882***	-0.064***
	(4.16)	(-6.95)	(-6.81)	(-5.71)
Collateral	0.824***	4.247	-0.440	-0.001
	(2.87)	(0.82)	(-0.38)	(-0.01)
Performance	4.029***	-21.194***	-5.409***	-0.071***
	(15.47)	(-2.93)	(-4.43)	(-6.08)
Loan purpose	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes
N	10417	6373	6373	6373
R-square	0.36	0.52	0.39	0.44

Table 3.9 Alternative syndicate structure measures

This table presents the second stage results of 2SLS with instrument variables estimation of Equation (3.1): effects of CEO risk-taking incentives on syndicate structure. The dependent variables are average amount of loan held by lead arrangers ($M) (Column 1), average percentage points of loan held by lead arrangers (Column 2) and the ratio of the number of lead arrangers to the number of total lenders (Column 3). *Delta* is defined as the change of CEO stock and option portfolio due to 1% change of stock price ($M). *Vega* is defined as the change of CEO option portfolio due to 1% change of standard deviation of annualized stock return ($M). The instrument variables for *vega* are CEO age and tenure. The instrument variable for *delta* is firm age. *Vega_predicted* is the predicted value of *vega* from the first stage regression of *vega* regressed on CEO age, tenure and all other independent variables. *Delta_predicted* is the predicted value of *delta* from the first stage regression of *delta* regressed on firm age and all other independent variables. All other variables are defined as the same in Table 3.2. 2 digits SIC industry dummies, calendar year dummies, loan purpose and loan type dummies are included in all models. Heteroscedasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Average amount of loan held by lead arrangers	Average percentage of loan held by lead arrangers	Ratio of num. of lead arrangers to num. of total lenders
	(1)	(2)	(3)
*Vega*_predicted	229.312***	15.618***	0.087**
	(2.84)	(4.35)	(2.52)
*Delta*_predicted	-0.523	0.054	0.001
	(-0.42)	(0.68)	(0.55)
Log(Assets)	1.433	-3.354***	-0.004
	(0.37)	(-4.60)	(-0.77)
Leverage	-24.457	-10.678***	-0.117***
	(-1.40)	(-2.93)	(-3.94)
Tobin Q	-1.242	0.250	0.018***
	(-0.41)	(0.37)	(2.97)
Tangibility	-36.071**	-3.240	-0.021
	(-2.07)	(-1.25)	(-0.90)
Profitability	92.834**	1.665	-0.123
	(1.97)	(0.16)	(-1.49)
Altman Z-score	-5.243	-2.160***	-0.017***
	(-1.55)	(-3.19)	(-2.89)

Return Volatility	13.526	5.428	0.041**
	(0.94)	(1.57)	(2.33)
Ownership	-0.804	0.105	-0.001
	(-0.52)	(0.40)	(-0.01)
Salary	-6.311*	-1.088*	-0.002
	(-1.70)	(-1.80)	(-0.42)
Log(Amount)	55.049***	-6.491***	-0.065***
	(8.07)	(-8.06)	(-10.50)
Log(Maturity)	-58.109***	-7.981***	-0.106***
	(-5.47)	(-7.00)	(-12.70)
Collateral	2.425	-0.667	0.011
	(0.52)	(-0.68)	(1.04)
Performance	-23.544**	-5.683***	-0.119***
	(-2.66)	(-5.30)	(-13.44)
Loan purpose	Yes	Yes	Yes
Loan type	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Year effect	Yes	Yes	Yes
N	6373	6373	10417
R-square	0.301	0.45	0.24

Chapter 4

Corporate Investments, Cash Flows and Cash Holdings: Evidence from the Oil Industry Before and After the Financial Crisis

4.1. Introduction

Modigliani and Miller (1958) argue that, when there is no financing friction, firms can fund all positive net present value (NPV) projects regardless of the availability of internal funds. Once financial market friction is introduced, the investment decisions of firms will depend on both investment opportunities (i.e., access to positive NPV projects) and internal fund availability because external funds are more expensive than internal funds. Following this intuition, Fazzari, Hubbard and Petersen (1988) (FHP hereafter) developed an empirical approach to examine the impact of financing friction on the relation between investments and internal funds. Their key results are that, after controlling for a firm's investment opportunities as proxied for by Tobin's *Q*, internal funds (cash flows) have a significant positive impact on investment activities. This positive impact is interpreted as evidence for the presence of financing friction.[24] Although it is important to consider external financing friction when analyzing the investment behaviors of firms, the key results of FHP are also based on the assumption that real investment friction is not present, i.e., investments are reversible and have

[24] There is a large body of literature on cash flow-investment sensitivity. For a review of this literature, please see Hubbard (1998) and Stein (2003).

smooth adjustment costs (e.g. Hayashi 1982). If this assumption does not hold, then the effects of cash flows on investments are subject to missing variable bias because Tobin's *Q* is a poor proxy for investment opportunities when investment adjustment costs are not smooth.[25] The captured effects of cash flows on investments may actually reflect the influence of investment opportunities on investments.

The extant literature has shown that real investment decisions are often subject to investment friction because investments can be indivisible and lumpy (e.g. Whited 2006), irreversible (e.g. Cooper and Haltiwanger 2006) with investment time lags and long investment horizons (e.g. Lamont 2000, Tsyplakov 2008, Tserlukevich 2008). The lumpiness of investment suggests that investments will be persistent, have inter-temporal features and have potentially high adjustment costs, especially if investment projects are irreversible. The time lag between when decisions to invest are made and when cash flows actually occur will also prevent firms from immediately making adjustments to investments when there are changes in cash flows. This is because cash flow levels for the coming year are uncertain when investment decisions are made, whereas required investment expenditures are clear because of investment persistence. Therefore, if the investment of capital expenditures is contingent on contemporaneous cash flows,

[25] A more accurate measure of investment opportunities is marginal *q*, which is defined as the market value of new *additional* investments divided by their replacement costs. Because marginal *q* is unobservable, empirical studies instead use average *q* (Tobin's *Q*, the ratio of the market value of *existing* capital to its replacement costs) to proxy for investment opportunities according to certain assumptions, i.e., frictionless capital markets and smooth adjustment costs. If these assumptions do not hold, average *q* will be a poor proxy for marginal *q*.

it may result in investment projects to be frequently halted and restarted, which can be costly. In addition to cash flows, firms can rely on current cash holdings as alternative sources of internal funds. Cash holdings can be particularly useful for firms facing real investment friction because cash holdings are a realized value at the time of investment decision making for the coming year. By making investments with cash holdings, firms can avoid potential adjustment costs associated with investing based on uncertain cash flows.

The purpose of this chapter is to examine corporate investments with internal funds (i.e., cash flows and cash holdings) and related cash flow policies when firms face investment friction such as adjustment costs and investment time lags. To this end, we investigate a sample of U.S. oil companies from 2003 to 2011. Extant empirical studies (e.g. Tsyplakov 2008) have used the oil industry to examine the effect of investment friction because of the high adjustment costs and irreversible nature of investments in this industry, such as expensive geological surveys, long-term land leases, and drilling and exploration activities. Therefore, the oil industry represents an ideal context to study the investment decisions of firms facing real investment friction. In addition, due to the 2008 financial crisis, the sample period from 2003 to 2011 includes two periods with opposite cash flow patterns: the cash flow windfall period from 2003 to 2007, during which oil prices grew by 25% per year on average, and the cash flow downfall period from 2009 to 2011, when the demand for oil declined due to the recession that took place after the 2008 financial crisis.[26] The financial crisis therefore serves as an exogenous shock to the financial status of oil companies and allows us to examine their investments with internal funds as well as their cash flow policies in response to positive and negative changes in cash flows.

We begin our analysis by investigating the impact of internal sources of funds (e.g., cash flows and cash holdings) on the investments of oil companies during the pre-crisis sample period. From 2003 to 2007, U.S. oil companies obtained significant cash inflows due to increasing oil prices. The boom in oil prices can be attributed to factors such as an increase in demand from emerging economies. On the supply side, oil output has been stable over time due to the "Peak Oil" effect.[27] For example, in 2007, Exxon extracted approximately 4.4 million barrels of oil and natural gas a day, which is roughly the same output as in 2000. This scenario provides us with an identifying strategy to isolate shocks to a firm's cash flows from shocks to its investment opportunities in that cash flow changes are not correlated with changes in investment opportunities. On one hand, the cash flow windfalls experienced by U.S. oil companies are procyclical and time variant,

[26] We exclude 2008 from our sample because of significant oil price volatility during this year ($92.97 in January, $133.88 in June and $41.12 in December). The inclusion of 2008 could lead to potentially biased results. We therefore split the sample into a pre-crisis sample period (2003-2007) and a post-crisis sample period (2009-2011). The average annual growth rate of oil prices is calculated based on the average monthly price of West Texas Intermediate grade for that year.

[27] The peak oil effect refers to the phenomenon that when the maximum rate of petroleum extraction is reached, the rate of production is expected to enter terminal decline. The concept was introduced by M. King Hubbert in the 1950s. The peak oil effect mostly refers to the depletion of *conventional* oil resources because *unconventional* oil resources such as oil shales and heavy oil were not economically and technically viable at the time. With an increase in oil prices and technological innovation, however, there is an ongoing debate within the industry regarding when the "Peak Oil" point actually is. Before 2008, global crude oil output reached its peak in 2005 (U.S. Energy Information Administration).

following crude oil price increases driven by demand mostly from outside the U.S. On the other hand, changes in the investment opportunities available to these companies are rather time invariant because of the limited conventional oil resources available at the time. One common criticism of the FHP approach is that the Tobin's *Q* might not fully capture investment opportunities because of measurement errors. Investment-cash flow sensitivity actually reflects the relationship between investments and investment opportunities due to missing variable bias because investment opportunities are not well accounted for.[28] The uncorrelated cash flows and investment opportunities in the pre-crisis sample can help mitigate the endogenous concern between cash flows and investments and produce less biased results.

Using an augmented regression model including capital expenditures, cash flows, Tobin's *Q*, firm size, leverage, lagged cash holdings and lagged capital expenditures, we find that the capital expenditures of oil companies are not sensitive to their cash flow levels in different regression specifications. In contrast, we find that the lagged cash holdings of firms have a significant impact on capital expenditures in different model specifications. The results suggest that the investments of firms are determined or planned based on realized cash holdings at the beginning of the year. Because firms are reluctant to change their investment plans due to adjustment costs, investments do not fluctuate with contemporaneous cash flows. In addition, lagged capital expenditures have a positive impact on

[28] For example, see Erickson and Whited (2000), Gomes (2001) and Alti (2003).

current capital expenditures, suggesting that there is investment persistence in capital expenditures. The positive impact of lagged cash holdings on investments is in line with the notion that investment friction, such as investment time lags and lumpy investments, will affect firms' choices relating to internal funds for investments. When firms make inter-temporal investment decisions, they will prefer to invest with realized cash holdings rather than uncertain contemporaneous cash flows. This allows firms to avoid potential investment adjustment costs that could be incurred when investing with uncertain cash flows from the coming year.

However, because of the existence of financing friction such as financial constraints, the insignificant investment-cash flow sensitivity that we find in our baseline model could be driven by two possibilities: first, most firms in our sample are not financially constrained; second, cash flow windfalls during the pre-crisis sample period could have eased financing friction for oil companies. To address the first alternative explanation, we follow a common practice in the extant empirical literature by splitting the pre-crisis sample into financially constrained and unconstrained firms based on firm size, bond ratings and commercial paper ratings.[29] Large firms with access to external capital markets are usually considered to be less financially constrained. We find that investment-

[29] Following common practices, we use the term "constrained" and "unconstrained" to describe a firm's financial constraint status, i.e., the cost wedge between internal funds and external funds will be greater for "constrained" firms and smaller for "unconstrained" firms. However, the terms "more constrained" or "less constrained" would be more appropriate because it is difficult to argue that a certain group of firms is completely constrained or unconstrained.

cash flow sensitivities remain statistically and economically insignificant, whereas investment-cash holding sensitivities are positive and significant regardless of the financial constraint status of firms. Moreover, the coefficients of cash holdings on investments are larger in magnitude for constrained firms than for unconstrained firms, suggesting that the investments of constrained firms rely more on cash holdings than those of unconstrained firms because unconstrained firms can easily build up cash reserves with external funds.

To address the second alternative explanation, we estimate the baseline model with the post-crisis sample. Credit rationing by financial institutions after the financial crisis generated additional barriers for accessing external funds and therefore exacerbated financing friction for all firms. Because the presence of financing friction for investments is more about being able to raise external funds when facing cash flow downfalls than it is about allocating surpluses when facing cash flow windfalls, we can mitigate the concern that the pre-crisis results are driven by cash flow surpluses by examining the investments of oil companies during the post-crisis period. We find that investment-cash flow sensitivities are insignificant, whereas investment-cash holding sensitivities are positive and significant regardless of the financial constraint status of firms in the post-crisis period. In addition, the coefficients of cash holdings on investments are larger for both constrained and unconstrained firms relative to the coefficients of cash holdings on investments in the pre-crisis period. The results suggest that the investments of oil companies are more dependent on cash holdings after the financial crisis.

The empirical results thus far have shown that investments do not represent an important outlay of contemporaneous cash flows and firms rely on cash holdings rather than cash flows for investments when they make inter-temporal investment decisions. Because firms accumulate cash holdings from cash flows, we next turn to the cash flow policies of oil companies to examine how firms allocate their cash flows among cash holdings and other cash-flow-related corporate policies during periods of cash flow windfalls and downfalls.

Bates et al. (2009) find that U.S. firms hold much more cash now than they did in the past in order to hedge against liquidity risks. Acharya et al. (2007) show that the impact of cash flows on cash holdings should be jointly determined with debt levels because cash can be readily used to repay debts. In addition, payout policies such as those related to dividends and stock repurchases also represent important cash outlays. Moreover, as suggested by Almeida et al. (2004), Acharya et al. (2007) and others, a firm's cash flow policies toward cash holdings, debts and payouts will vary based on its potential financial constraint level. Therefore, we estimate a system of joint determination among cash flows, cash holdings, net debt issuance, dividends and stock repurchases based on partitioning the potential financial constraint status of oil companies to investigate cash flow sensitivities on cash holdings, net debt issuances, dividends and share repurchases.

We next highlight the cash flow policies of oil companies during the pre-crisis sample period. For constrained firms, we find that cash flows have a significant positive impact on cash holdings, suggesting that constrained firms build up cash reserves with cash windfalls. With regard to dividends, share repurchases and debt issuances, cash flow sensitivities are neither statistically nor economically significant for constrained firms. The results suggest that cash holdings are a major outlay of cash flows for constrained firms. For unconstrained firms, we find that net debt issuance is negatively related to cash flows and share repurchases are positively related to cash flows. Cash flows have no significant impact on dividends or cash holdings. The results suggest that unconstrained firms use cash flows to repay debts and repurchase shares during cash windfall periods. The overall results indicate that financing friction plays an important role in the cash flow policies of oil companies and there seems to be a "pecking order" with regard to the uses of cash flows (Myers 1984, Myers and Majluf 1984). The priority for constrained firms is building up cash reserves and a large portion of cash flows goes to cash holdings for future investment purpose. These results are similar to those of other empirical studies, such as Almeida et al. (2004) and Acharya et al. (2007). For unconstrained firms, building up cash reserves is not the priority use of cash flows because easy access to low-cost external funding can usually help them maintain their cash holdings at a desired level. When there are cash flow windfalls, unconstrained firms will choose to repay their debts and buy back shares to reduce debt overhang costs (Myers 1977) and agency costs from free cash flows (Jensen 1986). Unconstrained firms thereby use cash flow surpluses in the current period to increase their financing capacity in case cash flows decline in the future.[30]

The systematic liquidity supply shocks after the 2008 financial crisis exacerbates the already present financing friction. Together with cash flow downfalls during the post-crisis period, the use of cash flows by oil companies for cash holdings, net debt issuances and payouts is also affected relative to the pre-crisis period. To highlight differences with the pre-crisis period results, unconstrained firms also save cash from cash flows and do not buy back shares during the post-crisis period. These results suggest that unconstrained firms build up cash reserves from cash flows and cut back on payouts to accommodate declines in cash flow and liquidity constraints after the crisis. Debt and dividend policies remain qualitatively unchanged. Cash flows have no significant impact on changes to dividends. The insensitivity of dividend changes toward cash flows in periods of cash windfalls and downfalls is consistent with the notion that firms usually smooth dividends to maintain stable dividends payouts regardless of cash flow conditions (Allen and Michaely 2003). Cash flows are negatively related to debt issuance in unconstrained firms but there is no such effect for constrained firms. The results suggest that unconstrained firms will raise debt to supplement declining cash flows and retain cash holding levels during the post-crisis period.

[30] Share repurchase is defined as stock repurchase net of sales of common and preferred stock. Therefore, we consider share repurchases to be a financing policy because they reflect net equity financing effects.

The rationing of the liquidity supply after the crisis limits the ability of constrained firms to raise debt even though they experienced negative cash flow shocks. The results relating to the post-crisis cash flow policies of oil companies are also consistent with the notion of a "perking order" in the use of cash flows. When there are positive cash flow shocks, firms use cash flows to accumulate cash holdings, repay debts and make payouts to shareholders. When there are negative cash flow shocks, firms accumulate cash, raise more debt and cut back on payouts to retain cash holdings.

A recent study by Gatchev et al. (2010) also investigates the impact of investment adjustment costs on the relation between investments and cash flows as well as related cash flow policies by examining cash flow sensitivities to investments and various cash flow outlays. After adding lagged investments as an explanatory variable, they show that cash flows virtually have no impact on investments and that lagged investments can explain a significant amount of current investments. They attribute the results to high investment adjustment costs and investment persistence. They also argue that the significant investment-cash flow sensitivities identified in previous studies are driven by missing variable bias because the inter-temporal nature of investment decisions is not accounted for. Our paper differs from their study in that we focus on investigating how firms invest with internal funds when investment persistence and adjustment costs are present by introducing lagged cash holdings as a new explanatory variable in the investment equation. We show that investments are highly sensitive to lagged cash holdings after considering investment persistence. Our results are intuitive in the context of investment planning time lags and investment persistence, showing that realized cash holdings are a more reliable internal source of funds for investment than uncertain cash flows when the investment decisions of firms are affected by real investment friction.

This paper is also related to empirical works that study cash flow windfalls. For example, Blanchard et al. (1994) investigate what happened to 11 firms when they won lawsuits or received cash settlements during the early 1980s. The authors find that cash flow windfalls were squandered by managers through unsuccessful diversification, debt-raising or compensation to ensure their self-interest and independence of firms with themselves at the helm. They attribute the empirical results to the agency cost of free cash flows (Jensen 1986). Apparently, the results of this study are not consistent with the managerial entrenchment of the free cash flows hypothesis. Instead, the findings are rather consistent with the financing resources irrelevance theory of Modigliani and Miller (1958) when financing friction is present, i.e., if there is a cash flow surplus, unconstrained firms will use cash flow windfalls to repay debts and make payouts to shareholders, whereas constrained firms will use cash flow windfalls to build up cash reserves and increase their financial flexibility.

The remainder of this paper is organized as follows. We describe the sample construction and the variable summary statistics in Section 4.2. Section 4.3 presents the empirical methodology and results. Section 4.4 concludes.

4.2. Sample construction and variables

4.2.1. Sample construction

Starting in the early 2000s, especially after 2003, there was impressive increase in global crude oil prices due to strong demand from emerging economies in developing countries. Before the 2008 financial crisis, oil prices increased by approximately 25% per year from 2003 to 2007. Oil prices peaked in mid-2008, right before the financial crisis, and plummeted quickly to roughly $40 per barrel at the end of 2008. In the post-crisis period from 2009 to 2011, oil prices bounced back with stock markets as a result of various stimulus plans from major economies around the world. Figure 4.1 presents monthly crude oil prices (West Texas Light Grade) from 2003 to 2011.

[Figure 4.1 about here]

To empirically test how cash flows affect an oil company's investments and other corporate financial policies, we choose U.S. oil companies with a two-digit SIC code of "13" in the Compustat North American universe database. This category includes crude petroleum and natural gas production and drilling as well as exploration services for gas wells and oil and gas fields. Many oil companies, such as Chevron, are listed under SIC code "2911", which stands for petroleum refining, even though their core businesses are crude oil production. Therefore, we also include these firms in our sample. Following extant empirical studies (e.g. Almeida and Campello 2007), we exclude firms with capital stocks (net amount of property, plant and equipment) of less than $5 million. This eliminates very small firms to avoid the small denominator problem because linear investment models are likely to be inadequate for those firms (Gilchrist and Himmelberg 1995). Our final sample consists of 233 U.S. oil companies from 2003-2011 (excluding 2008).

4.2.2. Variables

The main variables of interest are cash flows, cash holdings and investments. Following the extant empirical literature, cash flows (CF_t / K_{t-1}) are defined as earnings before extraordinary items plus depreciation deflated by the capital stock at the beginning of the period (net amount of property, plant and equipment). Cash holdings (CH_{t-1} / K_{t-1}) are defined as cash and short-term investments at the beginning of the period deflated by the capital stock at the beginning of the period. Investments (I_t / K_{t-1}) are defined as capital expenditures deflated by the capital stock at the beginning of the period. To control for investment persistence, we also include lagged investment (I_{t-1} / K_{t-2}) as an explanatory variable. Other variables examined in this paper include firm size, Tobin's *Q*, and leverage, among others. Please refer to the appendix for a full description and definition of the variables used in this paper.

[Table 4.1 about here]

Table 4.1 presents the summary statistics for the key variables in this study. We deflate all series to 2003 dollars using the Consumer Price Index. All variables are winsorized at 1% and 99%. We report summary statistics for all the sample years from 2003 to 2011 except 2008 (Panel A), the pre-crisis period from 2003 to 2007 (Panel B), the post-crisis period from 2009 to 2011 (Panel C) and a mean comparison of key variables between the pre- and post-crisis samples (Panel D). Several points in the summary statistics are noteworthy. After the financial crisis, cash flows, capital expenditures and cash holdings all decline to a certain degree. However, the extent of this varies. Average cash flows decrease significantly from 0.193 to 0.088 after the financial crisis, a drop of over 50%. Average capital expenditures also decrease from 0.458 to 0.305, representing a much more moderate drop of 30%. Average cash holdings decrease from 0.196 to 0.166; this 15% drop makes this factor the least affected of the three. In contrast, average leverage increases from 0.284 to 0.304 after the financial crisis. The results of the summary statistics imply that after the financial crisis, oil companies raised more debt to compensate for declining cash flows. Based on the untabulated results, we also find that the correlation between cash holdings and investments is much higher than the correlation between cash flows and investments for both the pre- and post-crisis samples. The correlations between cash flows and investments are -0.005 and -0.035 for the pre- and post-crisis periods, respectively, whereas the correlations between cash holdings and investments are 0.298 and 0.368 for the pre- and post-crisis periods, respectively. This implies that investments are more closely related to cash holdings than cash flows; this relationship becomes even stronger after the financial crisis. Next, we turn to the multivariate analysis to present the main results of this paper.

4.3. Methodologies and results

4.3.1. Investments, cash flows and cash holdings from 2003 to 2007

A widely used empirical model to test the impact of cash flows on investment is a reduced form regression between investments and cash flows after controlling for a firm's set of investment opportunities (proxied for by Tobin's *Q*) as developed by FHP. To consider the effect of cash holdings, leverage and investment persistence on investments, we estimate an augmented regression model among capital expenditures, cash flows, cash holdings, firm size, leverage, lagged capital expenditures and Tobin's *Q* in the Equation (4.1) below to examine the investment behaviors of oil companies.

$$I_{i,t} / K_{i,t-1} = \alpha + \beta_1 \times CF_{i,t} / K_{i,t-1} + \beta_2 \times CH_{i,t-1} / K_{i,t-1} + \beta_3 \times Q_{i,t-1} + \beta_4 \times Size_{i,t-1} + \beta_5 \times Leverage_{i,t-1} + \beta_6 \times I_{i,t-1} / K_{i,t-2} + \sum firm_i + \sum year_t + \varepsilon_{i,t} \quad \textbf{(4.1)}$$

where $I_{i,t} / K_{i,t-1}$ is defined as a firm's capital expenditures in fiscal year *t* deflated by the capital stock at the beginning of year *t*. $CF_{i,t} / K_{i,t-1}$ is defined as a firm's cash flows in fiscal year *t* deflated by the capital stock at the beginning of year *t*, where cash flows are defined as earnings before extraordinary items plus depreciation. $CH_{i,t-1} / K_{i,t-1}$ is a firm's cash in the beginning of year *t* and short-term investments scaled by capital stock. $Q_{i,t-1}$ is Tobin's Q at the beginning of year t, which is defined as the market value of assets divided by the book value of assets. $Size_{i,t-1}$ is the natural logarithm of a firm's total assets at the beginning of year t. $Leverage_{i,t-1}$ is a firm's leverage at the beginning of year t and is defined as long-term debt and current liabilities divided by total assets. $I_{i,t-1} / K_{i,t-2}$ is defined as a firm's capital expenditures in fiscal year $t-1$ deflated by the capital stock at the beginning of year $t-1$. Firm and year capture firm and year fixed effects, respectively. The OLS results of Equation (4.1) with different specifications are reported in Table 4.2, and standard errors are clustered at the firm level.

[Table 4.2 about here]

Column 1 of Table 4.2 reports the typical reduced form regression results with cash flows and Q as independent variables on capital expenditures. At 0.132, the coefficient of CF_t / K_{t-1} is statistically insignificant, whereas the coefficient of Q_{t-1} is 0.152 and significant at the 1% level, suggesting that cash flows do not have a significant impact on investments and that investments are more related to investment opportunities, as proxied for by Q. Columns 2 through 5 report augmented regression results with different specifications. Similar to the reduced form in Column 1, the coefficients of $CF_{i,t} / K_{i,t-1}$ remain insignificant in different regression specifications and decrease to only 0.029 when we add more control variables into the specifications. However, we find significant and positive coefficients of $CH_{i,t-1}/K_{i,t-1}$, ranging from 0.461 to 0.499, in the different regression specifications, suggesting that the capital expenditures of oil companies are more sensitive to their cash holdings at the beginning of the period than their contemporaneous cash flows. In addition, the coefficient of $I_{i,t-1} / K_{i,t-2}$ is 0.436 and statistically significant, suggesting that lagged investments also have a great impact on current investments and that investment decisions are inter-temporal and persistent. The results are consistent with the notion that investment friction affects firm choices regarding internal funds for investments. If investments are persistent and have high adjustment costs, firms will rely on their cash holdings at the beginning of the year instead of on contemporaneous cash flows for investments because realized cash holdings are a more reliable source of internal funds than the uncertain cash flows of the coming year.

4.3.2. Investments, cash flows, cash holdings and financial constraints from 2003 to 2007

Whereas the results from the previous section have indicated the importance of investment friction in firms' investment decisions regarding cash flows and cash holdings, we need to acknowledge that the oil companies in our sample may also encounter financing friction, such as financial constraints. If investment-cash flow sensitivity is a valid measure of a firm's financial constraint status, then our baseline results could be driven by the possibility that most of the firms in our sample are financially unconstrained. To rule out this alternative explanation, we follow the extant empirical literature (e.g. Kaplan and Zingales 1997, Almeida et al. 2004) and partition the pre-crisis sample into financially constrained and unconstrained firms based on firm size, long-term bond ratings and short-term commercial paper ratings. Large firms with access to external capital markets are less financially constrained than small firms without access to external capital markets. We then estimate Equation (4.1) with the pre-crisis sample for both constrained and unconstrained firms. The results are reported in Table 4.3.

[Table 4.3 about here]

Columns 1 through 6 of Table 4.3 report the OLS results of Equation (1) with the pre-crisis sample by partitioning firms according to their financial constraint status based on firm size, bond ratings and commercial paper ratings. A firm is financially constrained if its total assets are in the bottom quartile and it has no bond or commercial paper ratings. A firm is financially unconstrained if its total assets are in the top quartile and it has commercial paper or bond ratings. The coefficients of cash flows on capital expenditures are statistically and economically insignificant regardless of the financial constraint status based on different partition criteria, suggesting that investments are not sensitive to cash flows even among financially constrained firms. As in the baseline results, the coefficients of CH_{t-1} / K_{t-1} are positive and significant in all specifications, suggesting that investments are positively related to lagged cash holdings. In addition, the coefficients of CH_{t-1} / K_{t-1} for constrained firms are larger in magnitude than those of unconstrained firms (differences range from 0.187 to

0.349, with p-value<0.01), suggesting that investments made by constrained firms are more sensitive to cash holdings than those of unconstrained firms. The difference in investment-cash holding sensitivities between constrained and unconstrained firms suggest that cash holdings are more important to constrained firms because they allow for these firms to have sufficient internal funds for their investments.

4.3.3. Cash holdings, debt issuance and payouts from 2003 to 2007

If oil companies prefer cash holdings to cash flows as internal funds for investments when facing investment persistence and adjustment costs, then how oil companies allocate their cash flows to maintain an ideal cash holdings level will be the next research question to be explored. To this end, we examine the cash flow policies of oil companies with regard to cash holdings and other cash flow outlays, as suggested by the extant literature. For example, Almeida et al. (2004) and Han and Qiu (2007) model the corporate demand for precautionary cash holdings, showing that cash flows are positively related to cash holdings for financially constrained firms and that firms increase cash holdings as cash flows become riskier. In addition, Acharya et al. (2007) show that the impact of cash flows on cash holdings should be jointly determined with debt levels because cash can be readily used to redeem debt. Moreover, as shown by Gatchev et al. (2010) and Dasgupta et al. (2011), payout policies, such as those related to dividends and stock repurchases, should also be considered in joint determination because payouts to shareholders represent another important outlay of cash flows. To mitigate possible endogeneity among cash, debt and payout policies due to joint determination, we estimate a system of four simultaneous equations, similar to the specification in Acharya et al. (2007), to examine cash flow policies toward cash holdings and other outlays such as debt, dividends and share repurchases.[31] The system of equations is as follows:

$$\Delta CH_{i,t} = \alpha_0 + \alpha_1 \times CF_{i,t} + \alpha_2 \times Q_{i,t} + \alpha_3 \times Size_{i,t} + \alpha_4 \times CH_{i,t-1} + \alpha_5 \times \Delta Dividend_{i,t} + \alpha_6 \times \Delta Repurchase_{i,t} + \alpha_7 \times \Delta Debt_{i,t} + \sum firm_i + \sum year_t + \varepsilon^{c}_{i,t} \quad \mathbf{(4.2)}$$

$$\Delta Debt_{i,t} = \beta_0 + \beta_1 \times CF_{i,t} + \beta_2 \times Q_{i,t} + \beta_3 \times Size_{i,t} + \beta_4 \times Leverage_{i,t-1} + \beta_5 \times \Delta CH_{i,t} + \beta_6 \times \Delta Dividend_{i,t} + \beta_7 \times \Delta Repurchase_{i,t} + \sum firm_i + \sum year_t + \varepsilon^{d}_{i,t} \quad \mathbf{(4.3)}$$

$$\Delta Dividend_{i,t} = \gamma_0 + \gamma_1 \times CF_{i,t} + \gamma_2 \times Q_{i,t} + \gamma_3 \times Size_{i,t} + \gamma_4 \times Dividend_{i,t-1} + \gamma_5 \times \Delta CH_{i,t} + \gamma_6 \times \Delta Debti,t + \gamma_7 \times \Delta Repurchasei,t + \sum firm_i + \sum year_t + \varepsilon^{v}_{i,t} \quad \mathbf{(4.4)}$$

$$\Delta Repurchase_{i,t} = \delta_0 + \delta_1 \times CF_{i,t} + \delta_2 \times Q_{i,t} + \delta_3 \times Size_{i,t} + \delta_4 \times Repurchase_{i,t-1} + \delta_5 \times \Delta CH_{i,t} + \delta_6 \times \Delta Debt_{i,t} + \delta_7 \times \Delta Dividend_{i,t} + \sum firm_i + \sum year_t + \varepsilon^{r}_{i,t} \quad \mathbf{(4.5)}$$

where the dependent variables $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Dividend_{i,t}$ and $\Delta Repurchase_{i,t}$ are changes in cash holdings, net long-term debt issuance (difference between long-term debt issuance and long term-debt reduction), dividends and stock repurchases scaled by the capital stock, respectively. $CH_{i,t-1}$ is the cash holding at the beginning of year *t* scaled by the capital stock. $Leverage_{i,t-1}$ is the leverage at

[31] Acharya et al. (2007) show that it is important to consider that cash flow outlay policies are not orthogonal to each other and that spurious inferences could be drawn if endogeneity among cash flow outlay policies is not corrected for.

the beginning of year *t*. $Dividend_{i,t-1}$ is the dividend paid to common stockholders at the beginning period of year *t* scaled by the capital stock and $Repurchase_{i,t-1}$ is the net stock repurchase at the beginning of year *t* scaled by the capital stock.

Extant studies have also shown that the precautionary cash saving motive varies cross-sectionally according to the financial constraint status of firms. For example, Almeida et al. (2004) show that constrained firms will systematically save cash from cash flows, whereas unconstrained firms do not display this tendency. Similarly, payout policies, such as those related to share repurchases, are also closely related a firm's financial constraint status. Share repurchasers spend cash flows or raise more debt when buying back shares (Dittmar 2000; Stephens and Weisbach 1998). Therefore, the repurchase of shares by constrained firms may decrease equity value because of the decline in corporate liquidity and the increase of financial distress risk (Chen and Wang 2012). To address the cross-sectional differences among cash flow policies according to the financial constraint status of firms, we estimate Equations (2) through (5) across partitions based on the financial constraint status of firms with similar classifications as those used in Section 4.3.2. The regression results are reported in Table 4.4.

[Table 4.4 about here]

Panels A through D of Table 4.4 report the regression results of Equations (4.2) through (4.5), respectively. The dependent variables in Panels A through D are Δ*CH*, Δ*Debt*, Δ*Dividend* and Δ*Repurchase*, respectively. Columns 1 through 6 of each panel report the regression results of each equation according to the partition of the pre-crisis sample based on potential financial constraint levels, firm size, commercial paper ratings and bond ratings. A firm is financially constrained if its total assets are in the bottom quartile and it has no bond or commercial paper ratings. A firm is financially unconstrained if its total assets are in the top quartile and it has bond or commercial paper ratings.

In Panel A of the cash holding regression, the coefficients of *CF* are all positive and significant for the constrained firms, suggesting that financially constrained firms tend to accumulate cash reserves from cash flows. For unconstrained firms, the coefficients of *CF* are much smaller and statistically insignificant with different signs, suggesting that those firms do not systematically save cash from cash flows. The results are similar to the findings in Acharya et al. (2007), Almeida et al. (2004) and others, suggesting that constrained firms need to build up cash reserves from cash flows for investment purposes because of the higher costs associated with external funds. The insignificant cash holding-cash flow sensitivity for unconstrained firms suggests that saving cash from cash flows is not a priority for unconstrained firms. These firms usually have a desired level of cash holdings based on their investment needs. If cash reserves are below the desired level, firms can increase their balance by raising external funds. Therefore, when there are positive cash flow shocks, it is not necessary for unconstrained firms to build up extra cash holdings if they have already reached their target cash holding threshold because holding extra cash can be costly as well (e.g., agency cost of free cash flows). For constrained firms, saving cash is crucial. By building up cash holdings in the current period, when there are positive cash flow shocks, firms can also transfer current high cash flows to possible periods of low cash flows in the future to minimize the effect of cash flow fluctuations.

In Panel B of the debt capacity regression, the coefficients of *CF* are negative and significant for unconstrained firms, suggesting that these firms use cash flows for debt repayment. For constrained firms, the coefficients of *CF* are also negative, although there are economically negligible compared to unconstrained firms. The results from Panel B suggest that debt repayment is a major cash flow outlay for unconstrained firms. Because unconstrained firms face less financing friction than constrained firms, they can easily build up cash holdings through external funds when facing cash shortages. Therefore, when there are positive cash flow shocks, unconstrained firms will choose to repay their debts if they have already reached their desired cash holdings level. These results are consistent with debt overhang cost theory. When a firm experiences a positive cash flow shock, it may choose to optimally reduce debt overhang costs associated with future investments by decreasing its debt in the current period in order to increase investment in subsequent periods.

Panel C reports the impact of cash flows on dividend payouts. None of the coefficients of *CF* are significant either statistically or in magnitude regardless of the financial constraint status of firms. These results suggest that changes in dividends are not sensitive to cash flows during the sample period, consistent with the findings of Dasgupta et al. (2011). The results are consistent with the notion that dividends tend to be “sticky” and that firms will usually smooth dividends to keep them stable regardless of cash flow conditions (Allen and Michaely 2003).

Panel D reports the effect of cash flows on share repurchases. Our results show that only unconstrained firms will make repurchases, whereas constrained firms will not buy back shares. These results suggest that when there are positive cash flow shocks, unconstrained firms will make payouts to shareholders if there have cash flow surpluses beyond their financing needs (e.g., cash holdings, debt). Repurchases can thereby reduce free cash flow problems and mitigate conflicts of interest between shareholders and management. Constrained firms will not repurchase because building up cash holdings should be their primary use for cash flows.

In sum, this section presents the cash flow policies of oil companies with regard to cash holdings, debt issuances and payouts during the pre-crisis sample period. Together with the results of Sections 4.3.1 and 4.3.2, we show that there seems to be a “pecking order” with regard to the use of cash flows. Constrained firms need to accumulate cash holdings from cash flows for investment purposes because external funds are costly. Therefore, whenever there are positive cash flow shocks, their first priority will be to build up cash reserves. The easy access of unconstrained firms to external funds implies that they can usually maintain a desired cash holdings level based on their investment needs. When there are cash flow surpluses, unconstrained firms will repay their debts to increase their future financing capacity and make payouts to shareholders through share repurchases.

In reality, the cash flow policies of oil companies are also intuitive. After several years of oil price growth due to factors such as demand from emerging economies, the war in Iraq and Hurricane Katrina, oil companies expected oil prices to become more volatile in the future because of market speculation, slowing demand and the development of alternative fuels. In fact, oil prices dropped by over 60% during the 2008 financial crisis. Meanwhile, with the declining supply of conventional sources of oil, oil companies are waiting for the next technological and economically viable investment in the energy supply, either alternative fuels such as solar power or unconventional oil resources. By saving cash and decreasing debt when there are positive cash flow shocks, oil companies will be in a better financial position if oil prices become volatile in the future. The 2008 financial crisis acted as an exogenous shock to the cash flows of oil companies and exacerbated liquidity constraints for all firms. Next, we investigate how these exogenous shocks influenced the investments of oil companies with internal funds and the use of cash flows during the post-crisis period.

4.3.4. Investments, cash flows and cash holdings from 2009 to 2011

During the 2008 financial crisis, oil prices decreased from their peak of approximately $130 per barrel in mid-2008, to their lowest point of roughly $40 per barrel at the end of 2008. Because of stimulus plans from major world economies to cope with the financial crisis, oil prices started to rise along with stock markets and commodity prices during the post-crisis period from 2009 to 2011, as shown in Figure 1. However, oil companies still suffered significant declines in cash flows because of reduced demand due to the recession that took place after the crisis. In addition, liquidity constraints and rationing after the financial crisis systematically exacerbated financing friction across all firms (Campello et al. 2010). Therefore, it will be interesting to investigate how oil companies invest with internal funds when there are negative cash flow shocks. In addition, by examining the investment financing behavior of oil companies when there are negative cash flow shocks and additional financing friction, we can also rule out the alternative explanation to the baseline results in the pre-crisis sample that cash flow windfalls ease financing friction for all firms and that this causes the insignificant investment-cash flow sensitivity. To this end, we first estimate Equation (4.1) with the post-crisis sample from 2009 to 2011. The results are reported in Table 4.5.

[Table 4.5 about here]

Columns 1 through 5 of Table 4.5 report the regression results for Equation (4.1) with different specifications with the post-crisis sample. The overall results are similar to those of the pre-crisis period. Investments are not sensitive to cash flows in different specifications, whereas capital expenditures are positively and significantly related to cash holding levels. Compared to the results from the pre-crisis period, we also find that the coefficients of lagged cash holdings are larger in magnitude after the crisis. The coefficients of cash holdings range from 0.672 to 0.702 in the post-crisis sample compared to a range of 0.461 to 0.499 in the pre-crisis sample. Coefficient differences range from 0.201 to 0.211 (with p-value<0.01), suggesting that oil companies are more dependent on their cash holdings for investments after the financial crisis than they were before the financial crisis.

[Table 4.6 about here]

In addition, we examine firms' investments with internal funds with regard to different financial constraint statuses when cash flows decline during the post-crisis period. To this end, we apply a similar approach as that in Section 4.3.2 by estimating Equation (4.1) with the post-crisis sample of financial constraint status partitioning based on firm size, bond ratings and commercial paper ratings. The results are reported in Table 4.6. The overall results are generally as expected. Cash flows do not have a significant impact on investments regardless of the financial constraint status of firms and capital expenditures are positively related to lagged cash holdings for all firms. Moreover, as in the pre-crisis sample results, we find that the coefficients of lagged cash holdings are much higher for constrained firms than for unconstrained firms. Coefficient differences between constrained and unconstrained firms range from 0.483 to 0.537 (with p-value<0.01), suggesting that constrained firms rely on cash holdings for investments to a greater extent than unconstrained firms. Together with Sections 3.1 and 3.2, the overall results show that firms prefer to use cash holdings as internal funds for investments over cash flows to avoid adjustment costs when they encounter investment friction, such as investment persistence and investment time lags. Constrained firms rely on cash holdings for investments to a greater extent than unconstrained firms, and the relationship between investments and cash holdings is strengthened when cash flows decline.

4.3.5. Cash holdings, debt issuance and payouts from 2009 to 2011

The previous section (Section 4.3.3) has shown that there seems to be a "pecking order" with regard to cash flow outlays for oil companies during the pre-crisis period: firms will accumulate cash reserves from cash flows if they are financially constrained. Unconstrained firms will use cash flows to repay debts and repurchase shares. The 2008 financial crisis caused not only declines in the cash flows of oil companies but also the deterioration of financing friction for all firms. In this section, we examine the cash flow policies of oil companies during the post-crisis period. To this end, we employ a similar empirical approach as that used in Section 4.3.3 with a system of equations consisting of Equations (4.2) through (4.5) with post-crisis sample through a similar partitioning of firms according to their financial constraint status. The regression results are reported in Table 4.7. Panels A through D of Table VII report the regression results of Equations (2) through (5), respectively, with the post-crisis sample. The dependent variables in Panels A through D are Δ*CH*, Δ*Debt*, Δ*Dividend* and Δ*Repurchase*, respectively. Columns 1 through 6 of each panel report the regression results of each equation by the partitioning of the post-crisis sample based on a firm's potential financial constraint level according to firm size, commercial paper ratings and bond ratings.

[Table 4.7 about here]

We next highlight the results that differ from those of the pre-crisis sample. First, unconstrained firms also save cash from cash flows during the post-crisis period. Two out of three coefficients of cash flows on cash holdings are positive and significant at 5% for unconstrained firms, suggesting that these firms will try to build up cash reserves from cash flows to maintain their cash holding levels because of declines in cash flows and the exacerbation of financing friction for external funds after the financial crisis. Second, unconstrained firms do not buy back shares after the financial crisis. Only one coefficient of cash flows on share repurchases is marginally significant at 10%, suggesting that the decline in cash flows after the financial crisis prevented firms from making payouts to shareholders through share repurchases.

The debt and dividend policies remain qualitatively the same as during the pre-crisis period. Cash flows are negatively related to net debt issuance for unconstrained firms, suggesting that they will try to raise more debt when cash flows decrease. For constrained firms, the relation between cash flows and net debt issuance is not economically or statistically significant, suggesting that constrained firms have difficulty accessing external funds after the financial crisis. As in the pre-crisis period, dividend policies are not sensitive to cash flow changes, which is consistent with the "sticky" nature of dividends.

The overall results from this section suggest that the cash flow policies of oil companies with regard to cash reserves and share repurchases are affected by the financial crisis during the post-crisis period. The results are also consistent with the "pecking order" theory. When cash flows decrease, unconstrained firms will save cash from cash flows and cut back on payouts to shareholders. Whereas unconstrained firms can still raise debt from external sources, the access of constrained firms to external funds is limited because of liquidity constraints imposed after the crisis.

4.4. Conclusions

In this paper, we study firms' investments with internal funds using a sample of U.S. oil companies before and after the 2008 financial crisis. We show that firms will prefer to use cash holdings for their investments over cash flows if they face real investment friction, such as investment plan time lags and high adjustment costs. By making investments with cash holdings at the beginning of the year instead of on contemporaneous cash flows, oil companies can avoid costly investment adjustments when cash flows fluctuate. We also investigate the cash flow policies of oil companies with regard to cash reserves, net debt issuance and payouts to shareholders. We show that there seems to be a "pecking order" with regard to the uses of cash flows. For constrained firms, the priority use of cash flows is for accumulating cash reserves. For unconstrained firms, cash flows will be used to repay debts and buy back shares when there are positive cash flow shocks.

The declines in cash flows and the imposition of liquidity constraints after the 2008 financial crisis affect the investments of oil companies based on internal funds as well as their cash flow policies. During the post-crisis period, capital expenditures become more sensitive to cash holdings than they were prior to the crisis. In addition, unconstrained firms save cash holdings from cash flows, raise debt and cut back on share repurchases to compensate for declines in cash flow after the crisis. In sum, this paper contributes to our understanding of how firms invest with internal funds when they face real investment friction and how they use cash flows in response to exogenous cash flow changes.

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Appendix 4.A: Variable Definitions

Variable	Definition
Cash (CH)	Cash and short term investment
Tobin's Q (Q)	Market value of assets divided by the book value of assets, or [total assets + market value of equity – book value of equity – deferred taxes] / total assets.
Leverage	The sum of long term debt and debt in current liabilities scaled by total assets
Size	The natural log of total assets in $M.
Cash Flow (CF)	Income before extraordinary items plus depreciation
Investment (I)	Capital expenditure
Net debt change (Δ Debt)	Issuance of long term debt net of long term debt reduction
Dividend	Dividend paid to common shares
Capital stock (K)	Net amount of property, plant and equipment)
Repurchase	Stock repurchase net of sales of common and preferred stock

Figure 1 Crude Oil Price 2003-2011

Figure 1 presents monthly crude oil price from 2003 to 2011. Monthly price is based on West Texas Intermediate level.

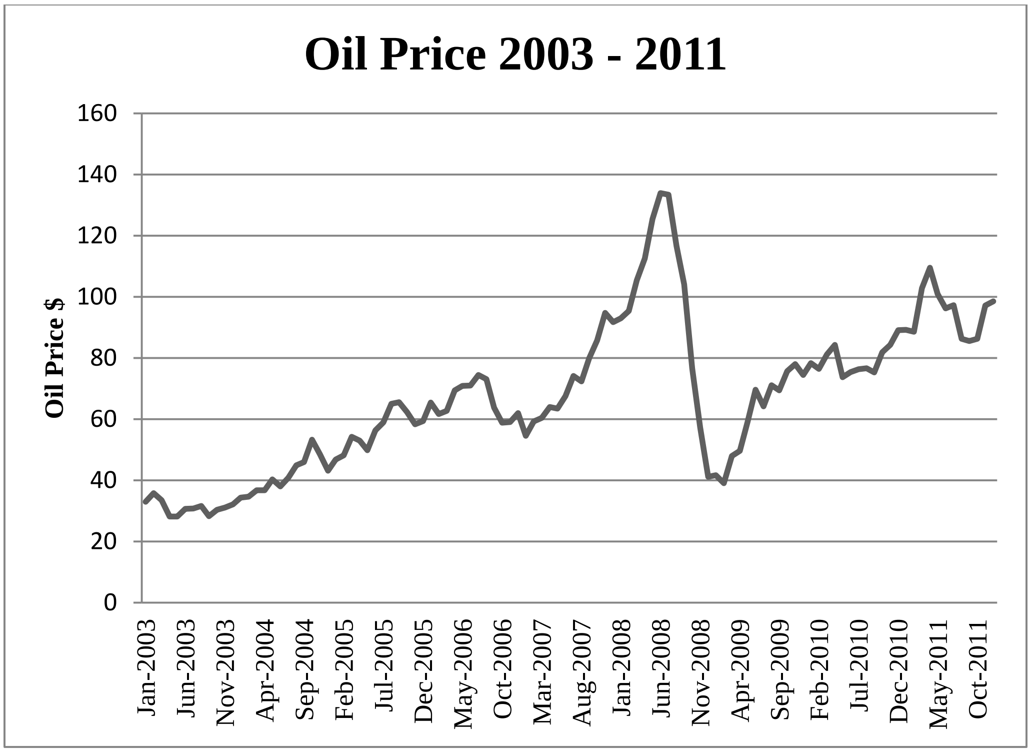

Table 4.1 Summary Statistics

This table presents the mean and standard deviation for some key variables used in this study. Full sample includes calendar years from 2003 to 2011 excluding 2008. Pre-crisis sample includes calendar years from 2003 to 2007. Post-crisis sample includes calendar years from 2009 to 2011. The definitions of variables are presented in Appendix. Cash flows, capital expenditures and cash holdings are scaled by the beginning of period capital stock (K) as in net amount of property, plant and equipment. *, **, *** represent statistical significance at 10%, 5% and 1% respectively.

Panel A (Full Sample)	Mean	Std. Dev.	5th	50th	95th
Cash Flow	0.152	0.378	-0.485	0.176	0.657
Capital Expenditure	0.398	0.489	0.025	0.263	1.225
Q	1.828	1.336	0.785	1.472	3.830
Cash Holding	0.184	0.429	0.012	0.046	0.834
Leverage	0.292	0.234	0	0.257	0.739
Size	6.178	2.147	2.586	6.234	7.583
Panel B (Pre-crisis)					
Cash Flow	0.193	0.397	-0.509	0.218	0.718
Capital Expenditure	0.458	0.532	0.032	0.310	1.361
Q	1.973	1.340	0.933	1.606	4.497
Cash Holding	0.196	0.442	0.014	0.048	0.908
Leverage	0.284	0.224	0	0.255	0.703
Size	5.933	2.113	2.515	5.973	9.687
Panel C (Post-crisis)					
Cash Flow	0.088	0.338	-0.439	0.124	0.534
Capital Expenditure	0.305	0.398	0.021	0.197	0.955
Q	1.612	1.302	0.683	1.271	3.463
Cash Holding	0.165	0.408	0.008	0.034	0.700
Leverage	0.304	0.248	0	0.262	0.773
Size	6.566	2.146	2.696	6.665	7.913

Panel D	Mean Comparison (pre- vs. post-crisis)
Cash Flow	0.104***
Capital Expenditure	0.153***
Cash Holding	0.031**
Leverage	0.020**

Table 4.2 Cash flows, cash holdings and investments from 2003 to 2007

This table presents OLS regression results of Equation (4.1) for U.S. oil companies from 2003 to 2007 with different specifications. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's Q. Tobin's Q is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	(1)	(2)	(3)	(4)	(5)
CFt / Kt-1	0.132	0.074	0.058	0.031	0.029
	(0.87)	(0.73)	(0.60)	(0.32)	(0.36)
Q t-1	0.152***	0.115**	0.109**	0.116**	0.118**
	(3.40)	(2.11)	(2.15)	(2.24)	(2.36)
CH_{t-1} / Kt-1		0.461***	0.498***	0.499***	0.487***
		(2.72)	(2.77)	(2.73)	(2.63)
Size t-1			-0.206**	-0.245***	-0.226***
			(-2.52)	(-2.88)	(-2.79)
$Leverage_{t-1}$				-0.431**	-0.429**
				(-2.38)	(-2.46)
I_{t-1} / K_{t-2}					0.436**
					(2.28)
Year Effect	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes
R-square	0.64	0.73	0.74	0.74	0.75
N	891	891	891	891	891

Table 4.3 Investments and financial constraint from 2003 to 2007

This table presents OLS regression results of Equation (4.1) for U.S. oil companies from 2003 to 2007 by partition of financial constraint status based on firm size, bond ratings and commercial paper ratings. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's Q. Tobin's Q is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Firm Size		Bond Rating		Commercial Paper Rating	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t / K_{t-1}	-0.086	0.041	-0.053	0.069	0.026	0.066
	(-0.90)	(0.58)	(-0.57)	(0.97)	(0.26)	(0.81)
Q_{t-1}	0.105	0.073**	0.114	0.132*	0.116	0.097**
	(0.94)	(2.02)	(1.06)	(1.87)	(1.21)	(2.28)
CH_{t-1} / K_{t-1}	0.514**	0.165**	0.497**	0.310*	0.505**	0.176**
	(2.56)	(2.30)	(2.59)	(1.73)	(2.37)	(2.16)
$Size_{t-1}$	-0.295**	-0.259***	-0.265**	-0.175**	-0.247***	-0.292**
	(-2.05)	(-3.53)	(-2.28)	(-2.26)	(-2.86)	(-2.21)
$Leverage_{t-1}$	-0.510*	-0.240**	-0.519*	-0.478**	-0.429**	-0.438**
	(-1.82)	(-2.15)	(-1.89)	(-2.19)	(-2.31)	(-2.01)
I_{t-1} / K_{t-2}	0.426**	0.440**	0.416**	0.452**	0.408**	0.467**
	(2.46)	(2.38)	(2.26)	(2.35)	(2.18)	(2.47)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.69	0.88	0.65	0.84	0.68	0.85
N	225	234	543	348	652	239

Table 4.4 Cash holding, debt and payout policy from 2003 to 2007

Panels A through D of this table present 3SLS regression results of Equations (4.2) through (4.5) respectively for U.S. oil companies from 2003 to 2007. The dependent variables of Panel A through Paned D are $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ respectively. $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ are defined as the change of cash holding, net long term debt issuance (difference between long term debt issuance and long term debt reduction), the change of dividend and the change of stock repurchase scaled by capital stock respectively. *CF* is defined as the firm cash flow deflated by capital stock. *Leverage* is defined as a firm's beginning period long term debt and debt in current liability scaled by its total assets. *CH* is defined as the firm's beginning period cash and short term investment deflated by capital stock. *Q* is defined as (market value of equity + book value of debt) / total asset. *Size* is the natural logarithm of total assets. *Div* is defined as the beginning period dollar amount of common share dividend scaled by capital stock and *Repurchase* is defined as the beginning period dollar amount of stock repurchase net of stock issuance scaled by capital stock. Sample is partitioned by a firm's total assets, commercial paper ratings and bond ratings. A firm is considered to be financially constrained if the firm's total asset is in the bottom quartile and unconstrained if the total asset is in the top quartile. A firm is considered to be financially constrained if the firm does not have commercial paper rating or bond rating. A firm is considered to be unconstrained if the firm has commercial paper rating or bond rating. Firm and year effects dummy are also included. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Panel A	Firm Size		Commercial Paper Rating		Bond Rating	
Δ CH_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.063***	-0.030	0.183**	-0.049	0.160**	0.039
	(2.61)	(-0.35)	(2.44)	(-0.01)	(2.41)	(0.51)
Q_t	0.006	0.003	-0.002	0.038	0.008	-0.003
	(0.93	(0.44)	(-0.14)	(0.11)	(0.65)	(-0.29)
$Size_t$	0.025	-0.001	-0.058	0.008	0.058	-0.002
	(0.52)	(-0.22)	(-0.44)	(0.08)	(0.43)	(-0.58)
CH_{t-1}	-0.308***	-0.261***	-0.205**	-0.567***	-0.350	-0.252***
	(-2.70)	(-4.19)	(-2.05)	(-2.62)	(-1.48)	(-5.74)
Δ $Debt_t$	-0.458	-0.195	-0.449	-0.268	-0.216	-0.216*
	(-0.89)	(-1.20)	(-0.39)	(-0.10)	(-0.49)	(-1.91)
Δ Div_t	0.01	-0.241	-0.085	-0.099	-0.872	0.918
	(0.68)	(-0.29)	(-0.41)	(-0.05)	(-0.46)	(0.47)

Δ $Repurchase_t$	-0.092	0.039	-0.515	0.344	0.295	-0.020
	(-0.36)	(0.54)	(-0.43)	(0.05)	(0.38)	(-0.18)
R-square	0.11	0.12	0.15	0.14	0.17	0.16

Panel B	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Debt_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.024**	-0.407***	-0.031**	-0.780**	-0.036***	-0.665***
	(-2.02)	(-3.83)	(-2.56)	(-2.58)	(-3.03)	(-3.38)
Q_t	0.001	-0.015	0.001	0.140	0.001	0.039
	(0.62)	(-1.37)	(0.66)	(0.88)	(0.46)	(1.34)
$Size_t$	0.013	-0.012*	0.010	-0.048	0.013***	-0.011
	(1.53)	(-1.65)	(1.42)	(-0.43)	(2.69)	(-1.38)
$Leverage_{t-1}$	0.013	-0.110**	-0.030**	-0.028**	0.006	-0.364***
	(1.00)	(-2.41)	(-2.31)	(-2.19)	(0.64)	(-3.30)
Δ CH_t	0.034	-0.168	-0.043	-0.116	-0.057	-0.224
	(0.34)	(-1.09)	(-0.44)	(-0.11)	(-0.58)	(-0.50)
Δ Div_t	0.815	-0.833**	-0.274	0.096	-0.339	-0.127*
	(1.22)	(-2.08)	(-1.07)	(0.46)	(-1.38)	(-1.74)
Δ $Repurchase_t$	-0.014	0.010	0.086	0.038	0.073	0.308
	(-0.20)	(0.06)	(1.51)	(0.44)	(1.31)	(1.20)
R-square	0.14	0.15	0.15	0.13	0.14	0.17

Panel C	Firm Size		Commercial Paper Rating		Bond Rating	
Δ Div_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.001	0.014	0.011	0.038	0.002	0.019
	(0.06)	(0.59)	(0.14)	(0.98)	(0.41)	(1.09)
Q_t	0.001	0.006***	0.001	-0.002	0.001	0.005**
	(0.41)	(2.77)	(0.07)	(-0.66)	(0.53)	(2.13)
$Size_t$	0.002	0.004***	-0.002	0.001	0.001	0.002**
	(0.24)	(2.73)	(-0.11)	(0.57)	(0.04)	(2.60)
Div_{t-1}	-0.473***	-0.328***	-0.367**	-0.307**	-0.214***	-0.151**
	(-4.94)	(-4.95)	(-2.21)	(-2.14)	(-3.20)	(-2.48)
Δ CH_t	-0.010	0.057	-0.021	-0.003	-0.007	0.037

	(-1.59)	(0.90)	(-0.15)	(-0.19)	(-0.61)	(1.18)
Δ $Debt_t$	-0.027	0.064	0.277	0.020*	0.034	0.072**
	(-0.42)	(1.12)	(0.13)	(1.65)	(0.26)	(2.47)
Δ $Repurchase_t$	0.004	-0.037*	-0.042	-0.027	-0.010	-0.041
	(0.93)	(-1.89)	(-0.15)	(-0.16)	(-0.85)	(-1.51)
R-square	0.16	0.18	0.14	0.19	0.12	0.17

Panel D	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Repurchase_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.010	0.443**	-0.078	0.774*	0.068	0.178**
	(0.074)	(2.24)	(-0.10)	(1.77)	(0.53)	(2.48)
Q_t	-0.007	-0.008	-0.005	-0.052	-0.010**	-0.054
	(-1.29)	(-0.51)	(-0.13)	(-0.91)	(-2.07)	(-1.48)
$Size_t$	-0.034	-0.008	0.230	0.015	-0.033	-0.007
	(-0.94)	(-0.76)	(0.10)	(0.73)	(-0.80)	(-0.52)
$Repurchase_{t-1}$	-0.478***	-0.487***	-0.667**	-0.648**	-0.459***	-0.534***
	(-5.24)	(-5.60)	(-2.14)	(-2.56)	(-3.43)	(-2.76)
Δ CH_t	0.077	-0.680	-0.087	-0.032	-0.055	-0.026*
	(0.27)	(-1.13)	(-0.09)	(-0.08)	(-0.18)	(-1.72)
Δ $Debt_t$	-0.019	-0.328	-0.337	0.404	0.358	-0.807
	(-0.39)	(-0.64)	(-1.00)	(1.03)	(0.39)	(-1.40)
Δ Div_t	0.391	0.912**	0.564	0.985	0.881**	0.850
	(1.30)	(2.16)	(1.08)	(1.03)	(2.50)	(1.41)
R-square	0.11	0.14	0.15	0.12	0.17	0.19
N	225	234	543	348	652	239

Table 4.5 Investments, cash flows, cash holdings from 2009 to 20011

This table presents OLS regression results of Equation (4.1) for U.S. oil companies with post-crisis sample from 2009 to 2011. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's *Q*. Tobin's *Q* is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	(1)	(2)	(3)	(4)	(5)
CF_t / K_{t-1}	0.086	0.072	0.062	0.059	0.046
	(0.60)	(0.43)	(0.33)	(0.21)	(0.24)
Q_{t-1}	0.132**	0.140**	0.114**	0.101**	0.109**
	(2.40)	(2.50)	(2.46)	(2.28)	(2.34)
CH_{t-1} / K_{t-1}		0.672***	0.699***	0.702***	0.692***
		(7.39)	(7.08)	(7.35)	(7.26)
$Size_{t-1}$			-0.142**	-0.121*	-0.130*
			(-2.27)	(-1.88)	(-1.90)
$Leverage_{t-1}$				-0.198**	-0.201**
				(-1.96)	(-2.01)
I_{t-1} / K_{t-2}					0.387**
					(2.36)
Year Effect	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes
R-square	0.74	0.78	0.79	0.80	0.82
N	531	531	531	531	531

Table 4.6 Investments and financial constraints from 2009 to 2011

This table presents OLS regression results of Equation (4.1) for U.S. oil companies from 2009 to 2011 by partition of financial constraint status based on firm size, bond ratings and commercial paper ratings. The dependent variables are I_t / K_{t-1}, which is defined as a firm's capital expenditures of year t deflated by year beginning capital stock (net amount of property, plant and equipment). Q_{t-1} is the year beginning Tobin's Q. Tobin's Q is defined as (market value of equity + book value of debt) / total asset. CF_t/K_{t-1} is defined as a firm's cash flows of year t deflated by year beginning capital stock. $Size_{t-1}$ is the beginning of period firm total asset in natural logarithm. CH_{t-1}/K_{t-1} is defined as a firm's cash and short term investment of year t-1 scaled by capital stock. $Leverage_{t-1}$ is defined as total liability divided by total assets. I_{t-1} / K_{t-2} is defined as a firm's capital expenditures of year t-1 deflated by year t-2 capital stock. Heteroskesdasticity robust t-statistics are in parentheses and clustered at firm level. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

	Firm Size		Bond Rating		Commercial Paper Rating	
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
	(1)	(2)	(3)	(4)	(5)	(6)
CF_t / K_{t-1}	0.092	-0.060	0.078	-0.033	0.062	-0.072
	(0.32)	(-1.14)	(0.21)	(-0.78)	(0.24)	(-0.40)
Q_{t-1}	0.094**	0.198**	0.085**	0.187**	0.099***	0.044
	(1.98)	(2.30)	(2.20)	(2.50)	(2.97)	(0.74)
CH_{t-1} / K_{t-1}	0.753***	0.216**	0.721***	0.205**	0.719***	0.236***
	(7.85)	(2.56)	(7.66)	(2.44)	(7.63)	(2.69)
$Size_{t-1}$	-0.255**	-0.077	-0.262**	-0.090	-0.139**	-0.206
	(-2.12)	(-1.61)	(-2.53)	(-1.50)	(-2.01)	(-1.30)
$Leverage_{t-1}$	-0.382	-0.578***	-0.292	-0.626***	-0.187	-0.382**
	(-1.17)	(-2.85)	(-0.93)	(-3.18)	(-0.87)	(-2.22)
I_{t-1} / K_{t-2}	0.354**	0.397**	0.402**	0.357**	0.336**	0.380**
	(2.12)	(2.26)	(2.38)	(2.21)	(2.41)	(2.19)
Year Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Effect	Yes	Yes	Yes	Yes	Yes	Yes
R-square	0.86	0.86	0.81	0.84	0.80	0.85
N	129	148	291	240	349	182

Table 4.7 Cash holding, debt and payout policy from 2009 to 2011

Panels A through D of this table present 3SLS regression results of Equations (4.2) through (4.5) respectively for U.S. oil companies from 2009 to 2011. The dependent variables of Panel A through Paned D are $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ respectively. $\Delta CH_{i,t}$, $\Delta Debt_{i,}t$, $\Delta Div_{i,t}$ and $\Delta Repurchase_{i,t}$ are defined as the change of cash holding, net long term debt issuance (difference between long term debt issuance and long term debt reduction), the change of dividend and the change of stock repurchase scaled by capital stock respectively. *CF* is defined as the firm cash flow deflated by capital stock. *Leverage* is defined as a firm's beginning period long term debt and debt in current liability scaled by its total assets. *CH* is defined as the firm's beginning period cash and short term investment deflated by capital stock. *Q* is defined as (market value of equity + book value of debt) / total asset. *Size* is the natural logarithm of total assets. *Div* is defined as the beginning period dollar amount of common share dividend scaled by capital stock and *Repurchase* is defined as the beginning period dollar amount of stock repurchase net of stock issuance scaled by capital stock. Sample is partitioned by a firm's total asset, commercial paper ratings and bond ratings. A firm is considered to be financially constrained if the firm total asset is in the bottom quartile, without bond rating or commercial paper rating. A firm is considered to be financially unconstrained if the total asset is in the top quartile, with commercial paper rating or bond rating. Firm and year effects dummy are also included. *, ** and *** indicate significance level at 10%, 5% and 1% respectively.

Panel A	Firm Size		Commercial Paper Rating		Bond Rating	
Δ CH_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	0.474**	0.118**	0.234***	0.067*	0.357**	0.126**
	(2.51)	(2.35)	(2.68)	(1.82)	(2.45)	(2.25)
Q_t	-0.196	0.001	-0.007	-0.046	-0.010	0.010
	(-0.20)	(0.02)	(-0.80)	(-1.15)	(-0.69)	(0.41)
$Size_t$	0.856	-0.001	-0.011	0.026	-0.009	-0.006
	(0.92)	(-0.12)	(-0.77)	(0.09)	(-0.58)	(-0.66)
CH_{t-1}	-0.307**	-0.100**	-0.101**	-0.646*	-0.139**	-0.677**
	(-2.35)	(-2.46)	(-2.57)	(-1.86)	(-2.00)	(-2.36)
Δ $Debt_t$	-0.154	-0.294*	-0.908	-0.794	-0.189	-0.229
	(-0.166)	(-1.79)	(-0.50)	(-0.46)	(-0.51)	(-0.35)
Δ Div_t	0.091	0.120	0.253	-0.866	0.199	-0.120
	(0.97)	(1.30)	(0.73)	(-0.23)	(0.60)	(-0.76)

Δ $Repurchase_t$	-0.212	-0.133	-0.404	-0.223	-0.527	0.224
	(-0.23)	(0.74)	(-0.64)	(-0.37)	(-0.57)	(0.99)
R-square	0.12	0.13	0.17	0.15	0.16	0.14

Panel B	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Debt_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.030*	-0.682**	-0.031	-0.656**	-0.040*	-0.392**
	(-1.72)	(-2.30)	(-0.80)	(-2.51)	(-1.72)	(-2.57)
Q_t	0.001	-0.067	0.007	-0.016	0.003	0.032*
	(0.81)	(-0.23)	(1.39)	(-0.22)	(1.35)	(1.76)
$Size_t$	-0.005	-0.004	0.010	0.046	0.003	0.003
	(-1.10)	(-0.07)	(1.57)	(0.17)	(0.70)	(0.05)
$Leverage_{t-1}$	-0.016	-0.202*	-0.010	-0.195**	-0.006	-0.087*
	(-0.14)	(-1.86)	(-0.32)	(-2.39)	(-0.38)	(-1.82)
Δ CH_t	0.095	-0.608	0.443	0.243	0.182	0.565
	(0.58)	(-0.28)	(1.04)	(0.32)	(0.84)	(0.86)
Δ Div_t	-0.586	-0.581	-0.241	0.177	-0.095*	0.083
	(-1.38)	(-0.29)	(-1.23)	(1.42)	(-1.80)	(1.37)
Δ $Repurchase_t$	0.141	-0.145	0.397	-0.476	0.251*	0.212
	(0.58)	(-0.25)	(1.56)	(-0.50)	(1.90)	(1.30)
R-square	0.13	0.12	0.13	0.11	0.17	0.19

Panel C	Firm Size		Commercial Paper Rating		Bond Rating	
Δ Div_t	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.002	0.008	0.004	0.032	0.010	0.006
	(-0.12)	(1.33)	(0.24)	(0.70)	(0.21)	(1.07)
Q_t	0.001	0.004	-0.001	0.001	-0.001	-0.002
	(0.68)	(0.34)	(-0.06)	(0.10)	(-0.08)	(-0.87)
$Size_t$	-0.002	-0.001	-0.002	-0.006	0.001	-0.001
	(-0.12)	(-0.02)	(-0.10)	(-0.71)	(0.05)	(-0.12)
Div_{t-1}	-0.078	-0.023	-0.104	-0.041	-0.279*	-0.069
	(-0.26)	(-0.49)	(-0.30)	(-0.45)	(-1.81)	(-1.38)
Δ CH_t	0.013	0.045	0.014	-0.004	0.011	0.111*

	(0.66)	(1.09)	(0.46)	(-0.12)	(0.25)	(1.73)
Δ $Debt_t$	-0.062	0.038	0.097	0.041	0.201	-0.015
	(-0.15)	(0.86)	(0.22)	(1.64)	(0.20)	(-0.26)
Δ $Repurchase_t$	0.012	0.006	-0.008	0.011	-0.021	0.006
	(0.27)	(0.35)	(-0.10)	(0.35)	(-0.13)	(0.29)
R-square	0.15	0.16	0.15	0.17	0.14	0.16

Panel D	Firm Size		Commercial Paper Rating		Bond Rating	
Δ $Repurchase_t$	(1)	(2)	(3)	(4)	(5)	(6)
	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained
CF_t	-0.083	0.135	-0.012	0.287	0.031	0.153*
	(-0.04)	(0.49)	(-0.05)	(0.14)	(0.27)	(1.67)
Q_t	0.004	-0.063*	0.014	-0.049	-0.002	-0.055
	(0.04)	(-1.83)	(0.15)	(-0.08)	(-0.16)	(-1.51)
$Size_t$	-0.065	0.021*	0.025	-0.118	-0.013**	0.005
	(-0.10)	(1.94)	(0.17)	(-0.14)	(-2.02)	(0.85)
$Repurchase_{t-1}$	-0.974**	-0.700**	-0.522	-0.281**	-0.600	-0.584**
	(-2.15)	(-2.56)	(-0.34)	(-2.16)	(-1.07)	(-2.15)
Δ CH_t	0.149	-0.109	0.171	0.462	0.363	0.433
	(0.10)	(-0.84)	(0.19)	(0.09)	(0.36)	(0.83)
Δ $Debt_t$	-0.65	-0.978*	-0.304	0.839	-0.841	0.052
	(-0.07)	(-1.94)	(-0.19)	(0.14)	(-0.19)	(0.13)
Δ Div_t	-0.341	0.602	-0.513	0.176	-0.223	-0.608
	(-0.49)	(0.23)	(-0.16)	(0.14)	(-0.06)	(-1.10)
R-square	0.12	0.13	0.17	0.14	0.16	0.21
N	129	148	349	182	291	240

Chapter 5

Conclusions

This thesis empirically investigates several important topics in empirical finance: CEO risk-taking incentives, syndicate bank loans, corporate investments, cash flows and cash holdings. Chapter 2 focuses on the relationship between CEO risk-taking incentives and the cost of syndicate bank loans and how relationship lending between borrowing firms and lending banks will affect such a relationship. Chapter 3 examines the relationship between CEO risk-taking incentives and the syndicate structure of bank loans, and the channels through which the relationship will be exacerbated or mitigated. Chapter 4 investigates corporate investments and the use of internal funds (e.g., cash flows and cash holdings) when firms face real investment friction and related cash flow policies before and after the financial crisis in 2008.

Each of these chapters is self-contained. The first essay investigates how CEO risk-taking incentives affect the cost of bank loans and, more importantly, how lending relationships provide an effective mechanism for attenuating the shareholder-creditor conflict of interest that arises from CEO risk-taking incentives. We find that firms with greater CEO risk-taking incentives have higher cost of bank loans. The results suggest that banks indeed consider CEO risk-taking incentives when pricing loans. We also show that the impact of CEO risk-taking incentives on loan cost is significantly lower for relationship loans than for non-relationship loans, which suggests that relationship lending attenuates bank sensitivity to CEO risk-taking incentives. In addition, our results suggest two channels through which relationship lending influences the impact of CEO risk-taking incentives on the cost of loans: it reduces the information asymmetry between lenders and borrowers and increases monitoring intensity through shorter loan maturities. Our results are robust to the endogeneity of lending relationship formation, simultaneous determinants of loan contract terms, and alternative measures of lending relationships. This essay presents new empirical evidence of the influence of CEO risk-taking incentives on loan contract terms. It also provides new insight into the importance of relationship lending by providing a channel through which relationship lending can benefit a borrowing firm and showing how these benefits can be translated into valuable gains for all firm stakeholders, including shareholders, creditors, and firm executives. Altogether, the results of this study can help us to better understand the interactions between the different contractual relationships within a firm and how best to optimize one contract when it is conditional on others.

The second essay explores how CEO risk-taking incentives of borrowing firms affect the syndicate structure for their syndicated loans. Excessive CEO risk-taking incentives are likely associated with asset substitution activities by shareholders and decreased debt value, which in turn necessitate more intensive monitoring by lenders. Therefore, we hypothesize that syndicate loans will have a concentrated structure and that lead arrangers will be required to hold large stakes in a syndicate when borrowing firms offer excessive risk-taking incentives to their CEOs. We find strong empirical evidence that the CEO risk-taking incentives (*vega*) of a borrowing firm will significantly affect the structure of its syndicated loans. Specifically, there will be fewer lenders and greater lender concentration, and lead arrangers will retain a greater portion of the loan if the CEO risk-taking incentives of the borrowing firm increase, all else being equal. Moreover, we investigate the channels through which the link between CEO risk-taking incentives and syndicate structure will be mitigated or exacerbated by identifying the factors that affect borrower moral hazard or syndicate moral hazard. CEO risk-taking incentives will have a smaller influence on syndicate structure if lead arrangers have a good reputation or a prior lending relationship with the borrowing firm. By contrast, CEO risk-taking incentives will have a greater influence on syndicate structure if the borrowing firm is informationally opaque, is experiencing financial distress or has low growth prospects. In summary, this essay contributes to our understanding of how CEO risk-taking incentives and the associated credit risk affect the structure of a syndicate loan when effective monitoring by financial institutions is required.

In the third essay, I study firms' investments with internal funds using a sample of U.S. oil companies before and after the 2008 financial crisis. I show that firms will prefer to use cash holdings for their investments over cash flows if they face real investment friction, such as investment plan time lags and high adjustment costs. By making investments with cash holdings at the beginning of the year instead of on contemporaneous cash flows, oil companies can avoid costly investment adjustments when cash flows fluctuate. I also investigate the cash flow policies of oil companies with regard to cash reserves, net debt issuance and payouts to shareholders. I show that there seems to be a "pecking order" with regard to the uses of cash flows. For constrained firms, the priority use of cash flows is for accumulating cash reserves. For unconstrained firms, cash flows will be used to repay debts and buy back shares when there are positive cash flow shocks. The declines in cash flows and the imposition of liquidity constraints after the 2008 financial crisis affect the investments of oil companies based on internal funds as well as their cash flow policies. During the post-crisis period, capital expenditures become more sensitive to cash holdings than they were prior to the crisis. In addition, unconstrained firms save cash holdings from cash flows, raise debt and cut back on share repurchases to compensate for declines in cash flow after the crisis. The overall results from this essay contribute to our understanding of how firms invest with internal funds when they face real investment friction and how they use cash flows in response to exogenous cash flow changes.

In summary, this thesis studies several important aspects in empirical finance and provides new evidence on the conflict of interests between shareholders and creditors arising from CEO risk-taking incentives and the effects on costs of bank loans, non-pricing bank loan terms and syndicate structures. The thesis also sheds lights on corporate investments with internal funds when firms face real investment friction such as investment time lags and investment persistence as well as related cash flow policies towards cash holdings, debt issuance and payouts to shareholders.