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Essays in empirical corporate finance: debt structure, cash holdings, and CEO compensation

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ESSAYS IN EMPIRICAL CORPORATE FINANCE:
DEBT STRUCTURE, CASH HOLDINGS, AND CEO COMPENSATION

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PH.D. THESIS

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To my parents and Jaesung

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ABSTRACT

This thesis consists of three essays and studies debt structure, cash holdings, and CEO compensation in empirical corporate finance. The first essay is sole-authored and is titled "How Do Firms Choose Their Debt Types?" The second essay, "Corporate Cash Holdings and Industry Risk," is a joint work with Jaewoo Kim and Erik Lie. The third essay is titled "Does Managerial Incentive Influence a Firm's Borrowing Diversity?" and is sole-authored.

In the first essay, we empirically investigate the joint determinants of a firm's debt types (i.e., bank debt, bonds-and-notes, capitalized leases, and convertible debt) using a simultaneous equation framework in which a firm's choice of a debt source is endogenous to other choices of debt sources. We find that firms with high growth opportunities and few tangible assets are more likely to depend on bank debt, and that firms with high profitability tend to use more convertible debt. We further examine the interactions between debt choices *within a firm*. Our research suggests that among a firm's debt components, bank debt has a complementary relation with bonds-and-notes, and that bank debt and convertible debt are substitutes. Finally, we examine the changes in composition of debt types across the market-to-book ratio and cash flow volatility quartiles. Our study shows that the proportion of firms using bank debt and convertible debt increases with firms' high growth opportunities. The propensity of using capitalized leases and convertible debt increases as firms are financially constrained or have severe asymmetric information problems; meanwhile, the propensity of using bank debt decreases.

In the second essay, we conjecture that a firm's sensitivity to industry shocks escalates its need to retain a cash buffer. Consistent with our conjecture, we find that a one standard deviation increase in a firm's industry risk exposure increases cash holdings by eight percent. In fact, industry risk has a greater effect on corporate cash holdings than economy-wide and idiosyncratic risk. The effect of industry risk is more pronounced for firms in competitive industries, firms with high leverage, and firms that are financially constrained.

Lastly, in the third essay, we empirically investigate how the structure of managerial compensation and corresponding incentives affect firms' borrowing diversity. We also explore which types of debt allow a CEO to have the flexibility to take more risks and provide more discretion in business decisions. We find that firms with higher CEO vega have lower borrowing diversity, and these firms increase the likelihood of convertible debt and capitalized leases issuances, relative to bank debt borrowing. Finally, after changes to the accounting standards (FAS 123R), we find that firms with higher CEO vega are more likely to issue capitalized leases and bonds-and-notes, but less likely to issue convertible debt. Our findings indicate that a CEO's risk-taking incentives affect a firm's debt structure and the adoption of FAS 123R has changed patterns of debt security choices.

PUBLIC ABSTRACT

This thesis consists of three essays and studies debt structure, cash holdings, and CEO compensation in empirical corporate finance. In the first essay, we ask whether a firm's usage of other debt sources affects its bank debt borrowing. We find that among a firm's debt components, bank debt has a complementary relation with bonds-and-notes, and that bank debt and convertible debt are substitutes. Our research confirms the following theoretical predictions. First, firms should use a combination of bank loans and public bonds-and-notes to decrease overall borrowing costs. Bank lenders can monitor firms' policy decisions closely, which helps to control managers' moral hazard problems. Moreover, the existence of a good banking relationship enhances a firm's ability to issue bonds-and-notes in the public debt market. Second, bank lenders' monitoring role can be partially accomplished by using convertible debt, which also helps to mitigate conflicts between shareholders and bondholders.

In the second essay, we find that if a firm is more easily influenced by events that affect the whole industry, its need for a cash buffer is greater and they increase their cash holdings. In fact, industry risk has a greater effect on corporate cash holdings than economy-wide and firm-specific risk. The effect of industry risk is more pronounced for firms in competitive industries, firms with high outstanding debt, and firms that are financially constrained.

Lastly, in the third essay, we empirically investigate whether and how a CEO's compensation structure influences the number of debt sources they borrow from. We find that compensation structure that motivates manages to take more investment risks (i.e., having higher "vegas") induces fewer borrowing channels. Moreover, these firms prefer to use convertible debt and capitalized leases rather than bank loans because both debt types allow a CEO to have the flexibility to take more risks and provide more discretion in business decisions. Our findings indicate that a CEO's risk-taking incentives affect a firm's debt structure and preferences of debt security choices.

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CHAPTER 1
HOW DO FIRMS CHOOSE THEIR DEBT TYPES?

1.1 Introduction

Many researchers have been asking the question: Should high-growth firms mainly rely on bank debt or borrow mainly from arm's-length investors? It is an important question because these firms have high investment potential for investors and high potential for moral hazard problems. Therefore, many researchers have particularly focused on the role of bank debt in the capital structure of these firms because bank lenders can closely and efficiently monitor the firms, and strong covenant restrictions in bank debt help to mitigate these agency conflicts. However, other theoretical studies have elaborated on this commonly held assumption and argued that the role of bank debt is important because the established relationship with banks allows firms to have other kinds of corporate financing options. For instance, Park (2000) argues that the existence of bank debt helps firms to establish credibility (reputation) in the capital market, allowing them to go to the capital market and issue bonds-and-notes. Furthermore, the presence of junior bonds-and-notes enhances the senior bank lender's incentive to monitor the firms. Park (2000) argues that, to a certain extent, firms should use a combination of bank loans and public bonds-and-notes in the presence of possible agency conflicts, which helps not only to reduce moral hazard problems but also to minimize overall contracting costs. Yet, despite the theoretical and empirical importance of a firm's usage of multiple debt types, previous research typically treats the use of debt types as *independent* and has overlooked complex debt structures and possible complementary and substitutionary interactions of existing debt types within a firm.

In this study, we pose a number of questions concerning the joint choices of debt types in order to re-investigate empirically how a firm's debt structure is determined. First, we ask, what are the empirical relations between firms' choices of debt types and firm characteristics after we control for the endogenous decisions regarding debt choices? Second, what are the relations among the jointly endogenous debt choices of bank debt, bonds-and-notes, convertible debt, and capitalized leases? Within a firm, is bank debt a substitute or complement for bonds-and-notes, and for convertible debt? To our knowledge, our paper is the first empirical investigation that accounts for the existing sources of debt that affect other debt choices.[1]

Answering the questions we pose can explain a number of puzzling findings about the effects of firm characteristics on the choice of debt types documented in the empirical literature. Our paper is closely related to Rauh and Sufi (2010), who find a spreading of the priority of debt structure across the distribution of credit-quality. Although it is not the primary focus of their study, they do examine the determinants of debt choices using OLS regressions, which assume a firm's choice of debt types is determined *individually*, not simultaneously. We argue that their methods could be problematic if there are interactions among debt choices and that we should account for the fact that firms use multiple debt types simultaneously.

Our dataset and methodology differ from Rauh and Sufi (2010) in that we use the Compustat database and focus on the joint determinants of debt types. While Rauh and Sufi (2010) hand-collected outstanding debt information for 305 rated firms from firms' 10-K filings, we construct a large panel data set that contains information on balance-sheet outstanding debt information (e.g., bonds-and-notes, bank debt, convertible debt, and capitalized leases) using the Compustat database. Our final sample consists of 57,644 firm-year observations for firms incorporated in the United States from 1980 to 2013. To investigate the *joint* determinants of debt structure, and find the substitute or complementary relations to each other, unlike Rauh and Sufi (2010), we use simultaneous equation methods in which bonds-and-notes, bank debt, convertible debt, and capitalized leases are endogenous variables.

[1] Rajan (1992), Houston and James (1996), and Faulkender and Petersen (2006) address a firm's choice between bank debt and public debt. However, their studies do not consider simultaneous usage of both debt types like we do in this paper.

We find overall results consistent with Rauh and Sufi (2010). However, after we control for the endogenous decisions regarding debt choices, we find that firms with high growth opportunities tend to use more bank debt—a result consistent with the theoretical prediction, but inconsistent with empirical evidence in Johnson (1997) and Rauh and Sufi (2010). Firms with high growth opportunities tend to use more convertible debt, which is also consistent with the theoretical prediction.[2] Furthermore, we find a negative relation between asset tangibility and bank debt, which is consistent with Berger and Udell's (1995) prediction that collateral is less important when there is a banking relation between the borrower and the lender, as bank monitoring can substitute for physical collateral. Unlike earlier studies, we find that profitability is positively related to convertible debt usage, which is consistent with the trade-off theory of capital structure.

In addition to re-investigating the literature's findings about the association between firm characteristics and the choice of debt types, this analysis allows us to investigate the possible relations—complementarity and substitutability—among four debt types: bank debt, bonds-and-notes, convertible debt, and capitalized leases. We emphasize that our view is different from many existing studies that focus on the determinants of each debt type across firm characteristics (e.g., small firms versus large firms for the choice of bank debt versus bonds-and-notes).[3] We examine interactions between debt choices *within a firm*. Our findings suggest that among a firm's debt components, bank debt has a complementary relation with existing bonds-and-notes. Our results do reflect a firm's actual financing patterns of including bank debt and bonds-and-notes together on its balance sheets, and are consistent with the theoretical predictions. A firm benefits from bank debt monitoring, which allows the firm to go to the public market and issue

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[2] See, for example, Jensen and Meckling (1976), Green (1984) for theoretical argument.

[3] Theoretical models in the literature often assume that the choice between public and private debt is discrete, thus implying their substitution. For example, Detragiache (1994) assumes that public debt and private debt are perfect substitutes, and argues that the choice between them depends on the costs of renegotiation in case of default. Furthermore, studies often argue that firms prefer bank debt over public debt to mitigate agency conflicts (Boot (2000)) and to reduce greater information asymmetry problems for small and young firms (Diamond (1984)).

bonds-and-notes (i.e., another funding source) and controls for moral hazard problems because it enables bank lenders to detect a firm's opportunistic behavior and punish it by liquidation or through renegotiation. Moreover, the presence of bonds-and-notes enhances the senior bank's incentive to monitor the firm's behavior. Thus, a combination of bank debt and bonds-and-notes achieves the optimal debt structure by minimizing overall contracting costs (Park (2000)). Similarly, Demarzo and Fishman (2007) also predict that firms should use a combination of bank debt and bonds-and-notes in the presence of agency problems (of managerial discretion).

We further find that bank debt and convertible debt are substitutes. Interestingly, this has rarely been discussed in the literature.[4] In fact, we observe that firm characteristic patterns are similar for the choice of bank debt and convertible debt, which supports this negative relation between the two debt types, and implies that a firm can choose one of them as an interchangeable alternative.[5] Moreover, empirically finding a negative relation between bank debt and convertible debt is meaningful because it confirms the theoretical argument that both bank debt and convertible debt are useful instruments to mitigate agency conflicts between shareholders and bondholders, and controlling managerial opportunistic behavior that deviates from shareholders' interests. The reasons are as follows: for bank debt, bank lenders have easier access to a firm's internal information, which entails greater monitoring and screening of borrowers (Diamond (1984, 1991), Hoshi, Kashyap, and Scharfstein (1993), Park (2000), and Boot (2000)). For convertible debt, a well-designed conversion option can control managers' corporate decision making process and induce them to make choices that balance bondholders' and shareholders' interests (Jensen and Meckling (1976), Green (1984), Jensen and Smith (1985), and Isagawa (2000)).

[4] To our knowledge, this has not been covered in widely-cited literature.

[5] Specifically, we find that a firm's profitability, growth opportunities, and firm size are positively and significantly associated with the predicted level of bank debt and convertible debt, while asset tangibility and cash flow volatility are negatively and significantly associated with the predicted level of bank debt and convertible debt.

Finally, our analysis allows us to examine the changes in composition of debt types across the market-to-book ratio and cash flow volatility quartiles. We find that firms' preference of using bank debt and convertible debt increases along with firms' high growth opportunities. However, the proportion of bank debt drops significantly in the firms with the highest growth opportunities. This evidence suggests that using both bank debt and convertible debt can mitigate the agency costs of debt for high growth firms. Moreover, it is optimal for firms to use less bank debt since an impaired senior lender's incentive to monitor is stronger if the bank's stake is smaller (Park (2000)). We further find that the proportion of using capitalized leases and convertible debt increases as firms are financially constrained or have severe asymmetric information problems, while the propensity for using bank debt decreases. This evidence suggests that when firms experience financial difficulties from financial distress or have severe information asymmetry problems, capitalized leases and convertible debt are rather easily accessible as financing sources, but bank debt is not attainable or these firms are dismissed from lenders' territories (i.e., rationed).

Therefore, our paper makes several contributions to the literature. The first is our consideration of the joint determinants of a firm's debt choices (i.**e.,** bonds-and-notes, bank debt, convertible debt, and capitalized leases) in a new way. While existing empirical research has explained a firm's debt choices independently (e.g., Rauh and Sufi (2010) and Erel, Julio, Kim, and Weisbach (2012)), ours considers how multiple choices of debt types are tightly linked.[6] Understanding the simultaneous determinants of debt structure could contribute to resolving endogeneity problems not addressed by current empirical studies, and to enriching capital structure literature which shows how a firm chooses particular types of debt as substitutes or

[6] For example, although Rauh and Sufi (2010) address the simultaneous use of different debt types, their test methods assume that each outstanding debt type is determined independently. Erel, Julio, Kim, and Weisbach (2012) look at security issuance in a multinomial logit regression framework by extending Denis and Mihov's (2003) study. Their focus is different from ours because they look at how macroeconomic conditions influence the likelihood of security issuance. In contrast, we examine how the overall cumulative amount of a given debt type influences the choice of other debt types (i.e., we examine a firm's debt structure).

complements. Most importantly, we are the first to find that bank debt and bonds-and-notes have a complementary relation, which challenges extant literature that assumes firms choose either bank debt or bonds-and-notes (e.g., Detragiache (1994), and King, Khang, and Nguyen (2011)). Second, our examination of the joint determinants of debt structure allows us to explain a number of puzzles in the literature. In particular, contrary to Rauh and Sufi (2010), we find that firms with high growth opportunities are more likely to rely on bank debt financing as bank debt monitoring can help mitigate agency problems, which is consistent with an implication in Myers (1977). The third contribution to the literature on debt choice is our use of the Compustat database over a much larger/longer time series sample, which is often based on the more limited Capital IQ database. We provide direct methods of extracting information regarding a firm's debt types using the Compustat database. Although Capital IQ provides researchers with detailed information about firm-level debt structure from 2002 onwards, the Capital IQ database is a narrow database because it has a limited time frame, and our study shows that it contains a lot of incomplete and missing data. Therefore, we use the much larger Compustat database for our study which includes data from 1980 onwards. Our analysis of the same firm data in Capital IQ and Compustat on debt structure components shows that they are close, and the Compustat data is acceptable to use for debt structure analysis. We further test a firm's debt structure using the Capital IQ database, and have results consistent with those from the Compustat database.

The remainder of our paper is organized as follows. Section 2 reviews prior literature that leads to the development of our hypotheses. Section 3 describes our sample construction, variables, descriptive statistics for the sample, and the estimation method. Section 4 presents the empirical results of our tests and discusses the findings in the context of previous studies. Section 5 presents robustness tests. Finally, Section 6 offers concluding remarks.

1.2 Related Literature and Hypotheses Development

In this section, we first provide an overview of debt structure (maturity, priority, and types), and then we selectively review theoretical and empirical studies in greater detail that primarily examine the choice of specific debt types. This research provides the foundation for our hypotheses. We include a literature review on the determinants of debt choices along with our discussion of results in Section 1.4.[7]

The basis of our hypotheses development builds on past several decades' research examining corporate capital structure. A tremendous amount of theoretical and empirical research has focused on the determinants of corporate capital structures in terms of measures such as the leverage ratio (Frank and Goyal (2009), and Lemmon, Roberts, and Zender (2008)). Recent empirical capital structure studies go beyond the debt-equity choice to focus on the various attributes of debt such as debt maturity (Barclay and Smith (1995a), Stohs and Mauer (1996), and Johnson (2003)), priority structures (Barclay and Smith (1995b), Brown and Marble (2006), and Hackbarth and Mauer (2012)), and covenants (Billett, King, and Mauer (2007) and Chava, Kumar, and Warga (2010)) in firms' capital structures. These attributes and others define debt structure. Based on priorities, market place, convertibility, and secured type, one can partition debt as senior debt versus subordinated debt (Barclay and Smith (1995b)), bank versus public debt (Denis and Mihov (2003)), convertible versus non-convertible debt (Isagawa (2000)) and secured versus unsecured debt (Brown and Marble (2006)). In this paper, we define debt structure as the composition of debt instrument types (e.g., bonds-and-notes, bank debt, convertible debt, and capitalized leases).

Role of bank lenders

Banks extract a firm's private information more efficiently than arm's length investors (Diamond (1984)), which implies that firms with high levels of information asymmetry are more

[7] Review papers for capital structure research: refer to Graham and Leary (2011) and for the choice between public and private debt: refer to Kale and Meneghetti (2011).

likely to depend on bank debt. There are two views on how banks use information.[8] The first view emphasizes the *ex post* use of information: bank lenders are good reorganizers, especially for financially distressed firms, because these firms need banks' help to restructure distressed loans, and in the renegotiation or liquidation processes. Hence, firms with high and stable cash flows, high profitability, high tangibility, and large size prefer public debt because they are less likely to be in financial distress and to need banks as reorganizers (Cantillo and Wright (2000)).

The second view emphasizes the *ex ante* use of information: bank lenders are good project screeners (Diamond (1991)). Firms with serious misalignments between managers and shareholders can benefit from bank debt financing because bank lenders' screening services can improve managers' investment decisions and significantly increase overall firm value. In these firms, for example, Hoshi, Kashyap, and Scharfstein (1993) predict that managers can extract private benefits and do not care much about shareholder value, and that this incentive can be controlled by bank monitoring and incentive compensation. Specifically, the manager of a firm with a high-profitability project chooses to borrow from banks who monitor and force him/her to invest efficiently, receives incentive compensation, and forgoes private benefits, while the manager of a firm with a low-profitability project uses public debt, insulates from monitoring, receives a flat reward, and extracts private benefits. In contrast, firms with minor incentive problems in selecting projects do not need to be monitored by a bank to ensure efficient investment and will choose public debt and avoid bank debt.

Bank Debt versus Public Debt

Most theoretical models assume that a firm's choice between bank debt and public debt is discrete and allow firms only one debt source, which implies that they are substitutes. For instance, Diamond's (1991) life cycle model predicts that firms with high credit quality borrow directly from the public debt market and avoid additional costs of bank debt associated with

[8] Cantillo and Wright (2000) provide helpful summaries regarding the role of intermediaries (i.e., bank lenders).

monitoring, firms with medium quality borrow from banks that provide incentives from monitoring, and the firms with lowest credit quality are rationed. Similarly, Bolton and Freixas (2000) predict that risky firms prefer bank loans and safe firms prefer to issue bonds in the public market. On the other hand, moral hazard models such as Park (2000) suggest that a firm should structure debt into multiple classes based on priority, and that the combination of a tough senior lender and soft junior lenders is the optimal debt contract. More specifically, in the optimal debt contract, banks get the first priority in the capital structure and their incentive to monitor borrowers become even stronger in the presence of junior debt (e.g., bonds-and-notes). Park's (2000) model also predicts that the bank lender's incentive is greater with smaller fixed claims, which is counterintuitive. Park's (2000) theory based on his intuition is as follows: compared to smaller fixed claims, debt with larger fixed claims becomes more "equity-like" because these bank lenders expect high upside potential (or risky investments) like equity holders do, they are reluctant to punish firms by liquidating the projects, and thus less likely to monitor borrowers.[9]

Although many empirical studies, like the theoretical studies, have assumed that a firm makes discrete choices of debt types[10], Johnson (1997)[11] and Rauh and Sufi (2010) have shown joint use of public and private debt. Rauh and Sufi (2010) empirically find that, relative to high-credit-quality firms, lower credit quality firms "spread" the priority of their capital structure between bank debt and subordinated debt, which suggests a "complementary" relation between bank debt and bonds-and-notes as firms' credit ratings deteriorate. Their findings are also consistent with Hackbarth and Mauer's (2012) model, which suggests that lower credit quality firms spread priority across debt classes.

[9] Park's (2000) model is discussed in great detail in Rauh and Sufi's (2010) paper.

[10] See, for example, Denis and Mihov (2003), Krishnaswami, Spindt, and Subramaniam (1999), and Rauh and Sufi (2010)).

[11] Johnson (1997) finds a widespread use of combinations of debt sources, about 73% of firms borrowing debt from at least two different debt sources. Moreover, about 41% of firms with long-term public debt also have bank debt.

Based on Park's (2000) theoretical model predictions and Rauh and Sufi's (2010) empirical findings, we propose the following hypothesis:

***Hypothesis 1**: Bank debt has a complementary relation to bonds-and-notes.*

Firms' growth opportunities

Myers (1977) argues that a firm's future investment opportunities can be viewed as call options. The value of these options depends on a firm's future discretionary investment decisions – whether the firm will exercise the call options optimally. With risky debt outstanding, the benefits from taking profitable investment projects are divided among shareholders and bondholders. In some cases, after the promised payments (i.e., principal and interest payments) to bondholders, the remaining benefits that go to shareholders are negative or lower than a normal return. Thus, if the firm has risky debt outstanding and managers act to maximize shareholder value rather than overall firm value, managers may be incentivized to pass up valuable investment opportunities, otherwise known as underinvestment problems.

With more growth options in the firm's investment opportunity set, the firm is more likely to face stockholder–bondholder conflicts. Myers (1977) suggests that a firm can control this incentive problem by several contracting mechanisms: by including a lower proportion of fixed claims in its capital structure (i.e., lower leverage), by shortening debt maturity, or by including restrictive covenants. Myers's model also implies that firms with high-growth opportunities can benefit more from bank loans because banks' monitoring role helps mitigate agency problems.

Moreover, Hoshi, Kashyap, and Scharfstein (1993) argue that reliance on bank debt is related to a firm's investment opportunities and the investment incentives of the firm's managers. Their model predicts a non-monotonic relationship between growth opportunities (Tobin's Q) and bank debt if managers' interests closely align with shareholders'. Specifically, for firms with high-growth opportunities, managers will select public debt financing because they would have sufficient incentive to select good projects and the need for monitoring is low. For firms with intermediate levels of growth opportunities, however, managers find that they can maximize their expected utilities by choosing bank debt with monitoring and investing in profitable projects rather than using public debt and investing in pet projects. But, for firms with low levels of growth opportunities, managers prefer to issue public debt and undertake their pet projects because they lose little from not taking profitable projects and they can insulate themselves from bank monitoring. By contrast, if managers care less about shareholder value, they do not have incentives to invest efficiently unless banks force them to do so. In this case, we would expect to see a monotonic increasing relationship between bank debt financing and growth opportunities.

Based on these studies, we propose the following hypothesis:

***Hypothesis 2**: Firms with high-growth opportunities are more likely to depend on bank debt.*

Many studies argue that firms with severe information asymmetry problems or those that are financially constrained are more likely to depend on lease financing or bank loans. For example, Sharpe and Nguyen (1995) hypothesize that firms can reduce the cost of external funds arising from asymmetric information problems through leasing, and find that firms facing high financial contracting costs are more likely to use leases. Additionally, Krishnan and Moyer's (1994) results indicate that as bankruptcy potential increases, lease financing becomes an increasingly attractive financing option. Their analysis suggests that leasing has lower associated bankruptcy costs relative to secured debt, and thus becomes (at some point) a preferred financing option for firms with a higher potential for financial distress or bankruptcy.

On the other hand, Chemmanur and Fulghieri (1994) argue that firms that are more likely to encounter financial distress prefer bank debt because they highly value the bank lenders' ability to renegotiate their debt in financial distress and thus, can avoid inefficient liquidation. Moreover, Hadlock and James (2002) find that firms are more likely to choose bank debt when their asymmetric information problems are elevated because banks' close access to firms' information can accurately price firms' real values.

Based on these studies, we propose the following hypothesis:

Hypothesis 3: *A firm's propensity to use capitalized leases and bank debt will increase with the expected costs of financial distress or information asymmetry problems.*

1.3 Data and Estimation Method

In this section, we discuss our sample construction, variables, sample description, and estimation method for our analysis.

1.3.1 Sample construction

We use the Compustat database to construct a sample of U.S. firms from 1980 to 2013. Consistent with previous capital structure studies, we exclude financial service firms (SIC code 6000-6999) and regulated utility firms (SIC codes 4900-4949). We further remove (1) firm-years with missing or zero values for total assets and total debt; (2) firm-years with market or book leverage outside the unit interval, where total debt (DLTT+DLC) is scaled by total asset (AT) for book leverage and by total asset plus market value of equity (PRCC_F*CSHO) for market leverage; (3) firm-years with less than zero percent or more than 100 percent of their total debt maturing after more than three years; (4) firm-years that have missing[12] or negative values for any of our debt types[13]; (5) firm-years that have zero or negative book values of equity (seq); (6) firm-years with less than 0 percent or more than 100 percent of total book capital for any of our debt types; (7) firm-years that have S&P Domestic Long-Term Issuer Credit Ratings equal to "SD (selective default)," "N.M.(not meaningful)," "D(default)," or "Suspended"; (8) firm-years that

[12] Missing values could sometimes mean $0, but we do not enter them as zero in our analysis. If a firm has positive debt that is not reported in the Compustat database, replacing missing values could distort the actual value of outstanding debt information.
[13] Variable definitions are introduced in Section 1.3.2.

have missing values for cash flow volatility, M/B, profitability, and tangibility. We require that firms have at least five years of valid data from 1980 to 2013. After excluding samples with missing information, our final sample consists of 57,644 firm-year observations involving 5,741 unique firms from 1980 to 2013.

For the purpose of robustness checks, we also merge the Compustat and the Capital IQ databases using GVKEY to collect detailed outstanding debt information from Capital IQ. We start with U.S. firms covered by both Capital IQ and Compustat from 2002 to 2013. We remove utilities and financial firms. We further remove (1) firm-years with missing values of total assets; (2) firm-years with missing value of total debt; (3) firm-years with market or book leverage outside the unit interval; (4) firm-years for which the absolute value of the difference between total debt as reported in Compustat and the sum of debt types as reported in Capital IQ exceeds 10% of total debt (as in Colla, Ippolito, and Li (2013)); (5) firm-years with less than 0 percent or more than 100 percent of their total debt maturing after more than three years; (6) firm-years that have zero or negative book values of equity (SEQ); (7) firm-years that have S&P Domestic Long-Term Issuer Credit Ratings equal to "SD (Selective Default)," "N.M. (Not Meaningful)," "D (Default)," or "Suspended." After excluding samples with missing information, our final sample consists of 17,083 firm-year observations or 1,555 firm-year observations depending on debt type information that we use from Capital IQ from 2002 to 2013.

Table 1.1 reports descriptive statistics for variables used in our joint determinants of debt structure analysis. We define and discuss the variable choices below.

1.3.2 Variables

1.3.2.1 Debt Outstanding Information: Endogenous Variables

We consider the joint determinants of a firm's debt choices in order to examine substitutionary and complementary relations among debt types. To do this, we break down a firm's total debt into four debt types and construct them (i.e., bank debt, convertible debt, capitalized leases[14], and bonds-and-notes). We construct and define balance sheet debt outstanding information using the Compustat database from 1980 to 2013. Most importantly, our bank debt information is imputed from Compustat as other long-term debt (DLTO) minus commercial paper (CMP). If the commercial paper information is missing, CMP is entered as a zero value. To verify whether our proxy represents a firm's bank debt precisely, in Section 1.5, we compare our bank debt proxy from Compustat with the actual amount of bank debt reported in the Capital IQ database, and we find a highly positive correlation (0.8365) between them. We further define convertible debt using the convertible debt (DCVT) variable in the Compustat database, and capitalized leases using the capitalized lease obligations (DLCO) variable, and finally, we define bonds-and-notes as the total debt (DLTT+DLC) minus the sum of bank debt, convertible debt, and capitalized leases. Each amount of debt is scaled by total capital following Rauh and Sufi's (2010) study, where total capital is defined as total debt (DLTT+DLC) plus the book values of shareholders' equity (SEQ).

1.3.2.2 Instruments

We use several different instruments for endogenous variables (i.e., bank debt, bonds-and-notes, capitalized leases, and convertible debt) in our regression models. The instruments include tax rate, tax loss carry-forward dummy, investment tax credits dummy, abnormal earnings, cash holdings, and bond rating dummy variables. As a proxy for the firm's marginal tax rate, we use the estimated before-financing marginal tax rate identified in Graham (1996) and available on John Graham's website. Years that are missing tax rates are filled in using piecewise linear interpolation. If this is not possible or if the firm is not in the dataset, we use the firm's

[14] Capitalized leases are different from operating leases. Operating leases are treated as operating costs in the income statement and off the balance sheet, while capitalized lease expenses are recorded as leased assets and corresponding debt obligations on the balance sheet. Therefore, signing a capitalized lease contract is like borrowing money to purchase leased assets, and the cash flow consequences of a capitalized lease and borrowing are similar. Hence, capitalized leases are considered alternative sources of financing while operating leases are not (Brealey, Myers, and Allen (2014)). In this study, we focus on capitalized leases and do not consider operating leases to analyze the determinants of debt structure on the right-hand side of the balance sheet.

effective tax rate, which is computed as the ratio of income tax paid to pretax income (Stohs and Mauer (1996)). As proxies for alternative tax shields that reduce the tax shield value of debt, we define two dummy variables. *I*(Loss carry-forward) is a dummy variable equal to one if the firm has any tax loss carry-forwards (TLCF) in a given year, and zero otherwise. In addition, *I*(Investment tax credit) is a dummy variable equal to one if the firm has any investment tax credits (ITC) in a given year, and zero otherwise. As a proxy for firm quality, abnormal earnings are defined as the difference between earnings per share in year t+1 minus earnings per share in year t, divided by the year t share price (Barclay and Smith (1995)). We measure corporate cash holdings as the ratio of cash plus marketable securities to the book value of total assets. *I*(Bond rated) is a dummy variable equal to one if the firm has a bond rating, and zero otherwise.

These instruments are well-known for being highly correlated with the choice of debt types or corporate total debt ratio in capital structure literature. We provide a brief discussion of instrumental variables that we use for predicting a firm's choice of debt types below.

Tax rate, I(Loss carry-forward), and I(Investment tax credit): Firms facing higher effective marginal tax rates should issue more debt that bears interest so that interest is fully deductible from taxable income, while firms with non-interest tax shields (e.g., tax loss carry-forward and investment tax credit) find higher leverage less valuable (DeAngelo and Masulis (1980)). Moreover, Graham, Lemmon, and Schallheim (1988) argue that tax incentives must be measured carefully and find that a firm's tax status is endogenous to financial policy based on their before-financing tax rates. Although there are not many studies that link tax effect and debt types, Barclay and Smith (1995b), and Sharpe and Nguyen (1995) find that low-tax-rate firms use relatively more capitalized leases, while Graham, Lemmon, and Schallheim (1998) find that capitalized leases are unrelated to marginal tax rates. Smith and Wakeman (1985) predict a positive relation between the tax loss carry-forward dummy and a firm's lease financing.

Abnormal earnings: Johnson (2003) finds that abnormal earnings are positively related to leverage, which is consistent with Ross's (1977) prediction that firms can use debt to signal optimistic future cash flows. Theoretical studies also predict that firms with positive future information issue claims with high priority (Harris and Raviv (1991)) and prefer short-term debt because it can be refinanced with better conditions after the information becomes public (Flannery (1986), and Diamond (1991, 1993)). Because firm's choices of debt types are highly correlated with debt priority and maturity structures, we also consider abnormal earnings (i.e., firm's quality measures) as an instrumental variable.

Cash holdings: As pointed out by Opler, Pinkowitz, Stulz, and Williamson (1999), most of the variables that are empirically associated with high cash holdings are also associated with low debt levels. For instance, Kim, Mauer, and Sherman (1998), and Opler, Pinkowitz, Stulz, and Williamson (1999) find a strong negative relation between cash holdings and leverage. Also, regarding the issuance of several debt sources, Erel, Julio, Kim, and Weisbach (2012) find that cash holdings are negatively related to bank loans and bonds-and-notes, but are positively related to convertible debt.

I(Bond rated): Several papers in the literature have used whether the firm has a bond rating as a proxy for a firm's access to public bond markets (e.g., Faulkender and Petersen (2006)), thus alleviating financial constraints (Whited (1992), Almeida, Campello, and Weisbach (2004), and Acharya, Almeida, and Campello (2007)). Moreover, Faulkender and Petersen (2006) find that firms with bond ratings have significantly higher leverage. Firms without bond market access are more likely to depend on bank debt (Kashyap, Lamont, and Stein (1994)), and financially constrained firms are more likely to rely on lease financing than financially unconstrained firms (Eisfeldt and Rampini (2009)).[15]

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[15] Eisfeldt and Rampini's (2009) study considers small firms, and firms that pay lower dividends and have lower cash flow, as financially constrained rather than using a bond rating dummy as a financially constrained proxy.

As seen in Table 1.2, we also find strong correlations between these instrumental variables and each debt type and leverage. We find that cash holdings are strongly negatively correlated with bank debt and bonds-and-notes, and the bond rating dummy is positively correlated with convertible debt and bonds-and-notes. Based on this set of instrumental variables, we search for the best instrumental variables that are highly correlated with the endogenous variables, while being uncorrelated with the disturbances in our model.

1.3.2.3 Control variables

We include basic determinants of capital structure as control variables used in previous studies: profitability, tangibility, M/B, firm size, and cash flow volatility (see, for example, Titman and Wessels (1988), and Rajan and Zingales (1995)). Profitability is the ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to the book value of total assets. Tangibility is the ratio of net property, plant and equipment (PPENT) to the book value of total assets. M/B is the market-to-book ratio, which is computed as: the sum of the book value of total assets, plus the market value of common stock, minus the book value of common stock, divided by the book value of total assets. Firm size is the natural log of the book value of total assets, where the book value of total assets is measured in constant 2008 dollars using the CPI. CF Volatility is the standard deviation of the first difference in EBITDA over the five years preceding and including the year in which a dependent variable is measured, scaled by the average book value of assets during this period. To account for possible differences and changes in the reliance on a particular type of debt through time and across industries, we also control for year and industry fixed effects in our analyses. Industry fixed effects are based on the Fama-French 48 industries classification. All continuous variables are winsorized at the 1^{st} and 99^{th} percentiles.

1.3.3 Sample description

Table 1.1 reports descriptive statistics for variables used in our joint determinants of debt structure analysis. The dataset comprises 57,644 firm-year observations for 5,741 unique firms. The average total debt to capital ratio is 34.9% in our sample. Bank debt makes up 8.2% of capital structure, and bonds-and-notes make up 22% of capital structure. We find that bank debt and bonds-and-notes comprise about 86.5% of the total debt ratio, suggesting the importance of bank debt and bonds-and-notes as debt financing sources.[16] Capitalized leases make up 1.4% and convertible debt is 2.8% of the capital structure. While the distributions of capitalized leases and convertible debt are skewed to the left (i.e., the mass of the distribution is concentrated on the right) and their standard deviations are small (0.038, 0.086 respectively), bank debt and bonds-and-notes have larger standard deviations of 0.139 and 0.202 respectively, and are widely distributed.

We note that sample firms generally have valuable investment opportunities based on an average market-to-book ratio of 1.713 and a median of 1.318. Because of a wide range of total asset values (the mean is $1,486 million, and the median is $163 million), we use the natural log of the book value of total assets in 2008 dollars. Finally, 22.7% of our sample firms have S&P Credit rating information available.

Table 1.2 reports Pearson correlation coefficients between the variables. Interestingly, bank debt is negatively correlated with capitalized leases, convertible debt, and bonds-and-notes. Note that these simple correlations are results before accounting for the interactions between several debt types, firm characteristics, and other instrument variables.

A number of correlations are notable between each debt type and control variables, and between each debt type and instrument variables. First, while tangibility is positively correlated with total debt, bank debt, capitalized leases, and bonds-and-notes, it is negatively correlated with convertible debt. Second, the M/B variable is positively correlated with convertible debt, but it is

[16] (0.082+0.220)/0.349 = 0.865

negatively correlated with total debt, bank debt, capitalized leases, and bonds-and-notes. These negative correlations are consistent with Myers's (1977) prediction that potential underinvestment problems negatively affect leverage. These opposing correlations reveal that firm characteristics such as tangibility and the M/B variable affect the choice of debt type positively or negatively depending on debt types and the importance of recognizing debt heterogeneity. Finally, cash holdings have high correlations among debt types. Cash holdings are positively correlated with convertible debt, but cash holdings are negatively correlated with total debt, bank debt, capitalized leases, and bonds-and-notes. As pointed out by Opler, Pinkowitz, Stulz, and Williamson (1999), most of the variables that are empirically associated with high cash holdings are also associated with low debt levels, which confirms these negative correlations.

1.3.4 Estimation method

In this paper, we argue that components of debt types in debt structure are simultaneously determined and that they are substitutes for and complements to each other. To account for the influence of other debt types on the choice of debt type, we estimate simultaneous equation models with bonds-and-notes, bank debt, convertible debt, and capitalized leases as endogenous variables.[17] Once we look at the joint determinants of debt structure, we can investigate whether the components are substitutes or complements, as well as how firm characteristics vary across different debt components.

Because the included endogenous variables in each equation are correlated with disturbance terms, the ordinary least squares (OLS) method provides inconsistent parameter

[17] When one empirically examines the determinants of these components in isolation, regression results could provide biased estimates and skew our understanding of actual firms' debt choices. For example, suppose one has a large universe of firms with high growth opportunities, half of which use bank debt, and half of which use convertible debt. If we assume that bank debt and convertible debt are substitutes, some firms will find it more cost effective to use bank debt, while others will find it more cost effective to use convertible debt. When an econometrician tests for a positive relation between bank debt and growth opportunities, he may get biased results. Specifically, we may observe that high growth firms use little bank debt. These results could be confounded because bank debt and convertible debt could be substitutes for one another, and high growth firms use convertible debt.

estimates. Thus, we adopt the instrumental variable technique to resolve these issues. More specifically, we use the method of two-stage least squares (2SLS), which is the most common method used for estimating simultaneous-equations models (Kennedy (2008)). The 2SLS methodology accounts for any correlations between the residuals of endogenous variables, and thus provides consistent parameter estimates under the valid instruments. Moreover, the 2SLS method focuses on one equation at a time without using all the information contained in the detailed specification of the rest of the model. By doing so, estimation results are less sensitive to model specification errors (Johnston (1984) and Kennedy (2008)).[18]

To examine the substitutive and complementary relation among different debt types, along with the determinants of debt structure, we estimate the following 2SLS baseline regression model:

First stage regressions:

$$Debt\ Type_{i,k,t} = \alpha_0 + \beta_0 X_{t-1} + \gamma Z_{t-1} + YearFE + IndustryFE + \varepsilon_{i,t}$$

Second stage regressions:

$$Debt\ Type_{i,k,t} = \alpha_1 + \delta \overline{DebtType_{i,-k,t}} + \beta_1 X_{t-1} + YearFE + IndustryFE + \varepsilon_{i,t}$$

The dependent variables—debt types: bank debt, capitalized leases, convertible debt, and bonds-and-notes—are calculated as a fraction of total book capital (debt plus equity at book values) following Rauh and Sufi (2010); $\overline{DebtType_{i,-k,t}}$ are the predicted values for the three debt types other than k from the first stage regressions; X is a set of exogenous variables including profitability, tangibility, M/B, firm size, and cash flow volatility; Z is a set of instrument variables

[18] In contrast to single-equation methods (e.g., 2SLS), system methods (e.g., 3SLS) use more information, and therefore result in more precise parameter estimates. However, the major disadvantage of system methods is that it is sensitive to model specification errors (Kennedy (2008)). Implementing system methods are much harder because there is not much literature that documents detailed determinants of a firm's debt choice so that we can construct correct economic models.

chosen from tax rate, tax loss carry-forward dummy, investment tax credits dummy, abnormal earnings, cash holdings, and bond rating dummy variables; and $\varepsilon_{i,t}$ is the residual term.

In the first stage, we regress each of the endogenous variables: bank debt, capitalized leases, convertible debt, and bonds-and-notes on all the exogenous variables (i.e., instruments and control variables) in the model, and calculate the predicted values of these endogenous variables. In the second stage, we regress each of the endogenous variables on the predicted values for the other three debt types (from the first-stage regressions) and control variables using OLS. By following Johnson (2003), all control and instrument variables except cash flow volatility and the abnormal earnings are measured at the fiscal year-end prior to the year in which the amount of each debt type is measured. We control for year and industry fixed effects in all models. Industry fixed effects are based on the Fama-French 48 industries classification.

For the instruments, as suggested by Greene (2002) and Kennedy (2008), we combine all the exogenous variables (i.e., control variables and instruments) to create a combined variable to act as a "best" IV. The best choices of instruments are variables that are highly correlated with the endogenous variables and are uncorrelated with the disturbances. We address these concerns later by testing whether our set of instrument variables passes tests for 1) relevant (Weak IV test: IVs are highly correlated with endogenous variables) and 2) exogenous tests (Over-identification test: IVs are not correlated with error terms).

1.4 Empirical Results

We report our findings on a firm's joint determinants of debt structures in Table 1.3. We first discuss the determinants of corporate debt choices (i.e., firm characteristics) estimated by 2SLS, and provide a brief discussion of the attributes, their relation to the optimal capital structure choice or choice of debt types, and their observable indicators (i.e., positive/negative relation to the predicted debt types) based on theoretical and empirical findings. We then compare the determinants of debt structures estimated by 2SLS with those estimated by OLS regression. We subsequently discuss the substitutability and complementary relations among our four debt types: bank debt, bonds-and-notes, convertible debt, and capitalized leases. Lastly, we analyze how a firm's growth opportunities and cash flow volatility influence debt type preferences.

1.4.1 Firm characteristics and their influences on debt choices

Table 1.3 reports regressions of the joint determinants of debt structure. We first discuss the influence of each control variable on the choice of debt type based on the results from Panel A in Table 1.3. The dependent variables in Models [1], [2], [3], and [4], are bank debt, capitalized leases, convertible debt, and bonds-and-notes scaled by the total book capitalization (D+E). The control variables in all regression models are based on Titman and Wessels (1988), and Rajan and Zingales (1995). These include profitability, tangibility, market-to-book ratio, firm size, and cash flow volatility. All of the regressions include industry fixed effects (based on Fama-French 48 industry classifications) and year fixed effects. The t-statistics in parenthesis below the parameter estimates are computed using robust standard errors.

In each equation of Panel A in Table 1.3, relations (some positive and some negative) between individual outstanding debt and firm characteristics (i.e., control variables) are not only statistically significant at 1% (or 5%) level, but also reasonably economically significant. For example, using the coefficient estimates from Model [1] in Table 1.3, the effect of a one standard deviation increase in profitability is to increase bank debt by about 0.005 (an increase of 6.14% versus the mean bank debt of 0.082). In a similar vein, a one standard deviation increase in M/B ratio (firm size) increases bank debt by about 9.24% (30.75%), and a one standard deviation increase in tangibility (cash flow volatility) decreases bank debt by about 49.66% (18.77%). Notice that absolute values of the coefficient on the M/B ratio seem to be very small (i.e., 0.006, 0.001, 0.003, and 0.018, respectively for Models [1]-[4]), but their economic influences are still significant (9.24%, 9.02%, 13.53%, and 10.33% respectively). Because we estimate each piece of debt type by controlling other existing debt types rather than estimating a total debt ratio (e.g., specifically, the average of bank debt is 0.082 (smaller), and the average of total debt is 0.349 (bigger)), it would increase the likelihood that the absolute values of the coefficient of each regressor will be smaller.

The results in Table 1.3 show that there are similar patterns of firm characteristics that determine choices of both bank debt and convertible debt. Specifically, we find that a firm's profitability, growth opportunities, and firm size are positively associated with the predicted level of bank debt and convertible debt, while asset tangibility and cash flow volatility are negatively associated with the predicted level of bank debt and convertible debt. On the other hand, we find that the patterns of firm characteristics that determine the bonds-and-notes and capitalized leases are similar and opposite to those for bank debt and convertible debt. Specifically, we find that a firm's profitability, growth opportunities, and firm size are negatively and significantly associated with the predicted level of bonds-and-notes and capitalized leases, while asset tangibility and cash flow volatility are positively and significantly associated with the predicted level of bonds-and-notes and capitalized leases. Below we discuss these associations between firm characteristics and leverage or debt types, if possible, based on existing academic findings.

Profitability: As a firm's profitability increases, bank debt and convertible debt increase, while bonds-and-notes and capitalized leases decrease.

Profitable firms generally have high expected marginal tax rates and high tax benefits of debt, thus profitability would be positively correlated with leverage under the tradeoff theory. However, profitability would be negatively correlated with leverage under Myers and Majluf's (1984) Pecking Order Theory, which argues that firms follow a pecking order when raising capital and prefer using retained earnings first, implying that more profitable firms will have lower leverage.

The negative coefficient on profitability determining bonds-and-notes and the positive coefficient on profitability determining bank debt are inconsistent with Cantillo and Wright's (2000) model, which predicts that firms with high profitability prefer public debt because they are less likely to be in financial distress and need bank support for the liquidation or renegotiation process. However, our results are consistent with Hoshi, Kashyap, and Scharfstein's (1993) prediction: in firms with severe agency conflict issues between managers and shareholders, firms with high profitability projects choose bank debt to discipline managers through bank monitoring. Moreover, our finding on the positive association between profitability and bank debt is consistent with Sufi's (2009) empirical study. He finds that firms with low profitability or high cash flow volatility are less likely to obtain a line of credit from banks (i.e., bank debt) and instead rely more on internal cash for their liquidity management. Meanwhile, as long as firms maintain high profitability thereby remaining compliant with bank covenants, bank credit lines are a viable liquidity substitute.

Tangibility: As tangible assets increase, bank debt and convertible debt decrease, while bonds-and-notes and capitalized leases increase.

Several prior studies have documented tangible assets as being useful in mitigating agency costs or in providing better collateral for financing, therefore resulting in a positive relation between tangibility and leverage. For example, Harris and Raviv (1990) argue that firms with more tangible assets have higher liquidation values, which reduces the cost of inefficient liquidation and increases optimal leverage.

The positive coefficient on tangibility determining bonds-and-notes is consistent with Hoshi, Kashyap, and Scharfstein's (1993) hypothesis that firms with tangible assets that can be used as collateral prefer to issue public debt. On the other hand, the negative coefficient of tangibility determining bank debt is consistent with Berger and Udell's (1995) findings that collateral is less important when there is a banking relationship between the borrower and the lender, as a bank's close monitoring of a firm's information can substitute for physical collateral. This supports Boot and Thakor's (1994) prediction. Additionally, Johnson (1997) and Denis and Mihov (2003) find that public debt issuers have more tangible assets than bank debt borrowers, and Krishanaswami, Spindt, and Subramaniam (1999) find a negative association between a firm's asset tangibility and bank debt reliance.

Essig (1991) finds that convertible debt use is negatively related to asset tangibility and argues that convertible debt should be particularly attractive to issuers facing potentially large costs of financial distress with lower levels of tangible assets.

Graham, Lemmon, and Schallheim (1998) find a positive relation between leasing and the fixed asset ratio. Because leasing contracts are usually tied to a specific fixed asset, firms using more fixed assets in the production process should utilize more lease financing.

M/B: As a firm's M/B ratio increases, bank debt and convertible debt increase, while bonds-and-notes and capitalized leases decrease.

We use the market-to-book ratio as a proxy for the firm's growth opportunities from high-quality projects (Smith and Watts (1992), and Barclay and Smith (1995)). Myers (1977) and Hart (1993) predict that firms with significant growth opportunities will use less leverage to avoid the underinvestment problem.

The positive coefficient on the M/B ratio determining bank debt and the negative coefficient on the M/B ratio determining bonds-and-notes are inconsistent with Diamond (1991) and Rajan (1992)'s models, in which firms with high-quality projects prefer public debt to bank debt because bank monitoring and control rights are less important for low-risk firms. However, our results are consistent with Yosha's (1995) and Hoshi, Kashyap, and Scharfstein's (1993) models. Yosha's (1995) model predicts that firms with high quality projects will prefer private debt (e.g., bank debt) and avoid issuing public debt (e.g., bonds-and-notes) in order to avoid the high costs of information disclosure and leakage of information about innovative projects to product market competitors. Hoshi, Kashyap, and Scharfstein (1993) predict that managers may choose public debt financing either because the need for bank monitoring is low (i.e., firms with high net worth and valuable investment opportunities) or as a way of insulating themselves from bank monitoring (i.e., firms with low net worth and low investment opportunities). However, if firms have a high degree of agency conflict between shareholders and managers and managers care less about shareholder value, they do not have incentives to invest in good projects efficiently unless banks force them to do so. In this case, we would expect to see a monotonic, increasing relationship, between bank debt financing and growth opportunities. In other words, firms with profitable investment opportunities rely more heavily on bank debt financing (Hoshi, Kashyap, and Scharfstein (1993)).

In empirical studies regarding growth opportunities and bank debt and bonds-and-notes, Krishnaswami, Spindt, and Subramaniam (1999) find a positive relation between a firm's M/B ratio and privately placed debt. Additionally, Houston and James (1996) find a positive relation between a firm's M/B ratio and bank debt among firms that borrow from multiple banks, but the relation is negative for firms with a single bank relation. In contrast, Johnson (1997) finds a negative and statistically insignificant (significant) relation between the reliance on public debt (bank debt) and the importance of growth options. Meanwhile, Denis and Mihov (2003) find that the M/B ratio is not a significant determinant of bank debt and bonds-and-notes.

The positive coefficient on the M/B ratio determining convertible debt is consistent with existing theoretical models and empirical findings. Jensen and Meckling (1976), Green (1984), and Kahan and Yermack (1998) argue that using more convertible debt helps resolve risk-shifting problems likely to arise when a firm has high investment opportunities. Consistent with these studies, Essig (1991), Lewis, Rogalski, and Seward (1999), and King and Mauer (2014) find that highly leveraged, high growth firms[19] are more likely to issue convertible debt. Financing growth

[19] Essig (1991) uses the R&D-to-sales ratio as a proxy for a firm's growth opportunities.

opportunities with convertible debt is beneficial for these firms because they can also reduce high debt levels from security conversions (i.e., from debt into equity).

Our findings of the negative coefficient on the M/B ratio determining capitalized leases indicate that firms with more growth opportunities use fewer fixed claims in the form of capitalized leases. Likewise, Barclay and Smith (1995) and Graham, Lemmon, and Schallheim (1998) find that market-to-book is negatively related to capitalized leases.

Overall, our findings are partially consistent with Myers (1977)'s model, which predicts that firms with more growth options in their investment opportunity sets should have a lower proportion of fixed claims in their capital structure (i.e., lower leverage) to limit the underinvestment problem. Our findings suggest that high growth firms tend to reduce their total leverage mainly from bonds-and-notes and capitalized leases, among other types of debt.

Firm Size: As firm size increases, bank debt and convertible debt increase, while bonds-and-notes and capitalized leases decrease.

Firm size may serve as a proxy for the cost of issuing other types of securities, or for the firm's investment flexibility and the diversification of its asset base. Size-based theories suggest that large firms are more likely to be debt-financed than small firms. This is because large firms tend to be more diversified, and have more collateral assets and stable cash flows, which implies that these firms have lower expected bankruptcy costs and higher optimal leverage.

With regard to the influence of firm size on a firm's choice of debt types, Fama (1985) argues that small firms tend to rely on bank debt because the cost of producing the information required for public debt financing is too high. On the other hand, large firms tend to rely on bonds-and-notes since it is less costly for them to produce the information required for public debt securities (Fama (1985)), and they can exploit economies of scale in issuing securities (Blackwell and Kidwell (1988)). Consistent with these predictions, several empirical studies find a positive relation between firm size and the reliance on public debt[20] and, thus, we would expect that firm size is negatively related to bank debt and positively related to bonds-and-notes.

However, the evidence in Table 1.3 indicates that as firm size increases, bank debt and convertible debt increase, while bonds-and-notes and capitalized leases decrease, which runs counter to our hypothesis. We argue that our results support the Pecking Order Theory of capital structure. Specifically, large firms are very profitable (correlation coefficient, ρ, between firm size and profitability in Table 1.2 is 0.352.) and when they have good investment opportunities, they use internal profitability first rather than external funds. However, when they need to use debt, the first types of debt they use are bank debt and convertible debt, and they do not use long-term debt like bonds-and-notes or capitalized leases. This is why the firm-size variable has a positive relation with bank debt and convertible debt, but a negative relation with bonds-and-notes and capitalized leases. Our results follow directly from the pecking order theory.

In large and dispersed ownership firms, where we can expect conflicts between shareholders and management to be more severe, managers may secretly seek private interests rather than working to maximize shareholder value. Thus, these firms are more likely than small firms to depend on convertible debt to control managerial opportunistic behaviors (Isagawa (2000)). Our findings support this prediction, and similarly, Mayers (1998) finds that within industries, large firms tend to issue callable convertible debt. In contrast, Essig (1991) reports that across industries, small firms tend to have high degrees of information asymmetries and less visibility to the public, and a tendency to use convertible debt. Firms with these characteristics can incur severe asset substitution problems, enhancing the need for convertible debt.

Furthermore, because of greater information asymmetries between firms and investors, smaller firms are likely to face higher costs for obtaining external funds. Sharpe and Nguyen

[20] See for example, Johnson (1997), Cantillo and Wright (2000), and Denis and Mihov (2003).

(1995) suggest that leases mitigate information asymmetry problems and provide lower financing costs. Thus, lease usage should be inversely related to firm size, consistent with our results.[21]

Cash flow volatility: As cash flow volatility increases—in other words, when a firm has high risk in the operational business in the market—bank debt and convertible debt decrease, while bonds-and-notes and capitalized leases increase.

We use cash flow volatility as a proxy for a firm's observable credit risk and the likelihood of financial distress. Johnson (1997) argues that "firms with more volatile earnings growth may experience more states where cash flows are too low for debt service, implying higher credit risk" and the likelihood of financial distress. In the presence of significant bankruptcy costs, firms with more volatile cash flows may experience difficulties in repaying debt and be expected to choose lower levels of debt, which would imply a negative relation between cash flow volatility and leverage (Bradley, Jarrell, and Kim (1984)). Moreover, a firm's volatile cash flows could make it more difficult to communicate with investors and exacerbate information asymmetry problems between a firm and its investors.

With regard to cash flow volatility's influence on a firm's choice of debt types, Berlin and Mester (1992), and Chemmanur and Fulghieri (1994) predict that firms that are more likely to encounter financial distress prefer bank debt because they highly value the bank lenders' ability to renegotiate their debt in financial distress; thus, they can avoid inefficient liquidation. Meanwhile, firms that are less likely to encounter financial distress may prefer public debt because they would not need to renegotiate it. Consistent with these predictions, Johnson (1997) finds a negative relation between earnings growth volatility and public debt. Additionally, Denis and Mihov (2003) find that firms facing a high likelihood of bankruptcy, indicated by an Altman Z-score less than 1.81, tend to use bank debt.

[21] Barclay and Smith (1995), and Graham, Lemmon, and Schallheim (1998) also find a negative relation between firm size and capitalized leases.

Our findings of the negative relation between cash flow volatility and bank debt and the positive relation between cash flow volatility and bonds-and-notes are inconsistent with the argument that bank debt is more valuable when the firm is more likely to be in financial distress (Berlin and Mester (1992), and Chemmanur and Fulghieri (1994)). However, our findings are consistent with Sufi's (2009) findings, which argue that cash-flow-based financial covenants associated with bank debt require firms to maintain high cash flows; therefore, firms with unstable cash flows or high cash flow volatility may prefer to avoid bank debt. Moreover, volatile changes in cash flows can trigger covenant violations in bank debt contracts and renegotiation processes, which would affect drops in bank debt outstanding and allowable borrowing from banks (Sufi (2009), and Roberts and Sufi (2009)). This suggests a negative relation between cash flow volatility and bank debt. While bank debt has more stringent and detailed restrictive covenants, bonds-and-notes have loose covenant restrictions (Berlin and Mester (1992)). Therefore, financing with bonds-and-notes would leave room for flexibility for firms with high cash flow volatility; thus, they would prefer bonds-and-notes.

Brennan and Schwartz (1988) assert that the value of convertible debt is relatively insensitive to the risk of the issuing company, suggesting that convertibles have their greatest value in firms with high market and earnings volatility. Consistent with this model, Essig (1991) finds that convertible debt use is positively related to the volatility of a firm's cash flows, which suggests that convertible debt is particularly attractive to issuers facing potentially large costs of financial distress. Our findings of a negative coefficient on cash flow volatility as related to convertible debt prove otherwise. Due to the equity-like characteristics of convertible debt, it is the most informationally sensitive among all debt securities (Rauh and Sufi (2010)). Furthermore, financing with convertible debt may increase the cost of external funds arising from a firm's severe asymmetric information (Myers and Majluf (1984)), which also supports our findings.

Lastly, the positive coefficient on cash flow volatility determining capitalized leases is consistent with the argument that financially constrained firms are more likely to depend on lease financing (Krishnan and Moyer (1994), Graham, Lemmon, and Schallheim (1998), and Eisfeldt and Rampini (2009)).

1.4.2 OLS versus 2SLS

So far, we have discussed the determinants of corporate debt choices based on results from the 2SLS method and found that firms' characteristics influence their choice of debt type in different ways. Interested readers may ask: your findings are quite different from many existing studies; is this because you assume a firm's choice of debt type is determined simultaneously, or are there other reasons? Indeed, like other studies (e.g., Rauh and Sufi (2010)), we examine the determinants of debt structure estimated by OLS regressions, which assumes a firm's choice of debt type is determined individually, not simultaneously. Table 1.4 reports regressions of determinants of debt structure estimated by OLS regressions. We run OLS regressions separately by following Rauh and Sufi's (2010) study.[22] The dependent variables in Models [1], [2], [3], [4], and [5] are total debt, bank debt, capitalized leases, convertible debt, and bonds-and-notes scaled by the total book capitalization (D+E). Panel A includes profitability, tangibility, market-to-book ratio, and firm size as control variables following Rauh and Sufi (2010). Panel B includes cash flow volatility in addition to these four variables. All of the regressions include industry and year fixed effects. The t-statistics in parentheses below the parameter estimates are computed using robust standard errors that are clustered at the firm level.

As shown in Panel A and Panel B of Table 1.4, we replicate Rauh and Sufi's (2010) OLS results and get mostly consistent coefficient signs. However, we find that larger firms tend to have a higher amount of total debt, bank debt, and bonds-and-notes. This could be due to sample differences because Rauh and Sufi (2010) use randomly selected 305 rated firms (2,453 observations), while our sample includes both unrated and rated firms.

[22] We replicate Table 1.3 results on page 4253 in Rauh and Sufi (2010).

Next, we compare each individual equation in the 2SLS (i.e., Table 1.3) and OLS test results (i.e., Table 1.4), and find several discrepancies in firm characteristics that determine bank debt, and convertible debt between the two methods. In the 2SLS tests, we find opposite signs on tangibility (-) and on the market-to-book ratio (+) in the bank debt equation, yet Rauh and Sufi (2010) find that firms with high asset tangibility depend on bank debt, and firms with high growth opportunities are less likely to depend on bank debt. Furthermore, we have a positive coefficient sign on the profitability variable that determines convertible debt, yet Rauh and Sufi (2010) find that firms with high profitability are less likely to depend on convertible debt.

Indeed, controlling for the interactions of other debt types in the choice of debt type—which changes our current understandings of a firm's debt structure, i.e., the relations among corporate debt choice decisions and various firm characteristics—gives us totally different interpretations of a firm's debt choices, and challenges the existing literature's empirical findings that do not account for the influences of other debt types on the choice of debt type (e.g., Denis and Mihov (2003), Krishnaswami, Spindt, and Subramaniam (1999), and Rauh and Sufi (2010)). As theory suggests (e.g., Diamond (1991, 1993), Park (2000), DeMarzo and Fishman (2007), and Hackbarth, Hennessy, and Leland (2007)), we emphasize that firms simultaneously use several debt types, which should be accounted for in the empirical studies.

1.4.3 Firm's joint determinant of debt structures

Here, we come back to Table 1.3 and investigate the possible relations among four debt types: bank debt, bonds-and-notes, convertible debt, and capitalized leases. Table 1.3 reports the results of pooled simultaneous equation regressions for four debt types estimated using two-stage least squares. The dependent variables in Models [1], [2], [3], and [4], are bank debt, capitalized leases, convertible debt, and bonds-and-notes scaled by the total book capitalization (D+E). The predicted values of bank debt, capitalized leases, convertible debt, and bonds-and-notes are computed from the first stage regressions of these variables on all of the independent variables plus the instruments {tax rate, cash holdings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)} for Panel A, and {tax rate, abnormal earnings, cash holdings, *I*(tax loss carry-forward), *I*(bond rated)} for panel B. The first-stage regressions used to generate the predicted values of each debt types are not reported. Both results in Panel A and Panel B of Table 1.3 show consistent patterns regarding the relations among the four debt types and firm characteristics. Therefore, we focus our discussion on the Panel A regression results with higher explanatory power (R^2). All control and instrument variables except cash flow volatility and the abnormal earnings are measured at the fiscal year-end prior to the year in which the amount of each debt type is measured (Johnson (2003)).

Models [1]-[4] from Panel A in Table 1.3 account for the endogenous choice of bank debt, capitalized leases, convertible debt, and bonds-and-notes using instrumental variable (2SLS) regressions. We report tests for whether our set of instrument variables—{tax rate, cash holdings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)}—are relevant (i.e., correlated with the endogenous regressors, bank debt, capitalized leases, convertible debt, and bonds-and-notes) and whether the instruments are exogenous (i.e., uncorrelated with the error terms in the second stage regressions). To assess whether the instruments are weak, we use the Cragg-Donald Wald F-statistics of the reduced form equations (i.e., the additional explanatory power of the instruments in the first stage regressions for bank debt, capitalized leases, convertible debt, and bonds-and-notes). Following standard convention (see, e.g., Baum et al. (2003), and Wooldridge (2009)), because computed Cragg-Donald Wald F-statistics are 12.249, 17.704, 14.763, and 9.179 (close to 10) in the reduced form equations for bank debt, capitalized leases, convertible debt, and bonds-and-notes, respectively, and exceed 10, we conclude that our instruments are not weak. Next, since we have five instruments and three endogenous regressors in each 2SLS regression, we use Hansen's test for overidentifying restrictions to assess whether the instruments are uncorrelated with the error terms. As reported at the bottom of Panel A, none of the p-values for the Hansen's over-identification test fail to reject the null hypothesis that the instruments are uncorrelated with the regression error term in each choice of debt types, which supports the validity of instruments. Both test results confirm that our instrumental variables help control for interaction effects among debt choices and that our parameter estimates are reliable and not biased.

As seen in Table 1.3, we have six pairs of relations between the four debt types (${}_4C_2 = 6$) in these regressions. We find a positive relation between bank debt and bonds-and-notes, a negative relation between bank debt and convertible debt, a negative relation between capitalized leases and bonds-and-notes, a positive relation between bank debt and capitalized leases, a positive relation between capitalized leases and convertible debt, and a positive relation between convertible debt and bonds-and-notes. In the following section, we focus the discussion on the theoretical motivations for the first three relations among the six pairs, and readers can infer the remaining three.

1.4.3.1 Bank debt and Bonds-and-notes: a positive relation

In Models [1] and [4] In Table 1.3, we show that in the bank debt equation, the coefficient on bonds-and-notes is positive and significant at the one percent level, and so is the coefficient on bank debt in the bonds-and-notes equation. To gauge the economic significance of these estimates, we calculate the effect of a one standard deviation change in bank debt on bonds-and-notes. We scale bank debt and bonds-and-notes by total book capitalization (D+E). Based on the coefficient estimates from Model [1] in Table 1.3, a one standard deviation increase in bonds-and-notes increases bank debt by about 0.063 (an increase of 77% versus the mean bank debt of 0.082). In contrast, a one standard deviation increase in bank debt increases bonds-and-notes by about 0.440 (an increase of 200% versus the mean bonds-and-notes of 0.220) in Model [4]. The effects of bank debt and bonds-and-notes appear to be large and economically significant. In sum, our results indicate that bonds-and-notes and bank debt are complements in general and the relation is economically significant for our sample.

The positive relation between bank debt and bonds-and-notes is consistent with Park (2000)'s model. Park (2000) predicts that in the presence of high moral hazard, firms are more likely to use a combination of senior bank debt and other junior debt (e.g., bonds-and-notes) to lower contracting costs. More specifically, banks' superior access to information and monitoring mitigate moral hazard problems in firms because it enables bank lenders to detect any opportunistic activities by corporate insiders, and to punish firms either by liquidation or through renegotiation. Simultaneously, the presence of junior bonds-and-notes enhances the senior bank's incentive to monitor, and the bank has stronger incentive if its stake is smaller. While this theory sounds counterintuitive, Park (2000) describes his reasoning as follows: bank monitoring "serves as a deterrent to moral hazard, and as such, it is carried out to identify and liquidate a bad project, not to raise the going concern value of a project." In other words, if an impaired senior lender claim becomes larger in the borrower's capital structure, the lender is more reluctant to liquidate the bad projects and punish the borrower, and wants to continue the risky projects because their full returns will be much more impaired by liquidation. Therefore, using both bank debt (with smaller claims) and bonds-and-notes (with larger claims) is the optimal structure of debt contracts because it controls for moral hazard problems from monitoring and the bank lender's incentive is greater with smaller fixed claims (Park (2000)). In addition, our results are also consistent with Demarzo and Fishman's (2007) predictions that the optimal contract can be implemented by a combination of equity, long-term debt, and a line of credit (a component of bank debt) in the face of agency problems. In their model, an agent has incentive to divert a firm's cash flow for his own private benefits, and this combination of securities helps smooth out his expected future compensations under uncertain (i.e., high/low cash flows) business outcomes. Both papers support our findings from a theoretical perspective.

Our study also gains empirical support from Rauh and Sufi's (2010) study. They find that many firms use different types of debt simultaneously and tend to use both secured bank debt with tight covenants and subordinated non-bank debt with loose covenants as their credit quality deteriorates. In sum, firms use bank debt and bonds-and-notes together, and this combination helps firms to mitigate agency conflicts between managers and creditors.

1.4.3.2 Bank debt and Convertible debt: a negative relation

In Models [1] and [3] in Table 1.3, we show that in the bank debt equation, the coefficient on convertible debt is negative and significant at the one percent level, and so is the coefficient on bank debt in the convertible debt equation. This indicates that bank debt and convertible debt are substitutes. In economic theory, substitute relations imply that firms perceive similar or comparable characteristics between bank debt and convertible debt; thus, having more bank debt makes them want less convertible debt and usually the demand for bank debt will increase when the cost of borrowing money from convertible debt rises, and vice versa. Moreover, convertible debt has an economically significant effect on bank debt: a one standard deviation increase in convertible debt decreases bank debt by about 0.143 (a decrease of 175% versus the mean bank debt of 0.082) in Model [1]. In contrast, a one standard deviation increase in bank debt decreases convertible debt by about 0.083 (a decrease of 295% versus the mean convertible debt of 0.028) in Model [3].

Why are bank debt and convertible debt substitutes? First of all, recall that we have similar firm characteristics that determine the choice of bank debt and convertible debt: we find that a firm's profitability, growth opportunities, and firm size are positively and significantly associated with the predicted level of bank debt and convertible debt, while asset tangibility and cash flow volatility are negatively and significantly associated with the predicted level of bank debt and convertible debt. This supports the negative relation between bank debt and convertible debt, and implies that a firm can choose one of them as an alternative.

Given the comparable firm characteristics determining both debt types, are there any similarities between bank debt and convertible debt as economic theory suggests? Yes, and it is also well-known that bank debt and convertible debt are useful instruments to resolve agency problems in firms. For example, the banking literature argues that bank lending, which entails greater monitoring and screening of borrowers, is effective at mitigating agency conflicts (Diamond (1984, 1991), Hoshi, Kashyap, and Scharfstein (1993), Park (2000), and Boot (2000)). Specifically, banks' easier access to firms' information and its rich set of covenant restrictions help control potential conflicts of interest and reduce agency costs.

Due to its convertibility (having both debt and equity characteristics gives it a hybrid nature), convertible debt can be used to adjust firms' debt levels, and help firms to avoid under-investment and restrict over-investment at the same time. Hence, well-designed callable convertible debt has an important role in controlling managerial opportunistic behavior, a feature that neither common debt nor equity has, and reduces conflicts between shareholders (i.e., firm owners) and management (Isagawa (2000)). In the same vein, Jensen and Meckling (1976), and Green (1984) discuss that firms issue convertible debt in order to reduce agency costs resulting from conflict between shareholders and bondholders. More specifically, Jensen and Smith (1985) provide detailed information about conversion options in convertible debt: normally, stockholders have incentives to take some unprofitable but variance-increasing projects; however, these "risk taking activities increase the value of the conversion option and thus reduce the gains to existing stockholders from taking high-risk projects by transferring part of the gains to convertible bondholders." This shareholders' incentive motivates firms with convertible debt to turn down negative NPV projects, which eventually reduces agency costs. In sum, these two debt types—bank debt and convertible debt—are working as substitutes for each other as a control mechanism for agency problems between shareholders and bondholders or management.

1.4.3.3 Bonds-and-notes and Capitalized leases: a negative relation

In Models [2] and [4] in Table 1.3, we see that the coefficient on bonds-and-notes is negative and significant at the one percent level in the capitalized leases equation, and the coefficient on capitalized leases in the bonds-and-notes equation is negative and significant. This indicates that capitalized leases and bonds-and-notes are substitutes. Moreover, the negative relation between bonds-and-notes and capitalized leases is economically significant. In Model [2], a one standard deviation increase in bonds-and-notes decreases capitalized leases by about 0.009 (a decrease of 64.9% relative to the mean of capitalized leases of 0.014). Although 0.009 seems to be small, it has an economically significant impact when we consider that the overall mean for capitalized leases is 0.014. In contrast, a one standard deviation increase in capitalized leases decreases bonds-and-notes by about 0.803 (a decrease of 365% relative to the mean of bonds-and-notes of 0.220) in Model [4].

The negative relation between bonds-and-notes and capitalized leases suggests that they are substitutes. Why are bonds-and-notes and capitalized leases substitutes? As noted before, the patterns of firm characteristics that determine bonds-and-notes are similar to those that determine capitalized leases[23], which implies that firms make decisions based on their preference by considering trade-offs between their costs and benefits. Both debt types require a long-term commitment, which suggests that they can be substitutes for each other in terms of contract length. Moreover, the negative relation between bonds-and-notes and capitalized leases also gains empirical support from existing studies.[24] For instance, Marston and Harris (1988) find that changes in the debt ratio and lease ratio for individual firms are inversely related, which confirms that debt and capitalized leases are substitutes. In addition, leasing is a more attractive financing option for firms with a higher potential for financial distress or bankruptcy (Krishnan and Moyer (1994), Graham, Lemmon, and Schallheim (1998), and Eisfeldt and Rampini (2009)). Thus, leasing is often perceived as a *substitute* for debt (bonds-and-notes) for firms that are too risky or are unable to access conventional debt markets (Lease, McConnell, and Schallheim (1990)).

[23] We find that a firm's profitability, growth opportunities, and firm size are negatively and significantly associated with the predicted level of bonds-and-notes and capitalized leases, while asset tangibility and cash flow volatility are positively and significantly associated with the predicted level of bonds-and-notes and capitalized leases.
[24] In contrast, Ang and Peterson, in "The Leasing Puzzle" (1984) find that debt and lease financing are complements and not substitutes.

1.4.3.4 Others

So far, we have found a positive relation between bank debt and bonds-and-notes, a negative relation between bank debt and convertible debt, and a negative relation between capitalized leases and bonds-and-notes. Specifically, we have discussed 1) bank lenders' monitoring roles along with bonds-and-notes, 2) the comparable economical features and similar firm characteristics determining both bank debt and convertible debt as well as determining both bonds-and-notes and capitalized leases. Based on these findings, readers could infer the other three relations – a positive relation between bank debt and capitalized leases, a positive relation between capitalized leases and convertible debt, and a positive relation between convertible debt and bonds-and-notes. Thus, we do not discuss those relations further in our paper.

1.4.4 Firm's growth opportunities and debt structure

In this section, we analyze how a firm's growth opportunities influence debt type preferences. Table 1.5 reports the average percentage in each debt component across the market-to-book ratio quartiles. In the first five rows, each amount of debt is scaled by total book capital and in the next four rows, each amount of debt is scaled by total debt. To visualize this information in Table 1.5, we include Figure 1.1 and Figure 1.2. Figure 1.1 shows the total leverage information (%) across the market-to-book ratio quartiles. As the market-to-book ratio moves from the 1st to 2nd quartile, the average leverage increases from 37% to 41%. However, after the 2nd quartile in market-to-book ratio, the average leverage decreases to 35%, and to 26% in the 3rd and 4th quartile. Our findings suggest that the relation between leverage and the market-to-book ratio is not linear and forms an inverse-U shape. When firms have low growth opportunities, they are more likely to have high leverage, but when firms have high growth opportunities, their dependence on debt lessens. The negative relation between leverage and high growth firms is consistent with Myers's (1977) prediction. Myers (1977) argues that firms with high growth opportunities are more likely to face shareholder and bondholder conflicts, which could induce underinvestment problems. He suggests that firms can mitigate these problems by using less leverage. Moreover, the negative relation between leverage and high growth opportunities also confirms that shareholder and bondholder conflicts are economically important (Hackbarth and Mauer (2012)).

Figure 1.2 shows the average proportion of debt types across the market-to-book ratio quartiles. Here, we use the debt structure information scaled by total debt in Table 1.5. As we can see in Figure 1.2, we do not find significant patterns in bonds-and-notes and capitalized leases across the market-to-book ratio quartiles. However, as firms' growth opportunities increase from the 1st to 4th quartile, the dependence on bank debt increases to 21.10%, 22.70%, 23.30%, and then decreases to 17.60%. Meanwhile, the dependence on convertible debt increases to 4.30%, 6.60%, 7.90%, and 9.40% respectively. These findings imply that the propensity to use bank debt and convertible debt increases as firms are given high growth opportunities, which confirms the theoretical prediction that bank debt and convertible debt are useful instruments to mitigate agency conflicts between shareholders and bondholders over the exercise of growth options (Hoshi, Kashyap, and Scharfstein (1993), Yosha (1995), Park (2000), and Boot (2000) for bank debt; Jensen and Meckling (1976), Green (1984), and Isagawa (2000) for convertible debt).

It is interesting to note the drop in bank debt in the 4th quartile market-to-book ratio group. It is likely that the firms with the highest growth opportunities may not need bank monitoring as do other groups because managers in these firms would have sufficient incentive to consistently select profitable projects as a means to maximize overall firm value (Hoshi, Kashyap, and Scharfstein (1993)). Park (2000), on the other hand, argues that impaired bank lenders have greater incentive to monitor firms closely when they have relatively smaller fixed claims; thus, firms optimally decrease the bank debt portion in their debt structure as they are more likely to have agency conflicts.

1.4.5 Financially constrained or high information asymmetry firms and debt structure

In this section, we analyze how a firm's high information asymmetry problems or financially constrained status influences the dependence on debt types. We use the cash flow volatility measure as a proxy for information asymmetry problems or financial distress. Table 1.6 reports the average percentage in each debt component across the cash flow volatility. In the first five rows, each amount of debt is scaled by total book capital and in the next four rows, each amount of debt is scaled by total debt. To visualize this information in Table 1.6, we include Figure 1.3 and Figure 1.4. Figure 1.3 shows the total leverage information (%) across the cash flow volatility quartiles. As cash flow volatility increases from the 1st to 4th quartile, the average leverage decreases to 38%, 37%, 34%, and 32%. Our findings suggest a negative relation between cash flow volatility and leverage, which implies that as firms have severe information asymmetry problems or are financially constrained, their dependence on debt financing decreases (Bradley, Jarrell, and Kim (1984)).

Figure 1.4 shows the average proportion of debt types across the cash flow volatility quartiles. Here, we use the debt structure information scaled by total debt in Table 1.6. As we can see in Figure 1.4, we do not find significant patterns in bonds-and-notes across the cash flow volatility quartiles. However, as firms' cash flow volatility increases from the 1st to 4th quartile, the dependence on capitalized increases to 5.00%, 5.60%, 6.60%, and 7.50% and the dependence on convertible debt increases to 6.00%, 6.80%, 7.00%, and 8.30% respectively. These findings suggest that the propensity to use capitalized leases and convertible debt increases as firms have volatile cash flows, which also supports the existing literature's findings that financially constrained firms are more likely to depend on capitalized leases because lease financing provides them with more favorable terms than other debt types and reduces firms' contracting costs (Sharpe and Nguyen (1995), and Krishnan and Moyer (1994)). Moreover, other factors being equal, convertible debt is a relatively attractive financing option for firms with high earnings volatility, which supports Brennan and Schwartz's (1988) argument that convertibles have their greatest value in those firms. Lastly, contrary to our hypothesis, the propensity for using bank debt decreases as firms experience volatile cash flows. However, Sufi's (2009) findings support these results: when firms have volatile cash flows, they are more likely to violate covenant restrictions in bank loan contracts, bank lenders are less likely to provide lines of credit to these firms, and they may even cut their existing bank loans when they renegotiate contracts.

1.5 Robustness of the Results

In this section: 1) We compare the Compustat and Capital IQ databases by showing matched comparison tables and by doing missing data analysis. 2) We run 2SLS regressions by replacing bank debt information only from Capital IQ and by using other debt types from Compustat, and we run 2SLS regressions by using all debt outstanding information from the Capital IQ database. 3) We run 2SLS regressions based on firms with longer histories.

1.5.1 Database comparison: Compustat versus Capital IQ

Using the Capital IQ database both helps and hinders an analysis of a firm's debt structure. Specifically, the Capital IQ (CIQ) database has been receiving more attention recently for its use in academic research because it provides detailed information about a firm's debt structure and equity structure globally (e.g., Rauh and Sufi (2010), Gao, Harford, and Li (2013), and Colla, Ippolito, and Li (2013)). However, our comparison analysis between the Compustat and Capital IQ databases shows that there are a lot of missing values with outstanding debt information variables from the Capital IQ database.

Panel A in Table 1.7 shows the comparison of data coverage of firms with firm-year observations in the Compustat and Capital IQ databases. While Compustat includes 110,727 firm-year observations for public, OTC, and private companies, Capital IQ consists of 83,096 firm-year observations for global public and private companies from 2002 to 2013. Moreover, we match two databases based on GVKEY information to use accounting data information from

Compustat, and we end up with only 5,661 firms or 32,356 firm-year observations in both databases.

Panels B and C in Table 1.7 provide missing data information over the Compustat and Capital IQ databases. Surprisingly, we notice that the Capital IQ database has a lot of incomplete information compared to the Compustat database. Over 32,356 firm-year observations from Compustat, we are able to collect most of the debt outstanding information for (imputed) total bank debt, senior bonds and notes, capitalized leases, convertible debt, senior debt, subordinated debt, and secured debt. However, the Compustat database does not provide "sole" bank debt information, and commercial paper outstanding information is completely missing. On the other hand, drawing from the Capital IQ database, about 51% of these samples (32,356 firm-year observations) have missing values in total term loans, 95% of commercial paper outstanding is missing, 81.4% of subordinated debt is missing, and 77.2% of convertible debt information is missing, which makes it harder to analyze a firm's debt structure using the Capital IQ database. Mathers and Giacomini's (2014) study based on hand-collected data also supports our findings: they report that the Capital IQ base has many missing values on credit line usage (i.e., bank debt) even when firms have this information in 10-K filings, and argue that this misreporting by the Capital IQ is not systematic.

Our bank debt information is imputed from Compustat as other long-term debt (DLTO) minus commercial paper (CMP). Although we use the DLTO variable as a proxy for bank debt, this variable may include other types of debt which are not bank debt.[25] Our approach provides a larger sample size and longer time period for our debt structure analysis, but this variable may not capture a firm's actual bank debt information. To compensate for this potential shortcoming, we

[25] DLTO (Other long-term debt) includes revolving credit agreements, Eurodollar loans, notes and other debt, construction loans, equipment obligations, debt classified by currency only, accrued interest, and commercial paper from the Compustat database. In our final sample (N=57,644), 99.98% of the CMP variable has missing values, and 0.02% has value zero. We use the DLTO variable itself as outstanding bank debt information.

compare outstanding bank debt in both databases to see if our proxy for bank debt is appropriate to use.

Table 1.8 presents the descriptive statistics (mean, median, and correlation) for the matched sample of 32,356 firm-year observations from 2002 to 2013 in Compustat and Capital IQ. The Compustat mean (median) is calculated conditional on the corresponding variables in Capital IQ being non-missing, and vice versa. We find that our proxy for bank debt from Compustat is highly correlated with the reported bank debt information from Capital IQ, which is 0.8365. This high correlation gives us the green light to use imputed bank debt information as a proxy for a firm's actual bank debt, and leads us to analyze debt structure further. Also, we find high correlations among other variables in the two databases: total debt (0.9999), senior bonds and notes (0.9680), capitalized leases (0.9768), senior debt (0.9983), subordinated debt (0.8788), convertible debt (0.8597), long-term debt (0.9858), secured debt (0.9062), and unsecured debt (0.9866).

1.5.2 Analysis based on outstanding debt information from the Capital IQ database

Next, we collect a firm's outstanding debt information from the Capital IQ database from 2002 to 2013, and run the same analysis as in the main Table 1.3. As shown in Table 1.9, we run 2SLS regressions using outstanding debt information from the Capital IQ database. We only replace Bank $\text{Debt}_{\text{Compustat}}$ with Bank $\text{Debt}_{\text{Capital IQ}}$ and keep other debt types (i.e., capitalized leases, convertible debt, and bonds-and-notes) that are from the Compustat database for Panel A. We end up losing 47% of firm-year observations (initially, we have 32,356 firm-year observations, and later we only have 17,083 firm-year observations with all available information for our analysis). We find consistent substitutive and complementary relations among all four debt types. All the control variables have the same coefficient signs except the profitability variable that determines each debt type. This opposing pattern might be caused by a reduced sample size or using mixed outstanding debt information over two databases, which would reduce explanatory power to predict each debt type. Thus, our joint estimation of debt structure results cannot pass a weak identification test and an over-identification test perfectly as in Table 1.3.

Moreover, in Panel B, we collect all outstanding debt information - capitalized leases, convertible debt, bonds-and-notes, and bank debt information from the Capital IQ database. We end up losing 95% of firm-year observations (initially, we have 32,356 firm-year observations, and subsequently we only have 1,555 firm-year observations with 564 unique firms). Because of the very small sample size, finding perfect instrument variables for our analysis becomes more difficult. However, we continue to search to find the optimal IV set. The instrumental variables that are used in Panel B are as follows: {cash holdings, *I*(Altman's Z < 1.81), *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated), *I*(commercial paper rated)} for Panel B-1, and {tax rate, cash holdings, *I*(Altman's Z < 1.81), *I*(tax loss carry-forward), *I*(bond rated), *I*(commercial paper rated)} for Panel B-2. We find consistent relations for the six pairs of debt types, and all the control variables have the same coefficient signs except for the firm size variable. Meanwhile, some explanatory variables may not be statistically significant because of small sample size. We are not able to do an over-identification test, possibly because smaller samples influence the estimated covariance matrix of moment conditions not of full rank.

1.5.3 Analysis based on firms with longer histories

Next, we consider the determinants of debt structure for firms with longer histories. We posit that firms with longer histories are more likely to be large firms with stable profitability and low future growth opportunities. As shown in Panel A in Table 1.10, we find the relations across the debt types to be consistent with the relations shown in Table 1.3, where firms have been around for at least ten years. However, the coefficients of profitability variables in four equations are statistically insignificant, which suggests that a firm's choices of debt types are less influenced by profitability, but possibly influenced by a good bank relationship or an established market reputation.

We also run 2SLS regressions based on firms with at least a 20 years of history, and present the results in Panel B in Table 1.10. We find that the relations that predict capitalized leases are consistent, but they are not statistically significant. Furthermore, the signs of coefficients on profitability variables reverse. In this sample, as a firm's profitability increases, the dependence on bank debt and convertible debt decreases, the dependence on bond-and-notes increases, and the dependence on capitalized leases decreases, but the latter is not statistically significant.

1.5.4 Alternative estimation methods: 2SLS, 3SLS, OLS

Although our set of instruments {tax rate, cash holdings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)} satisfies the relevance and exogenous tests, it does not prove that our instruments are actually exogenous with error terms. In econometrics, "the instruments should be variables that can be excluded from the original list of control variables without affecting results" (Ferreira, Ferreira, and Raposo (2011)). However, this cannot be tested formally by econometrical methods. To address this issue, we use the industry instrumental variables approach.

In panel data estimation, it is difficult to identify good natural experiments or exogenous instruments (Grieser and Hadlock (2016)). In order to address endogenous issues among variables, researchers[26] have used independent variables' group averages as instrumental variables (Grieser and Hadlock (2016), Gormley and Matsa (2014))[27]. Following the literature, we also employ two-stage least squares using the industry instrumental variables approach. We use the industry averages of bank debt, capitalized leases, convertible debt, and bonds-and-notes as instrument variables for each firm's debt type to address simultaneity concerns. More

[26] For example, Lev and Sougiannis (1996), and Hanlon, Rajgopal, and Shevlin (2003) use industry instrumental variables approach to adjust for simultaneity bias in the regressions.

[27] Grieser and Hadlock (2016) address that in some cases "industry-year variation can be both useful and relevant as part of a theoretically defensible instrumental variable strategy." However, Gormley and Matsa (2014) raise concerns about limitation of industry-year variation: the instrument violates the exclusion restriction whenever an unobserved industry-level factor is correlated with the regressor.

specifically, the four instrument variables are the contemporaneous annual average values of the four debt type measures (bank debt, capitalized leases, convertible debt, and bonds-and-notes) at *other* companies in the same Fama-French 48 industry category. Thus, for a given firm-year, we compute the average values of bank debt, capitalized leases, convertible debt, and bonds-and-notes for firm-years with the same Fama-French 48 category, excluding the firm-year itself.

Besides computational ease, the industry averages of bank debt, capitalized leases, convertible debt, and bonds-and-notes are appealing instrumental variables. For example, let's consider the role of the firm's outstanding bonds-and-notes value in determining a firm's level of bank debt ownership. The industry-average bonds-and-notes value is likely to be highly associated with a firm's outstanding bonds-and-notes value because firms' overall capital structures are significantly influenced by their peers' capital structure practices (Leary and Roberts (2014)), which appear to satisfy the relevance condition. Moreover, the exclusion restriction is also very likely to hold, as feedback from changes in a firm's bank debt ownership to the industry-average of bonds-and-notes would appear to be negligible. Following the same logic for other cases, industry averages of bank debt, capitalized leases, convertible debt, and bonds-and-notes can be good candidates for instrumental variables.

The regressions in Panel A of Table 1.11 presents estimates of each debt type equation from the second-stage regression. In Models [1]-[4], we find consistent results with those in Table 1.3: bank debt and bonds-and-notes are complements, and bank debt and convertible debt are substitutes. Additionally, in untabulated results, we find that a couple of coefficient signs become the opposite in capitalized leases and convertible debt equations; however, they are not statistically significant. Although we find strong correlations between these industry instrumental variables and each debt type from Panel B in Table 1.2, as seen in Table 1.11, we find that our set of instruments suffer from weak instrument concerns, and Hansen's over-identification test indicates that we reject the null hypothesis that the instruments are uncorrelated with the regression error term in each choice of debt types.

In Models [5]-[8] from Panel A, we further estimate 2SLS regressions using more instrument variables[28] and we obtain similar estimates to those obtained in Table 1.3: bank debt and bonds-and-notes are complements, and bank debt and convertible debt are substitutes. The result shows that our estimates are unlikely to be biased from weak instruments. However, we reject the null hypothesis that the over-identification restrictions are satisfied and conclude that our four-equation system is over-identified.

In a final approach to address endogeneity concerns, we estimate a system that models bank debt, capitalized leases, convertible debt, and bonds-and-notes as jointly endogenous using three-stage least squares (3SLS). Three-stage least squares (3SLS) provides consistent estimates of the coefficients and standard errors as long as the model is identified correctly (Wooldridge (2010)). Therefore, as we addressed in Section 1.3.4, we are aware of possible model specification errors in our system equations model approach.

In addition to including profitability, tangibility, M/B, firm size, and cash flow volatility in each debt equation, we include a number of other exogenous variables. Our choice of additional control variables in bank debt (Johnson (1997)) and capitalized leases (Barclay and Smith (1995) and Eisfeldt and Rampini (2009)) equations is based primarily on prior literature. Meanwhile, in the bonds-and-notes equation, we follow control variables used in the capital structure studies (Johnson (2003) and Saretto and Tookes (2013)) because bonds-and-notes are a major debt type that comprises leverage. In convertible debt equation, we simply use base line control variables since we are unable to find relevant papers. More specifically, we jointly estimate the following models using three-stage least squares (3SLS).

[28] The excluded instrument variables in 2SLS regressions include firm age, abnormal earnings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(dividend payer), cash holdings, *I*(Altman's Z < 1.81), *I*(bond rated), *I*(commercial paper rated), and *I*(investment grade), and debt maturity.

$$Bank\ Debt = \sum_k OtherThreeDebtTypes_k + Proitability + \mathrm{Tan}\,gibility + MB + FirmSize + CF\ Volatility$$
$$+ FirmAge + YearFE + IndustryFE + \varepsilon_{i,t}$$

$$Capitalized\ Leases = \sum_k OtherThreeDebtTypes_k + Profitability + \mathrm{Tan}\,gibility + MB + FirmSize + CF\ Volatility$$
$$+ AbnormalEarnings + I\left(Tax\,Loss\,Carryforward\right) + ITC\,dummy + Dividend\ Payer$$
$$+ Cash\,holdings + I\left(Altman\text{'}s\,Z < 1.81\right) + YearFE + IndustryFE + \varepsilon_{i,t}$$

$$Convertible\ Debt = \sum_k OtherThreeDebtTypes_k + Profitability + \mathrm{Tan}\,gibility + MB + FirmSize + CF\ Volatility$$
$$+ YearFE + IndustryFE + \varepsilon_{i,t}$$

$$Bonds\ and\ Notes = \sum_k OtherThreeDebtTypes_k + Profitability + \mathrm{Tan}\,gibility + MB + FirmSize + CF\ Volatility$$
$$+ AbnormalEarnings + I\left(Tax\,Loss\,Carryforward\right) + ITC\,dummy + I(BondRated)$$
$$+ I(CP\ \mathrm{Program}) + I(InvestmentGrade) + DebtMaturity + YearFE + IndustryFE + \varepsilon_{i,t}$$

The regressions in Panel B of Table 1.11 reports the 3SLS estimates. We find consistent results with those in Table 1.3: bank debt and bonds-and-notes are complements, and bank debt and convertible debt are substitutes, and also the signs of coefficients on other firm characteristics show consistent patterns. In untabulated results, with regard to the additional control variables, we find that as firms are younger, they are more likely to depend on bank debt. We find that tax loss carry-forward is marginally negatively associated with capitalized leases, which is not consistent with existing studies on leases that predict that since firms with loss carry-forward, investment tax credit presumably have low or zero marginal tax rates, and thus low tax benefits of debt (e.g., Barclay and Smith (2003)), their reliance on leasing financing should be greater. Other additional control variables in the capitalized equations are not statistically significant. We further find that firms with a lower firm quality (abnormal earnings), higher tax shield benefits, and lower credit ratings along with access to the bond market, no commercial paper program, and lower percentage of short-term debt are more likely to depend on bonds-and-notes. These results should, however, be interpreted with caution, especially because no strong theoretical justifications exist for why a given variable is appropriate in one equation versus another.

1.6 Conclusions

In this paper, we have explored the joint determinants of a firm's debt choices (i.e., bank debt, bonds-and-notes, capitalized leases, and convertible debt) using a simultaneous equation framework in which a firm's choices of debt are endogenous. While past research has explained a firm's debt choices independently, our study considers interactions among debt choices, resolves endogeneity problems not addressed by current empirical studies, and sheds light on how a firm chooses particular types of debt as substitutes or complements.

We find that similar patterns in firm characteristics that determine choices of both bank debt and convertible debt, and choices of both bonds-and-notes and capitalized leases, suggest that bank debt is a substitute for convertible debt, and that bonds-and-notes are substitutes for capitalized leases. First, finding a negative relation between bank debt and convertible debt empirically is meaningful, because it confirms the theoretical argument that both bank debt and convertible debt are useful for mitigating agency conflicts between shareholders and bondholders, and controlling managerial opportunistic behavior that deviates from shareholders' interests. Second, a negative relation between bonds-and-notes and capitalized leases is consistent with the argument that leasing is the more attractive financing options for firms with a higher potential for financial distress or bankruptcy and is often perceived as a *substitute* for debt (bonds-and-notes) for firms that are too risky or are unable to access conventional debt markets (Lease, McConnell, and Schallheim (1990)).

We further find a positive relation between bank debt and bonds-and-notes, which confirms actual firms' financing patterns: having bank debt allows a firm to go to the public market to issue bonds-and-notes based on the reputation it has established with bank lenders. Also, our finding supports the existing theory (e.g., Park (2000)) that firms should use a combination of bank debt and bonds-and-notes to control moral hazard problems as bank lenders have a *stronger* incentive to monitor firms in the presence of junior debt (e.g., bonds-and-notes).

Lastly, we examine the changes in composition of debt types across the market-to-book ratio and cash flow volatility quartiles. Our univariate analysis results suggest that the propensity to use bank debt and convertible debt is increasing in growth opportunities. Also, the propensity to use capitalized leases and convertible debt increases as firms are financially constrained or have severe asymmetric information problems; meanwhile, the propensity for bank debt use decreases as firms' cash flow volatility increases.

Table 1.1: Descriptive Statistics: 1980-2013

This table presents the descriptive statistics for the sample. The dataset comprises 57,644 Compustat firm-year observations from 1980 to 2013. By following Johnson (2003), all control and instrument variables except CF volatility and the abnormal earnings measure are from the year before the year in which amount of each debt type is measured. Total debt is the ratio of total debt (long-term debt plus debt in current liabilities) to total book capital, where total book capital is total debt plus equity at book value. Bank debt is the ratio of bank debt to total book capital, where bank debt is imputed from Compustat as the category other long-term debt (DLTO) minus commercial paper (CMP). Capitalized leases is the ratio of capitalized lease obligations (DLCO) to total book capital. Convertible debt is the ratio of convertible debt (DCVT) to total book capital. Bonds-and-notes is the ratio of total debt minus bank debt minus capitalized leases minus convertible debt minus commercial paper over total book capital. Missing values for commercial paper is replaced with zero before constructing relevant sub-debt categories variables. Profitability is the ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to the book value of total assets. Tangibility is the ratio of net property, plant and equipment (PPENT) to the book value of total assets. MB is the market-to-book ratio, which is computed as the sum of the book value of total assets, plus the market value of common stock, minus the book value of common stock, divided by the book value of total assets. Firm Size is the natural log of the book value of total assets, where the book value of total assets is measured in constant 2008 dollars using the CPI. CF Volatility is the standard deviation of the first difference in EBITDA over the five years preceding and including the year in which a dependent variable is measured, scaled by the average book value of assets during this period. *I*(Dividend) is a dummy variable equal to one if the firm pays dividends in a given year, and zero otherwise. Log (Firm Age) is the natural log of the number of years the firm is listed with a non-missing stock price in Compustat. Tax rate is marginal tax rate based on income before interest expense has been deducted. The tax rates are available on John Graham's website: http://www.duke.edu/~jgraham. Years with missing tax rates are filled in using piecewise linear interpolation where possible; otherwise, or if the firm is not in the dataset, we use the firm's effective tax rate, which is computed as the ratio of income tax paid to pretax income. Abnormal Earnings is the difference between EPS in year t+1 minus EPS in year t, divided by the year t share price. Cash Holdings is the ratio of cash plus marketable securities to the book value of total assets. *I*(Altman's Z < 1.81) is a dummy variable equal to one when Altman's Z-score < 1.81 (a proxy for financial distress), and zero otherwise. Altman's Z-score is calculated as Z = 3.3 * EBIT / total assets + 1.0 * sales / total assets + 1.4 * retained earnings / total assets + 1.2 * working capital / total assets + 0.6 * market value equity / total debt. *I*(Tax Loss Carry Forward) is a dummy variable equal to one if the firm has any tax loss carry forwards (TLCF) in a given year, and zero otherwise. *I*(Investment Tax Credit) is a dummy variable equal to one if the firm has any investment tax credits (ITC) in a given year, and zero otherwise. *I*(Bond Rated) is a dummy variable equal to one if the firm has a bond rating and zero otherwise. *I*(Commercial Paper Rated) is a dummy variable equal to one if the firm has a commercial paper rating and zero otherwise. All continuous variables are winsorized at the top and bottom 1 percentiles.

Table 1.1: Continued

Variable	N	Mean	Median	Std Dev	Min	Max	5th Pct.	25th Pct.	Median	75th Pct.	95th Pct.
Total Debt$_t$[1]	57644	0.349	0.330	0.233	0.001	0.933	0.016	0.158	0.330	0.507	0.780
Bank Debt$_t$[1]	57644	0.082	0.004	0.139	0.000	0.625	0.000	0.000	0.004	0.115	0.403
Capitalized Leases$_t$[1]	57644	0.014	0.000	0.038	0.000	0.233	0.000	0.000	0.000	0.008	0.085
Convertible Debt$_t$[1]	57644	0.028	0.000	0.086	0.000	0.476	0.000	0.000	0.000	0.000	0.227
Bonds and Notes$_t$[1]	57644	0.220	0.173	0.202	0.000	0.832	0.000	0.044	0.173	0.342	0.625
Profitability$_{t-1}$	57644	0.099	0.122	0.148	-0.635	0.373	-0.168	0.063	0.122	0.176	0.271
Tangibility$_{t-1}$	57644	0.318	0.267	0.225	0.010	0.902	0.038	0.142	0.267	0.449	0.779
MB$_{t-1}$	57644	1.713	1.318	1.263	0.578	8.715	0.759	1.023	1.318	1.884	4.009
Firm Size$_{t-1}$	57644	5.435	5.398	2.101	0.999	10.499	2.069	3.897	5.398	6.887	9.043
CF Volatility$_t$	57644	0.074	0.047	0.081	0.005	0.488	0.010	0.025	0.047	0.088	0.232
***I*(Dividend Payer)$_{t-1}$**	57644	0.383	0	0.486	0	1	0	0	0	1	1
Log (Firm Age)$_{t-1}$	57644	2.426	2.565	0.882	0.000	3.829	0.693	1.792	2.565	3.091	3.638
Tax Rate$_{t-1}$	57644	0.290	0.340	0.143	-0.056	0.482	0.001	0.212	0.340	0.355	0.460
Abnormal Earnings$_t$	57644	0.016	0.003	0.305	-1.248	1.692	-0.310	-0.037	0.003	0.039	0.385
Cash Holdings$_{t-1}$	57644	0.124	0.063	0.155	0.000	0.766	0.003	0.020	0.063	0.165	0.461
***I*(Altman's Z < 1.81)$_{t-1}$**	57644	0.131	0	0.338	0	1	0	0	0	0	1
***I*(Tax Loss Carry-Forward)$_{t-1}$**	57644	0.317	0	0.465	0	1	0	0	0	1	1
***I*(Investment Tax Credit)$_{t-1}$**	57644	0.193	0	0.395	0	1	0	0	0	0	1
***I*(Bond Rated)$_{t-1}$**	57644	0.227	0	0.419	0	1	0	0	0	0	1
***I*(Commercial Paper Rated)$_{t-1}$**	57644	0.075	0	0.264	0	1	0	0	0	0	1

[1] denominator = total debt + equity at book values

Table 1.2: Pearson Correlation Coefficients

This table presents a correlation matrix for the final samples. The dataset comprises 57,644 firm-year observations from 1980 to 2013. The variables are defined in the legend for Table 1.1. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	**Total Debt$_t$**	1.000																	
2	**Bank Debt$_t$**	0.422***	1.000																
3	**Capitalized Leases$_t$**	0.150***	-0.033***	1.000															
4	**Convertible Debt$_t$**	0.227***	-0.062***	-0.021***	1.000														
5	**Bonds and Notes$_t$**	0.702***	-0.179***	-0.008*	-0.150***	1.000													
6	**Profitability$_{t-1}$**	-0.021***	0.079***	0.006	-0.079***	-0.037***	1.000												
7	**Tangibility$_{t-1}$**	0.207***	0.118***	0.133***	-0.064***	0.159***	0.158***	1.000											
8	**MB$_{t-1}$**	-0.188***	-0.118***	-0.056***	0.050***	-0.150***	-0.159***	-0.124***	1.000										
9	**Firm Size$_{t-1}$**	0.155***	0.128***	-0.039***	0.045***	0.084***	0.352***	0.144***	-0.137***	1.000									
10	**CF Volatility$_t$**	-0.089***	-0.124***	-0.003	0.021***	-0.031***	-0.470***	-0.115***	0.271***	-0.475***	1.000								
11	**Tax Rate$_{t-1}$**	0.012***	0.014***	0.066***	-0.057***	0.026***	0.516***	0.063***	-0.187***	0.295***	-0.366***	1.000							
12	**Abnormal Earnings$_t$**	0.071***	0.018***	0.014***	0.011***	0.054***	-0.088***	-0.008*	-0.036***	-0.041***	0.074***	-0.062***	1.000						
13	**Cash Holdings$_{t-1}$**	-0.320***	-0.228***	-0.051***	0.128***	-0.262***	-0.272***	-0.310***	0.346***	-0.177***	0.231***	-0.226***	0.004	1.000					
14	***I*(Altman's Z < 1.81)$_{t-1}$**	0.362***	0.132***	0.033***	0.094***	0.261***	-0.264***	0.187***	-0.114***	-0.078***	0.138***	-0.252***	0.063***	-0.071***	1.000				
15	***I*(Tax Loss Carry Forward)$_{t-1}$**	0.060***	0.016***	-0.019***	0.069***	0.027***	-0.223***	-0.087***	0.051***	-0.073***	0.159***	-0.274***	0.033***	0.075***	0.144***	1.000			
16	***I*(Investment Tax Credit)$_{t-1}$**	-0.066***	-0.082***	0.091***	0.014***	-0.041***	0.147***	0.043***	-0.050***	0.092***	-0.100***	0.325***	-0.026***	-0.008*	-0.116***	-0.142***	1.000		
17	***I*(Bond Rated)$_{t-1}$**	0.258***	0.073***	-0.053***	0.118***	0.208***	0.134***	0.101***	-0.051***	0.623***	-0.218***	0.076***	-0.023***	-0.129***	0.048***	0.041***	-0.063***	1.000	
18	***I*(Commercial Paper Rated)$_{t-1}$**	0.063***	-0.031***	-0.043***	-0.053***	0.128***	0.125***	0.068***	0.022***	0.463***	-0.160***	0.114***	-0.013***	-0.110***	-0.066***	-0.031***	0.004	0.487***	1.000

Table 1.2: Continued

Panel B

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Total Debt$_t$**	1.000													
2	**Bank Debt$_t$**	0.422***	1.000												
3	**Capitalized Leases$_t$**	0.150***	-0.033***	1.000											
4	**Convertible Debt$_t$**	0.227***	-0.062***	-0.021***	1.000										
5	**Bonds and Notes$_t$**	0.702***	-0.179***	-0.008*	-0.150***	1.000									
6	**Profitability$_{t-1}$**	-0.021***	0.079***	0.006	-0.079***	-0.037***	1.000								
7	**Tangibility$_{t-1}$**	0.207***	0.118***	0.133***	-0.064***	0.159***	0.158***	1.000							
8	**MB$_{t-1}$**	-0.188***	-0.118***	-0.056***	0.050***	-0.150***	-0.159***	-0.124***	1.000						
9	**Firm Size$_{t-1}$**	0.155***	0.128***	-0.039***	0.045***	0.084***	0.352***	0.144***	-0.137***	1.000					
10	**CF Volatility$_t$**	-0.089***	-0.124***	-0.003	0.021***	-0.031***	-0.470***	-0.115***	0.271***	-0.475***	1.000				
11	**Industry Bank Debt$_t$**	0.197***	0.210***	-0.054***	-0.086***	0.128***	0.094***	0.278***	-0.127***	0.213***	-0.150***	1.000			
12	**Industry Capitalized Leases$_t$**	0.072***	-0.042***	0.294***	0.012***	0.048***	0.086***	0.175***	-0.059***	-0.043***	-0.072***	-0.138***	1.000		
13	**Industry Convertible Debt$_t$**	-0.133***	-0.087***	-0.039***	0.130***	-0.144***	-0.180***	-0.180***	0.164***	-0.131***	0.163***	-0.416***	-0.087***	1.000	
14	**Industry Bonds and Notes$_t$**	0.230***	0.069***	0.103***	-0.068***	0.227***	0.161***	0.205***	-0.222***	0.064***	-0.160***	0.295***	0.263***	-0.485***	1.000

Table 1.3: Main Result-Joint Estimation (2SLS)

This table presents the results of second-stage simultaneous equation regressions for each of four debt types on five explanatory variables, industry (Fama-French 48) and year fixed effect controls estimated using two-stage least squares. The sample contains 57,644 Compustat firm-year observations from 1980 to 2013. A sample selection criterion is described in the Appendix A.2. The variables are as defined in Table 1.1 or Appendix A.1. All dependent variables are scaled by total book capitalization (D+E) following Rauh and Sufi's (2010). Each endogenous variable (bank debt, capitalized leases, convertible debt, and bonds-and-notes) is regressed on all the exogenous variables, instrument variables, industry and year fixed effects in the first stage. Instrument variables are {tax rate, cash holdings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)} for Panel A, and {tax rate, abnormal earnings, cash holdings, *I*(tax loss carry-forward), *I*(bond rated)} for Panel B. First-stage regression results are omitted. For the 2SLS regressions, we report tests for whether the instruments are exogenous (i.e., uncorrelated with the error term in the second stage) and whether the instruments are relevant (i.e., correlated with the endogenous regressors bank debt, capitalized leases, convertible debt, and bonds-and-notes). We use the Hansen's J statistic for identifying restrictions to assess whether the instruments are uncorrelated with the second-stage error. If the test statistic—which is distributed chi-square—exceeds the critical value, we reject the null hypothesis that the instruments are uncorrelated with the structural error and conclude that at least some of the instruments are not exogenous. We use the Cragg-Donald statistic to assess whether the instruments are weak. When there are endogenous regressors, as in our 2SLS models, this statistic has an F distribution under the null hypothesis that the instruments have no explanatory power in the first stage regression. The instruments are validated both by being statistically significant in the first stage and by the above 10 Cragg-Donald F-Statistic (Baum et al. 2003; Wooldridge 2009). T-statistics are based on robust standard errors. Robust t-statistics are presented in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Table 1.3: Continued

Independent Variable	Panel A: Instrument variables list[1] [1] Bank Debt$_t$	[2] Capitalized Leases$_t$	[3] Convertible Debt$_t$	[4] Bonds and Notes$_t$	Panel B: Instrument variables list[2] [1] Bank Debt$_t$	[2] Capitalized Leases$_t$	[3] Convertible Debt$_t$	[4] Bonds and Notes$_t$
Bank Debt$_t$		0.143***	-0.595***	3.163***		0.147***	-0.603***	3.214***
		(5.65)	(-14.34)	(12.65)		(5.78)	(-14.98)	(13.17)
Capitalized Leases$_t$	6.690***		4.011***	-21.132***	5.909***		3.639***	-18.800***
	(5.72)		(6.29)	(-5.03)	(5.58)		(6.08)	(-4.77)
Convertible Debt$_t$	-1.668***	0.240***		5.282***	-1.620***	0.243***		5.230***
	(-14.42)	(6.25)		(9.89)	(-14.95)	(6.29)		(10.21)
Bonds and Notes$_t$	0.313***	-0.045***	0.186***		0.301***	-0.044***	0.182***	
	(12.67)	(-4.98)	(9.84)		(12.87)	(-4.85)	(10.01)	
Profitability$_{t-1}$	0.034**	-0.005***	0.020**	-0.109***	0.028**	-0.005***	0.017**	-0.094**
	(2.49)	(-2.82)	(2.37)	(-2.59)	(2.27)	(-2.67)	(2.09)	(-2.41)
Tangibility$_{t-1}$	-0.181***	0.027***	-0.108***	0.572***	-0.160***	0.027***	-0.099***	0.515***
	(-6.22)	(18.17)	(-7.14)	(5.65)	(-6.14)	(17.82)	(-7.01)	(5.46)
MB$_{t-1}$	0.006***	-0.001***	0.003***	-0.018***	0.005***	-0.001***	0.003***	-0.015***
	(3.45)	(-5.06)	(3.74)	(-3.55)	(3.10)	(-4.74)	(3.42)	(-3.24)
Firm Size$_{t-1}$	0.012***	-0.002***	0.007***	-0.038***	0.011***	-0.002***	0.007***	-0.036***
	(9.83)	(-7.35)	(12.80)	(-7.02)	(10.23)	(-7.48)	(13.17)	(-7.14)
CF Volatility$_t$	-0.190***	0.028***	-0.114***	0.602***	-0.180***	0.028***	-0.110***	0.580***
	(-7.92)	(6.52)	(-7.57)	(6.75)	(-8.14)	(6.55)	(-7.68)	(6.84)
Intercept	-0.108***	0.016***	-0.065***	0.345***	-0.099***	0.015***	-0.061***	0.327***
	(-3.34)	(3.19)	(-3.39)	(3.47)	(-3.20)	(3.06)	(-3.25)	(3.38)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.103	0.106	0.063	0.166	0.102	0.106	0.062	0.166
Number of Observations	57,644	57,644	57,644	57,644	57,644	57,644	57,644	57,644
Weak identification test (Cragg-Donald Wald F statistic):	12.249	17.704	14.763	9.179	14.304	17.734	16.525	10.000
Hansen J statistic p-value (overidentification test of all instruments):	0.4645	0.4613	0.4638	0.4568	0.1532	0.1735	0.1582	0.1448

[1] Instrument list = {tax rate, cash holdings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)}
[2] Instrument list = {tax rate, abnormal earnings, cash holdings, *I* (tax loss carry-forward), *I*(bond rated)}

Table 1.4: Leverage Regressions by Debt Type

To compare our 2SLS results (Table 1.3) from individual OLS regression, we run OLS regression separately following Rauh and Sufi's (2010) using Compustat data for 1980 – 2013. Each panel begins with a standard leverage regression of total debt by total book capitalization (debt plus equity at book value) on the four (five) explanatory variables in panel A (B). Each panel then shows regressions for each of four debt types on the same four (five) explanatory variables. All dependent variables are scaled by total book capitalization (D+E). Panel A uses four explanatory variables, profitability, tangibility, M/B, and firm size and Panel B uses five explanatory variables, profitability, tangibility, M/B, firm size, and CF Volatility. Standard errors are clustered by firm level. Robust t-statistics are presented in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Panel A: OLS regressions of the debt types against common set of variables in Rauh and Sufi (2010)

Independent Variable	[1] Total $Debt_t$	[2] Bank $Debt_t$	[3] Capitalized $Leases_t$	[4] Convertible $Debt_t$	[5] Bonds and $Notes_t$
$Profitability_{t-1}$	-0.234***	0.026***	-0.010***	-0.050***	-0.189***
	(-18.91)	(4.25)	(-5.04)	(-10.72)	(-18.13)
$Tangibility_{t-1}$	0.166***	0.050***	0.023***	-0.025***	0.116***
	(12.92)	(6.64)	(10.10)	(-5.82)	(9.90)
MB_{t-1}	-0.026***	-0.010***	-0.001***	0.002***	-0.017***
	(-19.17)	(-15.71)	(-4.54)	(3.08)	(-14.11)
Firm $Size_{t-1}$	0.017***	0.005***	-0.001***	0.005***	0.008***
	(14.03)	(6.62)	(-2.89)	(12.51)	(7.25)
CF $Volatility_t$					
Intercept	0.274***	0.014***	0.035***	0.011***	0.208***
	(29.53)	(2.83)	(18.79)	(3.52)	(24.49)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
SE Clustered by firm	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.142	0.072	0.104	0.040	0.098
N	57,644	57,644	57,644	57,644	57,644

Panel B: Independent OLS with additional control variables

Independent Variable	[1] Total $Debt_t$	[2] Bank $Debt_t$	[3] Capitalized $Leases_t$	[4] Convertible $Debt_t$	[5] Bonds and $Notes_t$
$Profitability_{t-1}$	-0.232***	0.011*	-0.008***	-0.050***	-0.175***
	(-17.96)	(1.77)	(-3.89)	(-10.28)	(-16.10)
$Tangibility_{t-1}$	0.166***	0.050***	0.023***	-0.025***	0.116***
	(12.92)	(6.58)	(10.14)	(-5.83)	(9.93)
MB_{t-1}	-0.026***	-0.009***	-0.001***	0.002***	-0.018***
	(-19.35)	(-14.44)	(-5.25)	(3.03)	(-15.01)
Firm $Size_{t-1}$	0.017***	0.003***	-0.0004**	0.005***	0.009***
	(13.30)	(4.64)	(-2.02)	(11.84)	(7.80)
CF $Volatility_t$	0.009	-0.084***	0.011***	-0.002	0.082***
	(0.36)	(-6.50)	(2.96)	(-0.20)	(3.52)
Intercept	0.273***	0.026***	0.034***	0.011***	0.196***
	(26.34)	(4.66)	(16.76)	(3.25)	(20.74)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
SE Clustered by firm	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.142	0.074	0.104	0.040	0.098
N	57,644	57,644	57,644	57,644	57,644

Table 1.5: Univariate Analysis for Debt Types across Firms' Growth Opportunities

This table presents the average percentage in each debt component across the market-to-book ratio quartiles. In the first five rows, each amount of debt is scaled by total book capital, and in the next four rows, each amount of debt is scaled by total debt. Time period for this sample is 1980-2013.

Item	**M/B = 1 Lowest**	**M/B =2**	**M/B=3**	**M/B=4 Highest**
Leverage = Total Debt/Total Book Capital	37.00%	41.00%	35.10%	26.40%
Bank Debt/Total Book Capital	8.60%	9.90%	9.00%	5.40%
Capitalized Leases/Total Book Capital	1.80%	1.60%	1.30%	1.00%
Convertible Debt/Total Book Capital	1.80%	2.80%	3.20%	3.40%
Bonds and Notes/Total Book Capital	24.50%	26.20%	21.30%	16.00%
Bank Debt/Total Debt	21.10%	22.70%	23.30%	17.60%
Capitalized Leases/Total Debt	6.60%	5.30%	5.40%	7.30%
Convertible Debt/Total Debt	4.30%	6.60%	7.90%	9.40%
Bonds and Notes/Total Debt	68.00%	65.30%	63.20%	65.60%
N	14,411	14,411	14,411	14,411

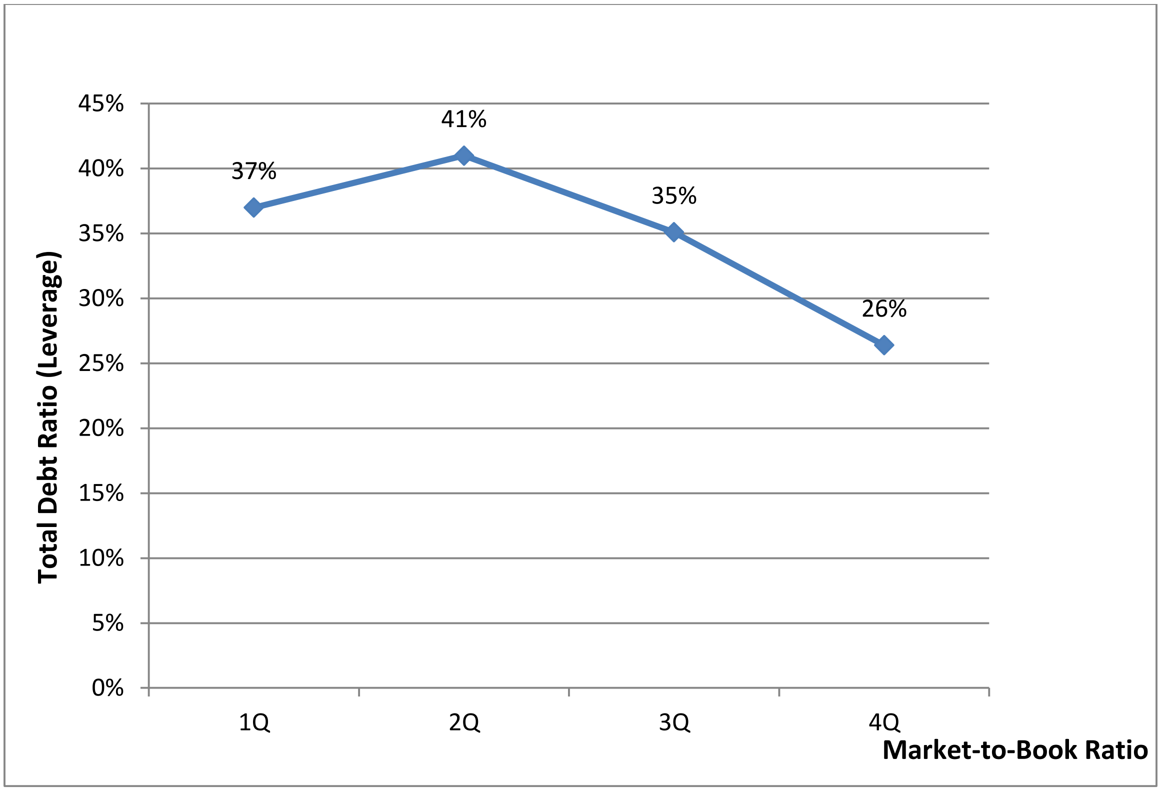


Figure 1.1: Leverage ratio across the market-to-book ratio quartiles

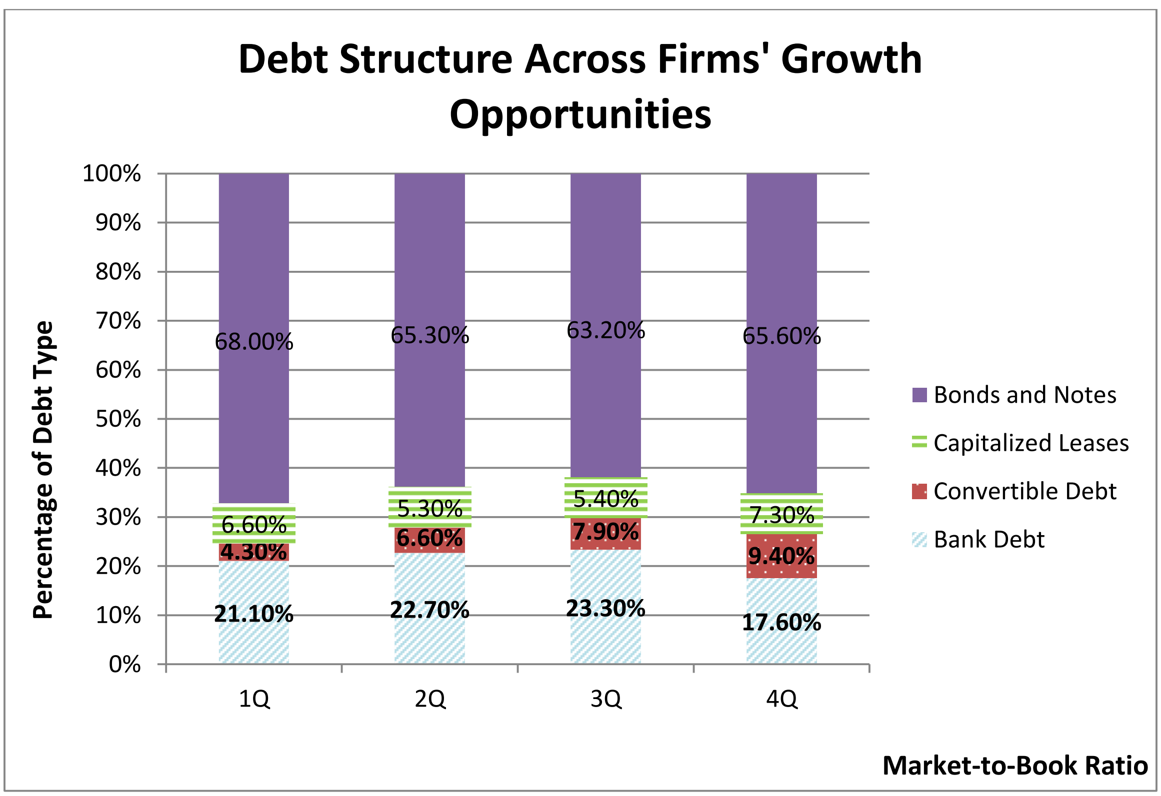


Figure 1.2: Percentage of each amount of debt over total debt across the market-to-book ratio quartiles

Table 1.6: Univariate Analysis for Debt Types across Firms' Cash Flow Volatility

This table presents the average percentage in each debt component across the cash flow volatility quartiles. In the first five rows, each amount of debt is scaled by total book capital, and in the next four rows, each amount of debt is scaled by total debt. Time period for this sample is 1980-2013.

	CF Volatility = 1 Lowest	**CF Volatility = 2**	**CF Volatility = 3**	**CF Volatility = 4 Highest**
Leverage = Total Debt/Total Book Capital	37.60%	36.50%	33.80%	31.60%
Bank Debt/Total Book Capital	9.50%	9.60%	8.40%	5.50%
Capitalized Leases/Total Book Capital	1.40%	1.40%	1.40%	1.40%
Convertible Debt/Total Book Capital	2.40%	2.70%	2.80%	3.30%
Bonds and Notes/Total Book Capital	24.10%	22.40%	20.80%	20.80%
Bank Debt/Total Debt	23.50%	23.90%	22.20%	15.20%
Capitalized Leases/Total Debt	5.00%	5.60%	6.60%	7.50%
Convertible Debt/Total Debt	6.00%	6.80%	7.00%	8.30%
Bonds and Notes/Total Debt	65.40%	63.60%	64.20%	68.90%
N	14,411	14,411	14,411	14,411

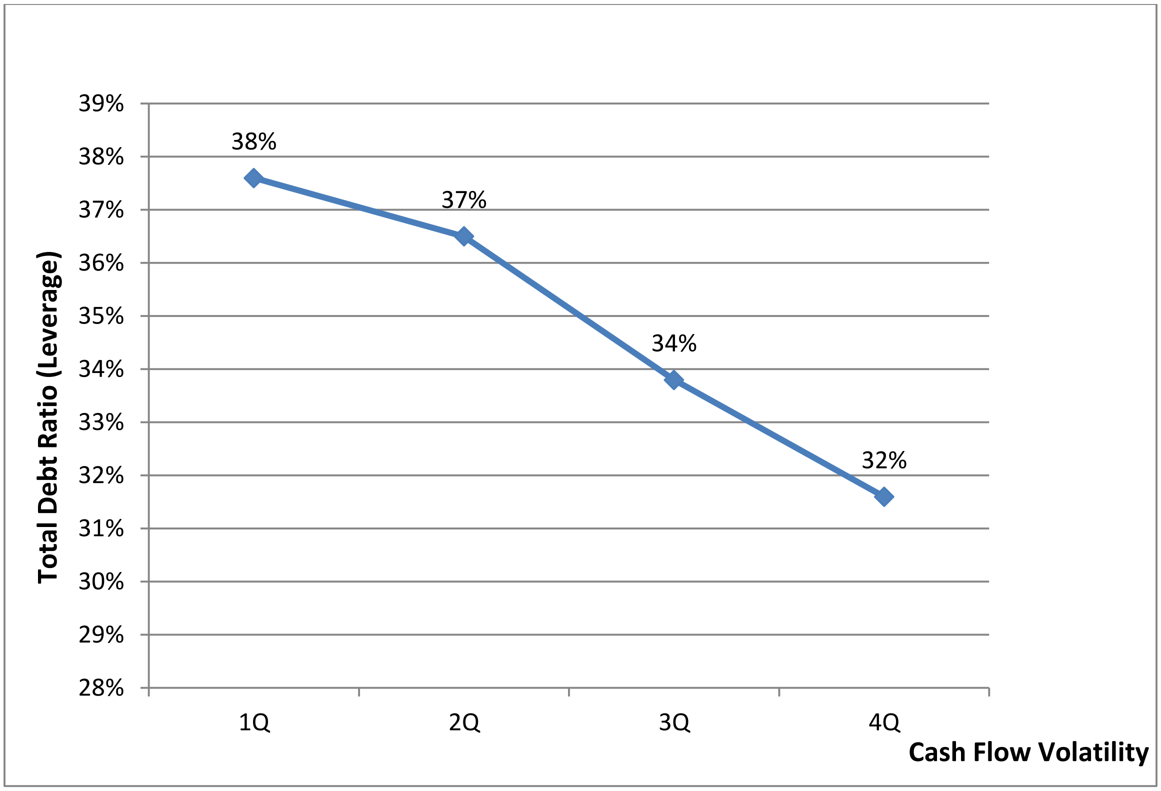


Figure 1.3: Leverage ratio across the cash flow volatility quartiles

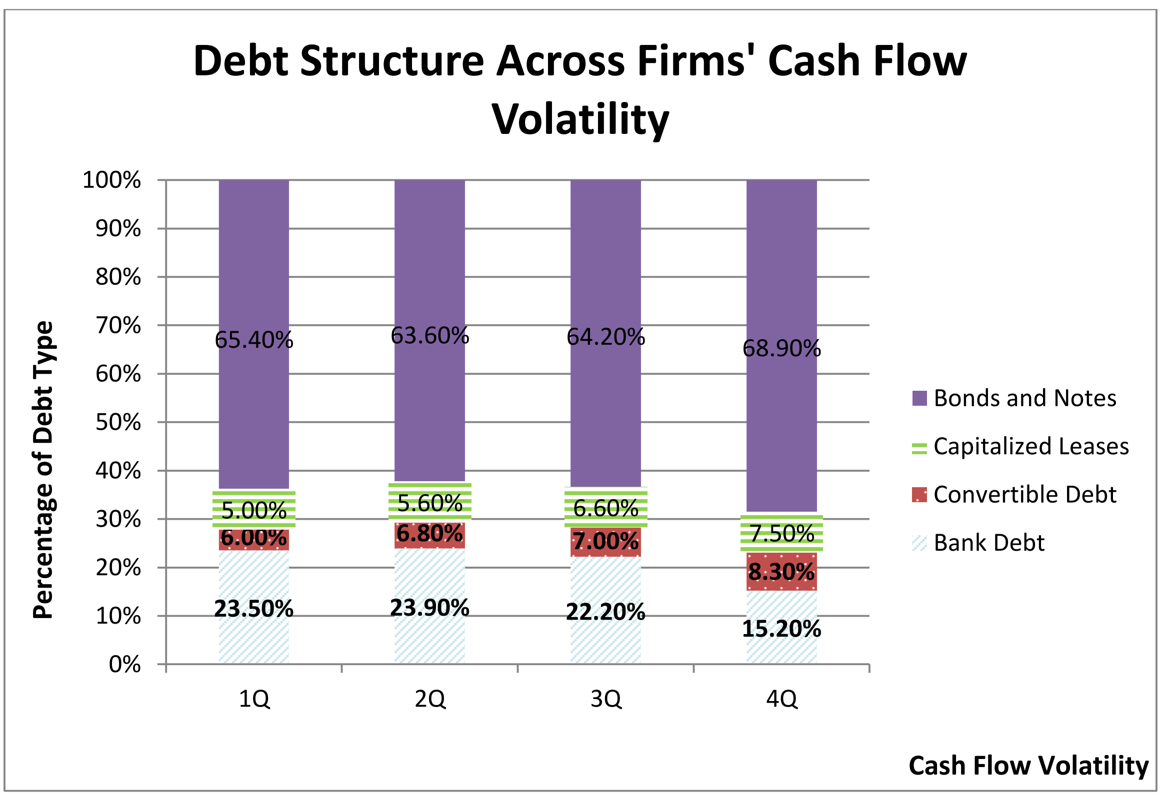
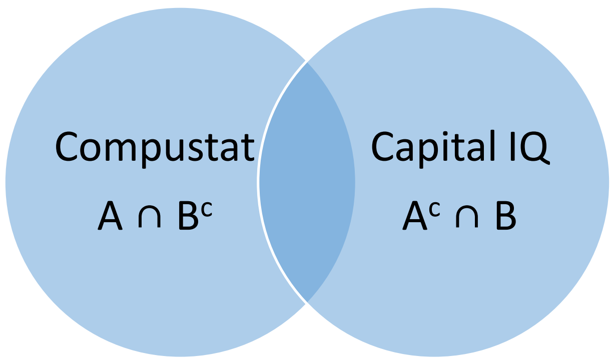


Figure 1.4: Percentage of each amount of debt over total debt across the cash flow volatility quartiles

Table 1.7: Missing Data - Compustat versus Capital IQ - Time Period: 2002-2013

This table presents missing data information in the Compustat and Capital IQ databases from 2002 to 2013 and shows that the Capital IQ database has incomplete information compared to the Compustat database. Panel A shows comparison of data coverage of firms and firm–year observations. Panel B shows detailed missing data information about a firm's capital structure and debt structures in each database without interaction. Panel C shows detailed missing data information about a firm's capital structure and debt structures that exists in both Compustat and Capital IQ and two databases are matched based on GVKEY information.



Panel A: Time Period: 2002 - 2013

	Compustat (A)	Capital IQ (B)	Compustat ∩ Capital IQ (A∩B)
# of firms	16,493	13,700	5,661
# of firm-year obs.	110,727	83,096	32,356

Table 1.7: Continued

Panel B: without intersection[29]

Item	Compustat				Capital IQ			
	# missing	% missing	Total Obs.	# of firms	# missing	% missing	Total Obs.	# of firms
Capital Structure Data								
Total Debt	0	0.0	110,727	16,493	0	0.0	83,096	13,700
Book Equity	6	0.0	110,727		N/A	N/A	83,096	
Total Capital	6	0.0	110,727		N/A	N/A	83,096	
Debt Summary Data								
Total Revolving Credit	N/A	N/A	110,727		38,883	46.8	83,096	
Total Term Loans	N/A	N/A	110,727		37,780	45.5	83,096	
Total Bank Debt	13,697	12.4	110,727		18,866	22.7	83,096	
Total Senior Bonds and Notes	13,760	12.4	110,727		35,004	42.1	83,096	
Total Capital Leases	13,515	12.2	110,727		57,894	69.7	83,096	
Commercial Paper	110,140	99.5	110,727		79,065	95.1	83,096	
Other Borrowings	N/A	N/A	110,727		57,810	69.6	83,096	
Additional Totals								
Total Senior Debt	13,760	12.4	110,727		640	0.8	83,096	
Total Subordinated Debt	13,760	12.4	110,727		69,476	83.6	83,096	
Total Convertible Debt	10,511	9.5	110,727		64,668	77.8	83,096	
Long-Term Debt	0	0.0	110,727		18,599	22.4	83,096	
Total Secured Debt	17,236	15.6	110,727		20,175	24.3	83,096	
Total Unsecured Debt	17,236	15.6	110,727		17,658	21.3	83,096	

[29] We use data samples with non-missing total debt outstanding from fiscal year 2002 to 2013. We define total debt outstanding as (dltt+dlc) from the Compustat database and use PrincipalAmtDbtOutstanding variable from Capital IQ database. We restrict samples with 20020630 <= periodenddate <= 2014531 from the Capital IQ database to match them with the Compustat database.

Table 1.7: Continued

Panel C: with intersection[30]

Item	Compustat		Capital IQ			
	# missing	% missing	# missing	% missing	Total Obs.	# of firms
Capital Structure Data						
Total Debt	0	0.0	0	0.0	32,356	5,661
Book Equity	0	0.0	N/A	N/A	32,356	
Total Capital	0	0.0	N/A	N/A	32,356	
Debt Summary Data						
Total Revolving Credit	N/A	N/A	12,158	37.6	32,356	
Total Term Loans	N/A	N/A	16,425	50.8	32,356	
Total Bank Debt	81	0.3	6,777	20.9	32,356	
Total Senior Bonds and Notes	97	0.3	12,144	37.5	32,356	
Total Capital Leases	1,684	5.2	18,289	56.5	32,356	
Commercial Paper	32,356	100.0	30,734	95.0	32,356	
Other Borrowings	N/A		23,629	73.0	32,356	
Additional Totals						
Total Senior Debt	97	0.3	320	1.0	32,356	
Total Subordinated Debt	97	0.3	26,351	81.4	32,356	
Total Convertible Debt	70	0.2	24,964	77.2	32,356	
Long-Term Debt	0	0.0	3,117	9.6	32,356	
Total Secured Debt	1,774	5.5	6,140	19.0	32,356	
Total Unsecured Debt	1,774	5.5	8,029	24.8	32,356	

[30] Dataset: Compustat ∩ Capital IQ matched through GVKEY key.

Table 1.8: Matched Comparison Table - Means (Medians)

This table presents the descriptive statistics (mean, median, and correlation) for the matched samples in Compustat and Capital IQ. The dataset comprises 32,356 Capital IQ ∩ Compustat firm-year observations from 2002 to 2013. The matching procedure is as follows: We start with U.S. firms covered by both Capital IQ and Compustat from 2002 to 2013 (64,300 firm-years with 9,158 unique firms). We remove utilities (SIC codes 4900-4949) and financial firms (SIC codes 6000-6999) and end up with 47,897 firm-years with 6,921 firms. We further remove 1) firm-years with missing values of total assets (46,065 observations remaining); 2) firm-years with market or book leverage outside the unit interval (34,848 observations remaining); 3) firm-years for which the absolute value of the difference between total debt as reported in Compustat and the sum of debt types as reported in Capital IQ exceeds 10% of total debt (32,356 firm-year observations involving 5,661 unique firms remaining). Missing values for commercial paper is replaced with zero before constructing relevant variables. The COMPUSTAT mean is calculated conditional on the corresponding Capital IQ as non-missing, and vice versa. Below is the correlation and comparison of means (medians). The items are winsorized at 1st and 99th percentile and expressed in million dollars.

Item	**Capital IQ**	**Compustat**	**Correlation**	**Obs$_{\text{Capital IQ} \cap \text{Compustat}}$**
Total Debt	769.728	768.802	0.9999	32,356
	(64.349)	(64.272)		
Total Bank Debt	164.539	173.665	0.8365	25,530
	(22.196)	(8.089)		
Total Senior Bonds and Notes	868.761	1,022.930	0.9680	20,161
	(71.429)	(143.421)		
Total Capital Leases	25.854	23.094	0.9768	13,440
	(1.085)	(0.600)		
Total Senior Debt	733.677	735.238	0.9983	31,939
	(48.101)	(49.158)		
Total Subordinated Debt	198.657	174.145	0.8788	5,980
	(89.012)	(40.641)		
Total Convertible Debt	195.272	155.432	0.8597	7,377
	(57.500)	(13.521)		
Long-Term Debt	733.802	754.684	0.9858	29,239
	(80.123)	(80.014)		
Total Secured Debt	167.150	145.850	0.9062	24,999
	(14.599)	(6.859)		
Total Unsecured Debt	674.790	688.877	0.9866	22,648
	(53.200)	(65.076)		
Total Revolving Credit	68.852	n/a		20,198
	(9.000)	n/a		
Total Term Loans	175.211	n/a		15,931
	(14.549)	n/a		

Table 1.9: Robustness Test using Capital IQ

This table presents the results of second-stage simultaneous equation regressions for each of four debt types on five explanatory variables, industry (Fama-French 48) and year fixed effect controls estimated using two-stage least squares. All dependent variables are scaled by total book capitalization (D+E) following Rauh and Sufi's (2010). Each endogenous variable (bank debt, capitalized leases, convertible debt, and bonds-and-notes) is regressed on all the exogenous variables, instrument variables, industry and year fixed effects in the first stage. Instrument variables are {tax rate, cash holdings, *I(*tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)}. We use outstanding debt information from Capital IQ to compare results from Compustat database. In panel A, only Bank $\text{Debt}_{\text{Compustat}}$ is replaced by Bank $\text{Debt}_{\text{Capital IQ}}$ and other debt types are from Compustat. In other words, capitalized leases, convertible debt, bonds-and-notes are from Compustat and only bank debt information is replaced by information from the Capital IQ database. In panel B, all $\text{Debt}_{\text{Compustat}}$ are replaced by $\text{Debt}_{\text{Capital IQ}}$. Specifically, all debt outstanding information—bank debt, capitalized leases, convertible debt, bonds-and-notes—is from the Capital IQ database. Sample selection procedure is described as following: We start with U.S. firms covered by both Capital IQ and Compustat from 2002 to 2013 (64,300 firm-years with 9,158 unique firms). We remove utilities (SIC codes 4900-4949) and financial firms (SIC codes 6000-6999) and end up with 46,897 firm-years with 6,921 firms. We further remove 1) firm-years with missing values of total assets; 2) firm-years with missing values of total debts; 3) firm-years with market or book leverage outside the unit interval; 4) firm-years for which the absolute value of the difference between total debt as reported in Compustat and the sum of debt types as reported in Capital IQ exceeds 10% of total debt; 5) firm-years with less than 0 percent or more than 100 percent of their total debt maturing after more than three years; 6) firm-years that have zero or negative book values of equity (seq); 6) firm-years that have S&P Domestic Long-Term Issuer Credit Ratings equal to "SD (Selective Default)," "N.M. (Not Meaningful)," "D (Default)," or "Suspended"; 7) firm-years with missing values in regressors. Robust t-statistics are presented in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Table 1.9: Continued

Panel A: Only Bank Debt$_{Compustat}$ is replaced by Bank Debt$_{Capital\ IQ}$ and other debt types are from Compustat.

	Panel A-1: Instrument variables list[1]				Panel A-2: Instrument variables list[2]			
Independent Variable	[1] Bank Debt$_t$	[2] Capitalized Leases$_t$	[3] Convertible Debt$_t$	[4] Bonds and Notes$_t$	[1] Bank Debt$_t$	[2] Capitalized Leases$_t$	[3] Convertible Debt$_t$	[4] Bonds and Notes$_t$
Bank Debt$_t$		0.029***	-0.156***	2.914***		0.031***	-0.160***	2.864***
		(3.92)	(-4.57)	(2.80)		(4.22)	(-4.76)	(2.94)
Capitalized Leases$_t$	32.456***		5.194***	-93.833**	30.432***		4.994***	-85.692**
	(4.00)		(3.98)	(-2.13)	(4.12)		(4.01)	(-2.13)
Convertible Debt$_t$	-6.103***	0.182***		18.228***	-5.887***	0.185***		17.356***
	(-4.67)	(3.97)		(2.69)	(-4.65)	(4.01)		(2.74)
Bonds and Notes$_t$	0.300***	-0.009*	0.048**		0.295***	-0.009**	0.049**	
	(2.62)	(-1.96)	(2.47)		(2.68)	(-1.99)	(2.55)	
Profitability$_{t-1}$	-0.155**	0.005**	-0.026***	0.449	-0.151**	0.005**	-0.026***	0.427
	(-2.20)	(2.08)	(-2.90)	(1.62)	(-2.22)	(2.12)	(-3.01)	(1.63)
Tangibility$_{t-1}$	-0.467***	0.014***	-0.075***	1.362**	-0.437***	0.014***	-0.072***	1.247**
	(-3.84)	(11.05)	(-3.98)	(2.22)	(-3.96)	(10.96)	(-4.03)	(2.23)
MB$_{t-1}$	0.015*	-0.0005***	0.003**	-0.046*	0.014*	-0.0005***	0.002**	-0.040*
	(1.95)	(-2.70)	(2.18)	(-1.73)	(1.89)	(-2.59)	(2.11)	(-1.68)
Firm Size$_{t-1}$	-0.003	0.0001	-0.0003	0.010	-0.004	0.0001	-0.0004	0.013
	(-0.49)	(0.37)	(-0.28)	(0.50)	(-0.62)	(0.49)	(-0.36)	(0.65)
CF Volatility$_t$	-0.450***	0.014***	-0.072***	1.334**	-0.432***	0.014***	-0.071***	1.257**
	(-3.75)	(4.04)	(-3.34)	(2.36)	(-3.77)	(4.10)	(-3.36)	(2.39)
Intercept	0.342*	-0.010	0.054	-1.012	0.343*	-0.010	0.055*	-1.000
	(1.71)	(-1.48)	(1.57)	(-1.50)	(1.81)	(-1.56)	(1.66)	(-1.60)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	17,083	17,083	17,083	17,083	17,083	17,083	17,083	17,083
Weak identification test (Cragg-Donald Wald F statistic):	4.500	9.963	4.881	1.208	5.671	9.973	5.141	1.342
Hansen J statistic p-value (overidentification test of all instruments):	0.5684	0.5723	0.5666	0.5364	0.5790	0.6075	0.5947	0.5333

[1] Instrument list = {tax rate, cash holdings, *I* (tax loss carry-forward), *I*(investment tax credit), *I*(bond rated)}
[2] Instrument list = {tax rate, abnormal earnings, cash holdings, *I* (tax loss carry-forward), *I*(bond rated)}

Panel B: ALL $Debt_{Compustat}$ are replaced by $Debt_{Capital\ IQ}$. (All debt outstanding information - bank debt, capitalized leases, convertible debt, bonds and notes is from Capital IQ database).

Panel B-1: Instrument variables list[3]

Independent Variable	[1] $Bank\ Debt_t$	[2] $Capitalized\ Leases_t$	[3] $Convertible\ Debt_t$	[4] $Bonds\ and\ Notes_t$
$Bank\ Debt_t$		0.067**	-0.008	1.231**
		(2.38)	(-0.02)	(2.42)
$Capitalized\ Leases_t$	10.393***		4.811	-15.126***
	(3.02)		(1.21)	(-2.69)
$Convertible\ Debt_t$	-0.002	0.008		0.004
	(-0.01)	(0.37)		(0.01)
$Bonds\ and\ Notes_t$	0.556**	-0.044**	0.007	
	(2.42)	(-2.17)	(0.03)	
$Profitability_{t-1}$	0.343***	-0.030***	0.085	-0.513***
	(2.64)	(-3.34)	(0.62)	(-2.80)
$Tangibility_{t-1}$	-0.623***	0.061***	-0.275	0.929***
	(-2.75)	(6.80)	(-1.15)	(2.91)
MB_{t-1}	0.031*	-0.003***	0.028*	-0.052**
	(1.71)	(-3.35)	(1.81)	(-2.14)
$Firm\ Size_{t-1}$	-0.030***	0.002	-0.002	0.044***
	(-2.98)	(1.37)	(-0.18)	(3.11)
$CF\ Volatility_t$	-0.445***	0.037**	-0.105	0.653**
	(-2.62)	(2.41)	(-0.56)	(2.37)
Intercept	0.594***	-0.042**	0.248	-0.769***
	(6.80)	(-2.33)	(1.17)	(-2.58)
Year & Industry FE	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes
Number of Observations	1,555	1,555	1,555	1,555
Weak identification test (Cragg-Donald Wald F statistic):	1.000	6.116	0.286	0.909
Hansen J statistic p-value (overidentification test of all instruments):	N/A[31]	N/A	N/A	N/A

Panel B-2: Instrument variables list[4]

Independent Variable	[1] $Bank\ Debt_t$	[2] $Capitalized\ Leases_t$	[3] $Convertible\ Debt_t$	[4] $Bonds\ and\ Notes_t$
$Bank\ Debt_t$		0.059**	-0.327	1.120**
		(2.11)	(-0.56)	(2.37)
$Capitalized\ Leases_t$	10.877***		9.977	-15.230***
	(2.81)		(1.42)	(-2.83)
$Convertible\ Debt_t$	-0.125	0.021		0.186
	(-0.43)	(0.83)		(0.46)
$Bonds\ and\ Notes_t$	0.589**	-0.043**	0.255	
	(2.37)	(-2.15)	(0.59)	
$Profitability_{t-1}$	0.356**	-0.029***	0.241	-0.507***
	(2.48)	(-3.27)	(1.00)	(-2.77)
$Tangibility_{t-1}$	-0.651**	0.061***	-0.594	0.938***
	(-2.45)	(6.82)	(-1.35)	(2.89)
MB_{t-1}	0.035*	-0.004***	0.046*	-0.057**
	(1.70)	(-3.67)	(1.70)	(-2.27)
$Firm\ Size_{t-1}$	-0.032***	0.002	-0.011	0.043***
	(-3.12)	(1.28)	(-0.53)	(3.03)
$CF\ Volatility_t$	-0.462***	0.035**	-0.293	0.642**
	(-2.59)	(2.36)	(-0.91)	(2.42)
Intercept	0.629***	-0.040**	0.439	-0.755***
	(6.70)	(-2.27)	(1.22)	(-2.61)
Year & Industry FE	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes
Number of Observations	1,555	1,555	1,555	1,555
Weak identification test (Cragg-Donald Wald F statistic):	0.825	6.125	0.345	0.882
Hansen J statistic p-value (overidentification test of all instruments):	N/A	N/A	N/A	N/A

[3] Instrument list = {cash holdings, I(Altman's Z < 1.81), *I*(tax loss carry-forward), *I*(investment tax credit), *I*(bond rated), *I*(commercial paper rated)}

[4] Instrument list = {tax rate, cash holdings, *I*(Altman's Z < 1.81), *I*(tax loss carry-forward), *I*(bond rated), *I*(commercial paper rated

[31] Hansen's J-statistic p-value is not available. Conducting analysis using statistical program results in the following error: "Warning: estimated covariance matrix of moment conditions not of full rank. Over-identification statistic not reported, and standard errors and model tests should be interpreted with caution. Possible causes: singleton dummy variable (dummy with one 1 and N-1 0s or vice versa) partial option may address problem."

Table 1.10: Robustness Test with Longer History Firms

This table presents the results of second-stage simultaneous equation regressions for each of four debt types on five explanatory variables, industry (Fama-French 48), and year fixed effect controls estimated using two-stage least squares. Panel A includes samples if a firm has at least 10 years of history from our finalized sample. Panel B includes samples if a firm has at least 20 years of history from our finalized sample. T-statistics are based on robust standard errors. Robust t-statistics are presented in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Panel A: firms with at least 10 years of history

Independent Variable	[1] Bank Debt$_t$	[2] Capitalized Leases$_t$	[3] Convertible Debt$_t$	[4] Bonds and Notes$_t$
Bank Debt$_t$		0.112***	-0.590***	3.117***
		(4.26)	(-12.63)	(10.03)
Capitalized Leases$_t$	7.505***		4.486***	-23.065***
	(4.37)		(4.44)	(-3.71)
Convertible Debt$_t$	-1.659***	0.189***		5.203***
	(-12.70)	(4.36)		(8.57)
Bonds and Notes$_t$	0.309***	-0.034***	0.183***	
	(9.93)	(-3.59)	(8.44)	
Profitability$_{t-1}$	0.008	-0.002	0.004	-0.028
	(0.37)	(-0.69)	(0.29)	(-0.43)
Tangibility$_{t-1}$	-0.181***	0.023***	-0.109***	0.563***
	(-5.19)	(13.48)	(-5.51)	(4.51)
MB$_{t-1}$	0.009***	-0.001***	0.005***	-0.028***
	(3.33)	(-5.67)	(3.54)	(-3.33)
Firm Size$_{t-1}$	0.008***	-0.001***	0.005***	-0.023***
	(5.90)	(-5.12)	(6.75)	(-4.41)
CF Volatility$_t$	-0.236***	0.029***	-0.140***	0.735***
	(-5.51)	(5.74)	(-5.17)	(4.65)
Intercept	-0.324***	0.041***	-0.194***	1.015***
	(-5.93)	(8.54)	(-6.06)	(5.19)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes
Number of Observations	40,770	40,770	40,770	40,770
Weak identification test (Cragg-Donald Wald F statistic):	6.350	11.124	6.540	4.602
Hansen J statistic p-value (overidentification test of all instruments):	0.1836	0.1980	0.1832	0.1618

Panel B: firms with at least 20 years of history

Independent Variable	[1] Bank Debt$_t$	[2] Capitalized Leases$_t$	[3] Convertible Debt$_t$	[4] Bonds and Notes$_t$
Bank Debt$_t$		0.079	-0.575***	3.060***
		(1.55)	(-11.18)	(8.51)
Capitalized Leases$_t$	1.596		0.962	-3.221
	(1.10)		(1.13)	(-0.69)
Convertible Debt$_t$	-1.645***	0.136		5.096***
	(-11.19)	(1.57)		(7.17)
Bonds and Notes$_t$	0.292***	-0.015	0.170***	
	(8.22)	(-0.92)	(6.94)	
Profitability$_{t-1}$	-0.082**	-0.004	-0.051***	0.253**
	(-2.48)	(-0.53)	(-2.78)	(2.36)
Tangibility$_{t-1}$	-0.065***	0.016***	-0.040***	0.190**
	(-3.04)	(5.51)	(-3.18)	(2.58)
MB$_{t-1}$	0.00002	-0.001*	0.0003	-0.001
	(0.01)	(-1.81)	(0.19)	(-0.13)
Firm Size$_{t-1}$	-0.001	-0.0002	-0.0002	0.003
	(-0.53)	(-0.89)	(-0.31)	(1.03)
CF Volatility$_t$	-0.116**	0.025***	-0.064*	0.336*
	(-2.11)	(2.96)	(-1.91)	(1.88)
Intercept	0.149***	0.001	0.087***	-0.470***
	(2.88)	(0.11)	(2.83)	(-2.88)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes
Number of Observations	15,748	15,748	15,748	15,748
Weak identification test (Cragg-Donald Wald F statistic):	4.813	2.139	4.841	4.222
Hansen J statistic p-value (overidentification test of all instruments):	0.0189	0.0003	0.0198	0.0117

Table 1.11: Alternative Estimation Methods

This table presents the estimates of panel regressions for each of four debt types on five explanatory variables, industry (Fama-French 48), and year fixed effects, and/or additional control variables using alternative estimation methods: 2SLS, 3SLS, OLS. The sample contains 57,644 Compustat firm-year observations from 1980 to 2013 and a sample selection criterion is described in the Appendix A.2. The variables are as defined in Table 1.1 or Appendix A.1. All dependent variables are scaled by total book capitalization (D+E) following Rauh and Sufi's (2010). In Panel A, we use two-stage least squares method based on two alternative set of instrumental variables. Each endogenous variable (bank debt, capitalized leases, convertible debt, and bonds-and-notes) is regressed on all the exogenous variables, instrument variables, industry, and year fixed effects in the first stage. First-stage regression results are omitted and we present second stage regression estimates only. In Models [1]-[4], we employ two-stage least squares using the industry instrumental variables approach. Specifically, we use the industry averages of bank debt, capitalized leases, convertible debt, and bonds-and-notes as instrument variables for each firm's debt type: the four instrument variables are the contemporaneous annual average values of the four debt type measures (bank debt, capitalized leases, convertible debt, and bonds-and-notes) at other companies in the same Fama-French 48 industry category. In Models [5]-[8], we use different set of instrument variables (i.e., excluded instrument variables) from Table 1.3, which includes {firm age, abnormal earnings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(dividend payer), cash holdings, *I*(Altman's Z $<$ 1.81), *I*(bond rated), *I*(commercial paper rated), *I*(investment grade), and debt maturity}. We measure debt maturity as the fraction of a firm's total debt that matures in 3 years or less. For the 2SLS regressions, we report tests for whether the instruments are exogenous (i.e., uncorrelated with the error term in the second stage) and whether the instruments are relevant (i.e., correlated with the endogenous regressors bank debt, capitalized leases, convertible debt, and bonds-and-notes). We use the Hansen's J statistic for identifying restrictions to assess whether the instruments are uncorrelated with the second-stage error. In Panel B, we use three-stage least squares and ordinary squares regression methods. Models [1]-[4] present the estimates of a system of simultaneous equations (3SLS), in which we include additional control variables in each equation following the existing literature. Models [5]-[8] present ordinary squares regression estimates. T-statistics are based on robust standard errors. Robust t-statistics are presented in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Table 1.11: Continued

Panel A: 2SLS

Independent Variable	2SLS				2SLS			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	Bank Debt$_t$	Capitalized Leases$_t$	Convertible Debt$_t$	Bonds and Notes$_t$	Bank Debt$_t$	Capitalized Leases$_t$	Convertible Debt$_t$	Bonds and Notes$_t$
Bank Debt$_t$		0.254*	-0.585***	1.372***		0.014***	-0.036	0.915***
		(1.75)	(-4.53)	(3.71)		(3.29)	(-0.84)	(24.90)
Capitalized Leases$_t$	0.295		0.120	-1.036*	5.760***		9.199***	3.033***
	(0.75)		(0.48)	(-1.93)	(7.28)		(11.31)	(3.26)
Convertible Debt$_t$	-1.238***	0.220		1.380*	-0.065	0.041***		0.177***
	(-4.11)	(1.05)		(1.91)	(-1.33)	(8.77)		(2.90)
Bonds and Notes$_t$	0.447***	-0.290***	0.212*		0.218***	0.002	0.024	
	(3.35)	(-3.90)	(1.88)		(13.68)	(0.75)	(1.03)	
Weak identification test (Cragg-Donald Wald F statistic):	13.689	1.904	5.084	4.888	8.212	170.300	12.198	7.560
Hansen J statistic p-value (overidentification test of all instruments):	0.0097	0.0000	0.0042	0.0039	0.0000	0.0000	0.0000	0.0000
Instrumental Variables	industry averages of bank debt, capitalized leases, convertible debt, and bonds-and-notes				firm age, abnormal earnings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(dividend payer), cash holdings, *I*(Altman's Z < 1.81), *I*(bond rated), *I*(commercial paper rated), and *I*(investment grade), and debt maturity			

Panel B: 3SLS and OLS

Independent Variable	3SLS				OLS			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	Bank Debt$_t$	Capitalized Leases$_t$	Convertible Debt$_t$	Bonds and Notes$_t$	Bank Debt$_t$	Capitalized Leases$_t$	Convertible Debt$_t$	Bonds and Notes$_t$
Bank Debt$_t$		0.111***	-1.055***	4.181***		-0.010***	-0.056***	-0.359***
		(26.04)	(-30.70)	(13.09)		(-5.02)	(-13.33)	(-36.30)
Capitalized Leases$_t$	7.224***		10.386***	-25.048***	-0.137***		-0.060***	-0.308***
	(14.93)		(29.82)	(-4.22)	(-5.29)		(-4.12)	(-7.30)
Convertible Debt$_t$	-0.487***	0.101***		0.167	-0.135***	-0.011***		-0.358***
	(-15.67)	(43.86)		(0.24)	(-14.77)	(-4.06)		(-28.02)
Bonds and Notes$_t$	0.265***	-0.032***	0.312***		-0.177***	-0.011***	-0.073***	
	(19.79)	(-13.79)	(15.74)		(-31.57)	(-6.69)	(-19.84)	
Instrumental Variables	firm age, abnormal earnings, *I*(tax loss carry-forward), *I*(investment tax credit), *I*(dividend payer), cash holdings, *I*(Altman's Z < 1.81), *I*(bond rated), *I*(commercial paper rated), and *I*(investment grade), and debt maturity				none			

CHAPTER 2
CORPORATE CASH HOLDINGS AND INDUSTRY RISK

2.1 Introduction

Previous research on corporate cash holdings and liquidity choices between cash and lines of credit examines the precautionary motive of cash holdings and provides evidence consistent with that motive (e.g., Opler, Pinkowitz, Stulz, and Williams (1999), and Bates, Kahle, and Stulz (2009)). These papers typically test the precautionary motive hypothesis by relating a firm's variability of cash flows to corporate cash holdings. A recent line of research extends this literature by examining whether corporate cash holdings are associated with the extent to which a firm's cash flows co-vary with aggregate market condition. For example, Acharya, Almeida, and Campello (2013) examine and find that the sensitivity of a firm's stock returns to banks' returns is a determinant of the firm's liquidity choice between cash and lines of credit. Gao and Grinstein (2014) decompose a firm's uncertainty into aggregate and firm-specific components and show that the aggregate component is a key determinant of corporate cash holdings but not the firm-specific components. Although prior work predicts and shows that a firm's corporate policies, such as capital structure and dividend policy, are substantially determined by its interaction with peers operating in the same industry (e.g., Harford, Mikkelson, and Partch (2003), Haushalter, Klasa, and Maxwell (2007), Fresard (2010), Morellec, Nikolov, and Zucchi (2013), and Hoberg, Phillips, and Prabhala (2014)), the evidence on whether and to what extent a firm's interdependence with industry peers affects corporate cash holdings is scant.

This paper predicts that a firm's sensitivity to industry shocks (i.e., industry-wide risk) increases the firm's demand for cash as a precautionary motive. Prior work posits and finds that asset sales are one of the capital raising channels (e.g., Shleifer and Vishny (1992), Dixit and Pindyck (1994), and Edmans and Mann (2015)). However, asset sales are not a perfect substitute for cash holdings because most fixed assets such as equipment and land are often illiquid. Firms may not be able to generate sufficient funds from asset sales when they need them, because potential buyers of these assets are also likely to be in financial trouble, thus having difficulties with raising external funds and buying assets (Shleifer and Vishny (1992)). Therefore, the extent to which asset sales are a substitute for cash critically depends on a firm's sensitivity to industry shocks. As such, we predict that a firm's sensitivity to industry shocks determines the level of a cash buffer that a firm retains *ex ante*.

To test this prediction, we decompose a firm's total risk into three components—economy-wide risk, industry-wide risk, and firm-specific risk—in two ways. First, we conduct regressions of a firm's daily stock returns on the daily CRSP value-weighted market returns and industry returns. As a robustness check, we also add local returns to the model.[32] Coefficient estimates on industry returns are used as a proxy for a firm's sensitivity to industry shocks (i.e., industry-wide shocks).[33] Second, we apply a variance decomposition method, wherein we measure industry-wide risk by subtracting economy-wide risk from overall risk. Putting these proxies in context, a higher coefficient on industry returns from regressions of a firm's returns on market returns and industry returns indicates that a firm's performance has a high covariance with returns of an industry in which that firm operates. Also, if a large proportion of total return variance is explained by industry components, a firm's performance has a high sensitivity to industry performance. Thus, we conjecture that firms' cash holdings are positively associated

[32] Notice that in a firm's stock return model, we also control for market and local effects, which are important factors affecting a firm's stock performance. In particular, Acharya, Almeida, and Campello (2013) use market-based measures of beta to capture aggregate market risk and use this measure to explain a firm's liquidity management. On the other hand, Pirinsky and Wang (2006) argue that locality affects the covariance structure of underlying stock returns and find that stock returns of companies headquartered in the same geographic area (location) exhibit a strong degree of positive co-movement. Hence, in our paper, we simultaneously control market returns, industry returns, and local returns in a firm's returns regression model.

[33] Our industry risk measure departs from previous studies' methods by Parrino (1997) and Haushalter, Klasa, and Maxwell (2007). For instance, Haushalter, Klasa, and Maxwell (2007) examine the relation between cash holdings and industry risk. In their cash holding model, however, they do not control for market, local, and idiosyncratic risk along with industry risk, which could lead to omitted variables bias.

with these two proxies for industry-wide risk after controlling for other determinants of cash holdings.

For a sample of 19,548 firm-year observations over the period 1980–2013, we find evidence consistent with our prediction using proxies measured from both regression and variance decomposition methods. We show that industry-wide risk is positively associated with cash holdings after controlling for other determinants of cash holdings, including industry sigma, a firm's idiosyncratic risk, and market risk. This effect is also economically significant. A one standard deviation increase in industry-wide risk corresponds to an increase in corporate cash holdings of 10.30% (7.59%) when industry-wide risk is measured from a regression method (a variance decomposition method). This confirms that firms hold more cash when they have higher exposure to industry risk. Overall, our findings support the notion that a firm's sensitivity to industry shocks is an important determinant of corporate cash holdings.

Research on investment under uncertainty highlights the role of competition in determining corporate investment. Dixit and Pindyck (1994) argue that when firms seek to sell their industry-specific assets, such as steel plants, the magnitude of industry competition affects the resale values of those assets. Dixit and Pindyck (1994) state that "if the industry is reasonably competitive, the value of the plants will be about the same for all firms in the industry, so there would be little to gain from selling it." Consequently, firms that are operating in highly competitive industries are more likely to encounter asset illiquidity when trying to sell assets such as plants or equipment to competitors. As such, we predict that the effect of industry-wide risk on cash holding is more pronounced for firms operating in more competitive industries. We find evidence consistent with this prediction using various measures of competition.

While firms can meet liquidity needs through asset sales, they also meet their liquidity demand by raising capital in capital markets. Thus, the effect of industry-wide risk on cash holdings will be more pronounced for firms that are less able to raise capital from capital suppliers such as lenders, because asset sales are a more critical financing channel for such firms.

We test this prediction and find this is indeed the case. Specifically, we find that the relation between industry-wide risk and cash holdings is more pronounced for firms that are highly leveraged, have shorter maturity of debt, and a low level of asset tangibility.

We also examine whether financial constraints affect the relation between industry-wide risk and cash holdings. The importance of asset sales as a channel of raising capital is stronger for firms that are financially constrained. We test this conjecture by using three measures of financial constraints: the presence of credit ratings, the status of paying dividends, and firm size. Across three measures, we find evidence consistent with financially constrained firms exhibiting a greater relation between industry-wide risk and tendency to retain cash. Specifically, we show that the effect of industry-wide risk on cash holdings is stronger for firms that are non-rated, smaller, and do not pay dividends.

Next, we investigate how a firm's internal capital market influences the relation between the industry-wide risk and cash holdings. Prior research posits that diversification effects of multi-segment firms allow them to be more leveraged and hold less cash. For example, Shleifer and Vishny (1992) predict that multi-segment firms are better candidates for debt financing than single-segment firms holding firm size constant. Duchin (2010) finds that multidivisional firms hold less cash due to diversification effects among multiple segments. We predict that if multiple segments create diversification effects within a firm, these firms' cash holdings are less sensitive to their industry-wide risk. Our findings are consistent with this prediction. Across two measures of industry-wide risk, we find that the sensitivity of cash holdings to industry-wide risk is more pronounced for single-segment firms than multi-segment firms.

One concern of our study overall is that a firm's industry risk is endogenous to the firm's cash holding policy. Although we include a fairly exhaustive set of control variables along with year- and industry-fixed effects, we cannot rule out a possibility that correlated-omitted variables are driving both cash holdings and industry-wide risk. To mitigate this concern, we perform change specifications and find that our results hold. These findings help rule out time-invariant factors as potential correlated-omitted variables. Nonetheless, we cannot preclude the possibility that unobservable time-varying variables drive our results.

Our paper contributes to the research examining the determinants of cash holdings. Prior work testing the precautionary motive hypothesis finds that the variability of a firm's cash flows is a determinant of the firm's cash holdings (Opler, Pinkowitz, Stulz, and Williamson (1999) and Bates, Kahle, and Stulz (2009)). A recent strand of research recognizes that the covariance of a firm's cash flows with overall market condition (i.e., aggregate risk) influences corporate cash holdings (Acharya, Almeida, and Campello (2013) and Gao and Grinstein (2014)). Our study predicts and finds that a firm's sensitivity to industry-wide risk is a determinant of corporate cash holdings after controlling for other determinants of cash holdings, including a firm's sensitivity to banks' wealth and aggregate risk. Our findings also reveal that industry risk has an economically greater effect on cash holdings than aggregate risk.

Our paper also contributes to the literature that investigates the role of a firm's interdependence on peers operating in the same industry. Prior research provides evidence that various corporate policies, such as capital structure, are related to the firm's interaction with industry peers (Jorion and Zhang (2007), Acharya, Bharath, and Srinivasan (2007), and Hertzel and Officer (2012)). Our evidence adds to this line of research by showing that corporate cash holdings are affected by a firm's sensitivity to industry shocks.

The remainder of our paper is organized as follows. Section 2 reviews prior literature and develops our hypotheses. Section 3 describes our sample construction, descriptive statistics for the sample, and the research design. Section 4 presents the empirical results of our tests and discusses the findings. Section 5 presents robustness tests. Finally, Section 6 offers concluding remarks.

2.2 Related Literature and Hypothesis Development

Several studies have examined corporate cash holdings and corporations' motivations for stockpiling cash. Bates, Kahle, and Stulz (2009) discuss four motivations for holding cash: the transaction motive, the tax motive, the agency motive, and the precautionary motive. The transaction motive posits that firms hold cash to avoid the cost of converting non-liquid assets into liquid assets (e.g., Baumol (1952), and Miller and Orr (1966)). The tax motive predicts that as firms face higher repatriation taxes, they prefer to deter converting their foreign earnings into U.S. dollars and instead hold cash abroad (e.g., Foley, Hartzell, Titman, and Twite (2007)). The agency motive suggests that poorly monitored or entrenched managers inefficiently manage cash flows and hold more cash (e.g., Jensen (1986), and Dittmar and Mahrt-Smith (2007)). Our study focuses on the precautionary motive for holding cash, which suggests that firms hold large cash reserves to better deal with adverse economic shocks and to improve investment opportunities when access to capital markets is costly. There are many studies that emphasize the precautionary aspects of a firm's cash reserves.[34] For instance, Lins, Servaes, and Tufano (2010) survey CFOs from 29 countries and find that non-operational (excess) cash protects firms against future cash flow shocks in bad times.

A large body of studies has examined the relationship between industry risk and corporate policies. For example, Lang and Stulz (1992) find that around the time of a peer firm's bankruptcy announcement the firm can experience valuation losses (contagion effect) in competitive industries, and valuation gain (competitive effect) in concentrated industries. Moreover, bankruptcy filings by industry rivals can lead to large jumps in a company's credit default swap (CDS) spread (Jorion and Zhang (2007)) and significant loan spread increase for new or renegotiated corporate loans (Hertzel and Officer (2012)). During times of industry-wide

[34] For example, Keynes (1936), Kim, Mauer, and Sherman (1998), Opler, Pinkowitz, Stulz, and Williamson (1999), Almeida, Campello, and Weisbach (2004), Almeida and Campello (2007)), and Bates, Kahle, and Stulz (2009). Review papers for corporate liquidity management include Almeida, Campello, Cunha, and Weisbach (2014) and Denis (2011).

distress, firms' debt recovery rates are lower (Acharya, Bharath, and Srinivasan (2007)) and they are especially lower for industries with high asset specificity.

Most importantly, our research heavily builds on Shleifer and Vishny's (1992) theoretical model on liquidation values and debt capacity. Shleifer and Vishny's (1992) model explains how asset illiquidity reduces a firm's optimal amount of debt in the capital structure, and emphasizes that economy- and industry-wide risk are important factors in determining asset liquidity. More specifically, when firms have trouble meeting their debt payments, they may need to sell their assets at fire sale prices.[35] The potential buyers of these assets are more likely to be other firms in the same industry. However, during industry downturns, these potential buyers are also likely to have financial difficulties in meeting their debt obligations at the same time. These potential buyers may not be able to raise funds even though they want to purchase the distressed firms' assets at cheap prices. Therefore, those assets may not be sellable at the best price in the market. Such a decline in asset liquidity triggers asset prices to drop further, which would be particularly damaging to highly leveraged firms for which asset sales are necessary in order to meet their debt obligations. As a result, such firms are more likely to have a high risk of default. After all, Shleifer and Vishny's (1992) model implies that liquidated assets are underpriced during recessions, and thus suggests that asset illiquidity is a potentially important cost of leverage and reduces a firm's debt capacity.

Meanwhile, in cash holdings literature, Bates, Kahle, and Stulz (2009) show that U.S. firms increase cash holdings because industry cash flows become riskier. Although a large number of studies document that industry risk is a significant determinant of corporate cash holdings[36], no study has directly examined how segregated systematic risks affect the likelihood

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[35] The existing literature suggests that asset sales are firms' alternative funding sources when debt and equity financing is not available (Edmans and Mann (2014)), and that firms use these proceeds from asset sales for their debt payments (Shleifer and Vishny (1992)) and for their investment and R&D expenditure (Hovakimian and Titman (2006), and Borisova and Brown (2013)).

[36] See, for example, Opler, Pinkowitz, Stulz, and Williamson (1999), Harford, Mikkelson, and Partch (2003), Haushalter, Klasa, and Maxwell (2007), and Bates, Kahle, and Stulz (2009).

of saving cash in order to sustain steady operations. In our study, we propose a new approach which separates systematic risk into three components—market risk, industry risk, and local risk—while controlling for idiosyncratic risk factors and firm characteristics. We focus on one component of systematic risk (industry risk) and hypothesize that firms with high industry risk exposure are more likely to hold a large cash balance.

Hypothesis 1: *Firms with high industry risk exposure are more likely to hold a large cash balance.*

The literature suggests that a firm's financial strength (e.g., large cash reserves) facilitates predatory strategies and improves market share at the expense of industry rivals (Bolton and Scharfstein (1990), Haushalter, Klasa, and Maxwell (2007), Fresard (2010), and Hoberg, Phillips, and Prabhala (2014)). Moreover, Morellec, Nikolov, and Zucchi (2013) find that firms in competitive industries hold more cash because their profitability of assets depends on the magnitude of product market competition and therefore, they are more likely to face greater risk raising costly external finance. Thus, we hypothesize that firms facing more competition will respond to the industry risk exposure sensitively and tend to save more cash.

Hypothesis 2: *The effect of industry risk exposure on corporate cash holding is greater among firms in highly competitive industries.*

Highly leveraged firms have less flexibility to respond to changes in market conditions (Bolton and Scharfstein (1990)) and a high chance of financial distress if they fail to refinance existing debt with creditors. When these firms face increased market uncertainty, refinancing becomes harder and external financing is more costly because they have to pay higher interest rates (Froot, Scharfstein, and Stein (1993)). High outstanding debt results in high default risk (or liquidation risk) if a firm does not hold enough internal cash to repay debt or does not have the ability to refinance it (Diamond (1991, 1993)). If a firm has a high percentage of debt maturing within three years or has a higher leverage ratio, it also has a greater refinancing risk (Harford, Klasa, and Maxwell (2014)). Thus, firms with higher leverage ratios or higher percentages of debt maturing in the near future should respond more sensitively to industry risk exposure and save more cash.

Hypothesis 3: *The effect of industry risk exposure on corporate cash holdings is greater among firms with higher leverage ratios or higher percentages of debt maturing within three years.*

Fixed assets support more external financing because they increase creditors' recovery value in the event of bankruptcy and mitigate loan contractibility problems. Firms with more tangible assets are less likely to be financially constrained (Almeida and Campello (2007)), and in the presence of financial friction, firms use tangible assets as collateral to finance new projects (Chaney, Sraer, and Thesmar (2012)). In contrast, firms with valuable growth opportunities or intangible assets tend to borrow less than firms holding mostly tangible assets (Myers (1984)). The value of growth opportunities or intangible assets will drop dramatically if a firm faces bankruptcy, which suggests that the expected bankruptcy costs for these firms will be higher (Myers (1984), Williamson (1988), and Harris and Raviv (1990)). This motivates firms with higher fixed asset ratios to be less likely to adjust cash holdings in the face of industry risk exposure.

Hypothesis 4: *The effect of industry risk exposure on corporate cash holdings is lower among firms with higher fixed asset ratios.*

Several studies find that financially constrained companies are highly vulnerable to economic shocks or product market competition. Reserve cash holdings mitigate these adverse effects (Hovakimian and Titman (2006), Duchin, Ozbas, and Sensoy (2010), Denis and Sibilkov (2010), and Morellec, Nikolov, and Zucchi (2013)). The existing literature has used several proxies to measure credit constraints, including public bond ratings, dividend payment history, and a firm's asset size information (see, Erickson and Whited (2000), Almeida, Campello, and Weisbach (2004), and Almeida and Campello (2007)). Financially constrained companies are often smaller, less established, and do not pay dividends to shareholders. Firms without bond ratings are more likely to have a higher level of information asymmetry and face higher credit constraints when exposed to high industry risk. Therefore, we hypothesize that the effect of industry risk exposure on corporate cash holdings will be greater among bank-dependent or financially constrained firms.

Hypothesis 5: *The effect of industry risk exposure on corporate cash holdings should be greater among financially constrained firms.*

2.3 Data and Research Design

2.3.1 Sample construction

We use data from the COMPUSTAT database to collect accounting information from 1980 to 2013.[37] Our sample includes firms incorporated in the United States with positive sales revenues and asset book values and excludes financial service firms (SIC code 6000-6999) and regulated utility firms (SIC codes 4900-4999). We estimate the separate components of systematic risk using stock return information from the CRSP database and CEO's vega and delta from the ExecuComp database.

In constructing firm characteristics, we use the same definitions as in Bates, Kahle, and Stulz (2009) and we also control for CEO's vega and delta by following Liu and Mauer (2011). We then merge the resulting sample of the Compustat firms with CRSP and ExecuComp and include (1) firm-years for those firms possessing an S&P Domestic Long-Term Issuer Credit Rating (investment grade or speculative grade); (2) firm-years for firms without rating information; (3) firm-years with leverage within the unit interval ($0 \leq$ leverage ≤ 1); and (4) firm-

[37] Our dataset from Compustat was downloaded on March, 13, 2014.

years with a percentage of daily stock trading volume per year that is greater or equal to 90% to exclude outliers. After we exclude samples with missing information, this leaves us with 2,177 firms and a total of 19,548 firm-year observations. All continuous firm characteristic variables are winsorized at the 1st and 99th percentiles. Tables in Appendix B.1 and B.2 provide a detailed description of the variables used in our analysis and sample selection procedures. Table 2.1 presents descriptive statistics.

To investigate how industry risk affects a firm's cash holdings under industry competition, we borrow existing measures from the current literature. We use three proxies—the Herfindahl-Hirschman Index (HHI), the number of peers, and the PctComp—to measure industry competition. We use the Fama-French 48-industry classifications to define the HHI and the number of peers.

Our first proxy for industry competition is the Herfindahl-Hirschman Index (HHI). The HHI is a widely used proxy for competition that is well grounded in industrial organization theory (see Tirole, 1988). A higher HHI implies weaker competition in the same industry. The HHI is defined as the sum of squared market shares:

$$HHI_{jt} := \sum_{i=1}^{N_j} s_{ijt}^2 \quad (1)$$

We define s_{ijt} as the market share of firm i in industry j in year t and N_j is the number of firms in the same industry, according to the Fama-French 48-industry classifications. Market shares are computed from Compustat based on firms' sales.

Our second proxy for industry competition is the number of peers, which measures the total number of firms.

Our third proxy for industry competition is the PctComp developed by Li, Lundholm, and Minnis (2013) and available on the authors' website. It is defined as 1000*(the number of competition-related words/the total number of words) from the 10-K filing. As PctComp increases, there is more competition in the market.

For the subgroup analysis, we divide our samples into two groups—financially constrained firms and financially unconstrained firms—according to the three categories used by Almeida, Campello, and Weisbach (2004): (1) rated and non-rated firms, (2) dividend paying and non-dividend paying firms, and (3) large-asset-size and small-asset-size firms. First, we define a sample as a rated firm if its S&P Domestic Long-Term Issuer Credit Rating (splticrm in COMPUSTAT) is not missing and it has investment or speculative grade. In other words, a rated firm has a credit rating from the following set {AAA, AA+, AA… CCC, CC, C}. We define a sample as a non-rated firm if its credit rating information is missing. Ratings equal to "SD (Selective Default)", "N.M. (Not Meaningful)", "D (Default)", and "Suspended" are not included. Second, a firm is considered to be a dividend paying firm if its common dividend (dvc) is positive from COMPUSTAT. Otherwise, a firm is defined as a non-dividend paying firm. Third, we define a firm as a large-size firm if its asset size is greater than the overall sample median and small-size firm if its asset size is smaller than the overall sample median.

2.3.2 Sample description

Panel A of Table 2.1 provides descriptive statistics for industry risk, market risk, cash holdings, and firm-specific control variables. Definitions for all variables are given in Table B.1 of the Appendix. Our main variable, β_2: Industry-wide, has a mean of 0.387 and a median of 0.307 and ranges from -0.268 to 1.465. Cash holding has a mean of 15% and a median of 8% with a standard deviation of 17.2%. We note that sample firms generally have high growth opportunities based on an average market-to-book ratio of 2.039 and a median of 1.623. Finally, 49% of our sample firms pay dividends and 47.6% of the firms have S&P Credit rating information. We use this dividend and rating information to determine if firms are financially constrained or more bank-dependent. The means (medians) of CEO's dollar vega and delta incentives (i.e., Vega/TC and Delta/TC) represent about 3% (2%) and 35% (7%) of total annual compensation respectively, which are similar to Liu and Mauer's (2011) results. Further, Panel B of Table 2.1 presents the Pearson correlation coefficients between the variables used in our regression.

2.3.3 Research design

To test our hypotheses, we regress a firm's daily stock returns based on the daily CRSP value weighted market returns and industry returns. Our stock return model is written as follows:

$$R_{it} = \beta_0 + \beta_1 ECONOMY\ RETURN_t + \beta_2 INDUSTRY\ RETURN_{it} + \epsilon_{it}, \quad (2)$$

We define Economy Return as the value weighted average return (vwretd) from CRSP and $\text{Industry Return}_{it} = \sum_{k \neq i} \omega_{kt-1} R_{kt}$ as the market value weighted average return of other firms in the same industry based on the 4-digit SIC code. Note that firm (i) itself is excluded from the construction on industry index.

To measure a firm's industry risk exposure, we apply two methodologies based on regression results (2) and use two different proxy variables. First, the regression coefficient of the industry returns (i.e., $\widehat{\beta_2}$) is used as a proxy for the correlation between a firm's stock returns and industry stock returns and functions as our baseline measure of industry risk.

Second, we apply a variance decomposition method based on Type I sum of squares method from the ANOVA table. Intuitively, if we assume that each variable is not correlated with the others in equation (2), we will have the following relation for a firm's stock return variance: $\sigma^2 = \sigma_1^2 + \sigma_2^2 + \sigma_3^2$. Here, $\{\sigma_1^2, \sigma_2^2\}$ captures systematic risks, which include economy-wide risk and industry-wide risk, and σ_3^2 captures firm-specific idiosyncratic risk, or unexplained variance. In particular, each systematic risk is sequentially considered, market risk first and then industry risk. In other words, industry risk captures "incremental systematic risk" after we control for market risk. The following example (Figure 2.1) shows how we estimate systematic risk—market risk and industry risk—using the variance decomposition method from the two factor model. In the example below, we define X_1= Market Return and X_2= Industry Return.

ANOVA Table Containing Decomposition of SSR -Type I Sum of Squares

Source of Variation	*SS*	*df*	*MS*
Regression	SSR (X_1, X_2)	2	MSR (X_1, X_2)
X_1	SSR (X_1)	1	MSR (X_1)
X_2 |X_1	SSR (X_2 |X_1)	1	MSR (X_2 |X_1)
Error	SSE (X_1, X_2)	n-3	MSE (X_1, X_2)
Total	SST	n-1	

SSR (X_1, X_2) = SSR (X_1) +SSR (X_2 |X_1)

SST = SSR + SSE

Type I Sum of Squares

Definition of Explained (Unexplained) σ	Variables Name Based on Variance Decomposition Methods
Explained $\sigma_{\text{all three}} = \sqrt{VAR(r_i) * SSR(X_1, X_2)/SST}$	
Explained $\sigma_1 = \sqrt{VAR(r_i) * SSR(X_1)/SST}$	**Explained σ_1 : Economy Wide**
Explained $\sigma_2 = \sqrt{VAR(r_i) * SSR(X_2 \mid X_1)/SST}$	**Explained σ_2 : Industry Wide**
Unexplained $\sigma_3 = \sqrt{VAR(r_i) * SSE(X_1, X_2)/SST}$	**Unexplained σ_3**

Figure 2.1: Variance decomposition methods

Next, to examine the relation between the firm's industry risk exposure and cash holdings, we include all explanatory variables in the model following Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009), and Liu and Mauer (2011). Standard errors are clustered at the firm level as in the analyses of corporate cash holdings conducted by Harford, Mansi, and Maxwell (2008) and Harford, Klasa, and Maxwell (2014).[38] Our empirical model is written as follows:

$$\begin{aligned} CASH\ HOLDING_{it} = {} & \gamma_0 + \gamma_1 \widehat{\beta_1}: ECONOMY\ WIDE_{it} + \gamma_2 \widehat{\beta_2}: INDUSTRY\ WIDE_{it} \\ & + \gamma_3 IDIOSYNCRATIC\ RISK_{it} + \gamma_4 VEGA/TC_{it} + \gamma_5 DELTA/TC_{it} \\ & + \gamma_6 INDUSTRY\ SIGMA_{it} + \gamma_7 MB_{it} + \gamma_8 SIZE_{it} + \gamma_9 CASHFLOW_{it} \\ & + \gamma_{10} NWC_{it} + \gamma_{11} CAPEX_{it} + \gamma_{12} LEVERAGE_{it} + \gamma_{13} R\&D_{it} \\ & + \gamma_{14} DIVIDEND_{it} + \gamma_{15} ACQUISITION_{it} + \sum_j INDUSTRY_j + \sum_t YEAR_t \\ & + \xi_{it}, \qquad (3) \end{aligned}$$

[38] Our test results are also consistent when standard errors are clustered at the year and firm level to correct for cross-sectional and time-series dependence because it is panel data (Peterson (2009)).

$$
\begin{aligned}
CASH\ HOLDING_{it} \ =\ & \gamma_0 + \gamma_1 EXPLAINED\sigma_1{:}\ ECONOMY\ WIDE_{it} \\
& + \gamma_2 EXPLAINED\sigma_2{:}\ INDUSTRY\ WIDE_{it} + \gamma_3 UNEXPLAINED\sigma_{3_{it}} \\
& + \ \gamma_4 VEGA/TC_{it} + \ \gamma_5 DELTA/TC_{it} + \ \gamma_6 INDUSTRY\ SIGMA_{it} + \gamma_7 MB_{it} \\
& + \gamma_8 SIZE_{it} + \ \gamma_9 CASHFLOW_{it} + \ \gamma_{10} NWC_{it} + \gamma_{11} CAPEX_{it} + \gamma_{12} LEVERAGE_{it} \\
& + \gamma_{13} R\&D_{it} + \gamma_{14} DIVIDEND_{it} + \ \ \gamma_{15} ACQUISITION_{it} + \sum_j INDUSTRY_j \\
& + \sum_t YEAR_t + \xi_{it}, \qquad (4)
\end{aligned}
$$

Variable definitions are as follows:

1. $\widehat{\beta_1}$: Economy-Wide is the estimated beta coefficient of economy return in the firm's stock return regression using a two-factor model equation (2).
2. $\widehat{\beta_2}$: Industry-Wide is the estimated beta coefficient of industry return in the firm's stock return regression using a two-factor model equation (2).
3. Idiosyncratic risk is the standard deviation of residuals in the firm's return regression (2). It is defined as $\sqrt{\frac{\sum (r_i - \hat{r}_i)^2}{n-k-1}}$, where n is the number of the sample size (from return observation), and k = 2 if using a two-factor model.
4. Cash holding is the ratio of cash and cash equivalents (che) to total assets (at).
5. Vega/TC is the ratio of vega to total compensation. Vega is the change in the value of the CEO's option grant in a year and any accumulated option holdings for a 0.01 change in the annualized standard deviation of stock returns.
6. Delta/TC is the ratio of delta to total compensation. Delta is the change in the value of the option or restricted stock grants in a year, shareholdings, and any accumulated restricted stock and option holdings for a 1% change in the stock price.
7. Industry sigma is the average of the standard deviations of cash flow over the past 10 years for firms in the same industry, as defined by two-digit SIC code. The definition of cash flow is described in number 10.

8. MB is the market-to-book ratio and computed as market value (at - ceq + prcc_f*csho) divided by assets (at).
9. Size is the natural logarithm of book assets (at) in 2004 dollars.
10. Cashflow is the earnings after interest, dividends, and taxes but before depreciation (oibdp - xint - txt - dvc), divided by assets (at).
11. NWC is working capital (wcap) minus cash (che), divided by assets (at).
12. Capex is capital expenditures (capx) divided by assets (at).
13. Leverage is long-term debt (dltt) plus debt in current liabilities (dlc), divided by assets (at).
14. R&D is the ratio of R&D expenses (xrd) over sales (sale), set equal to zero when it is missing.
15. Dividend is a dummy variable equal to one in years in which a firm pays a common dividend (dvc), and 0 otherwise.
16. Acquisition is acquisitions (acq) divided by assets (at).
17. Year and Industry capture year- and industry-specific effects, respectively. Industry fixed effects are based on the Fama-French 48 industries classification.

2.4 Empirical Results

2.4.1 What determines a firm's cash holdings?

Table 2.2 reports the results of our regression analyses of the relationship between a firm's cash holdings and industry risk exposure and firm characteristics by following Opler, Pinkowitz, Stulz, and Williamson (1999), Bates, Kahle, and Stulz (2009) and Liu and Mauer (2011). All of the regressions include industry and time effects, and the t-statistics in parentheses below the parameter estimates are computed using robust standard errors that are clustered at the firm level. We apply two methodologies to measure industry risk. Model [1] uses the estimated beta coefficients from a firm's return regression (2). Model [2] uses systematic risks estimated by the variance decomposition method (Type I sum of squares method from the ANOVA table). Because both results in Panel A and Panel B from Table 2.2 show consistent patterns regarding the relations between cash holdings and risk factors, we focus our discussion on the panel A regression results for the rest of our paper.

Model [1] and Model [2] in Table 2.2 show the contemporaneous relation between cash holdings and a firm's industry risk exposure. The regression reveals that a firm's economy-wide risk has a positive effect on cash holdings and industry risk has a strong positive effect on cash holdings. Idiosyncratic risk has a negative effect on cash holdings.[39] More specifically, firms hold more cash when they have higher exposure to industry risk, all things being equal. The positive effect of industry risk on cash holdings is not only statistically significant, but also economically significant. Specifically, in Models [1] and [2] a one standard deviation increase in a firm's industry risk exposure increases cash holdings by 10.30% and 7.59%, respectively, after controlling for other cash holding determinants including industry sigma, idiosyncratic risk, and market risk.[40] We also note that the economic impact of industry risk exposure on corporate cash holdings is much greater (10.30%) than the impact of economy-wide risk (4.23%) as shown by Model [1]. This is important, as researchers have typically focused on the effect of economy-wide risk on cash holdings and not on the effect of industry risk.

Overall, our findings are consistent with the argument made by Shleifer and Vishny (1992), Lang and Stulz (1992), Froot, Scharfstein, and Stein (1993), Haushalter, Klasa, and Maxwell (2007), and Hertzel and Officer (2012). For example, Shleifer and Vishny (1992) argue that during industry downturns many assets are often illiquid and firms may not be able to generate sufficient funds from asset sales because their potential buyers are also likely to have

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[39] Dixit and Pindyck (1994) and Shleifer and Vishny (1992) argue that firms faced with greater likelihood of company-specific shocks rather than industry-specific shocks can more easily sell assets to industry peers when they need to raise cash. Thus, high idiosyncratic risk relative to industry risk can actually be a hedge.

[40] Increasing $\hat{\beta}_2$:Industry-wide by one standard deviation (0.374) increases firm's cash holdings by 0.0413167*0.374= 0.0154, which represents 10.30 percent of cash holdings' average (0.150).

financial difficulties in raising external funds and buying assets, which lowers asset prices further. Moreover, Haushalter, Klasa, and Maxwell (2007) find that if a firm shares a significant proportion of growth opportunities with product market rivals—which they measure by the correlation of the firm's stock returns with industry stock returns—an inability to fully invest in these opportunities leads to losses in market share due to predatory behavior on the part of their rivals. To hedge these risks, firms tend to hold more cash and use financial derivatives. Both studies suggest that internal industry problems have a greater effect on individual firms than problems in the broader economy and explain why industry risk is important for firms and motivates them to hold more cash for precautionary reasons.

The regression coefficients for the control variables are generally consistent with Bates, Kahle, and Stulz (2009) and Liu and Mauer (2011), except that a few of the variables have a statistically weak relationship with cash holdings. First, for example, our industry risk measure rules out the "industry sigma" measure that was introduced by Opler, Pinkowitz, Stulz, and Williamson (1999) and Bates, Kahle, and Stulz (2009) and has been widely used in current literature. Industry Sigma is based on a firm's cash flow information and proxies for industry cash flow risk. Firms with greater cash flow risk in an industry hold more cash for precautionary reasons. Notice that the coefficient of this variable is almost zero and no longer statistically significant in our model. Second, the CEO's risk-taking (Vega/TC) incentive variable is positively related to a firm's cash holdings because bondholders require additional cash as a cushion against possible losses (Liu and Mauer (2011)), but is not statistically significant in our model. Lastly, the other control variables generally trend as expected. For example, in Model [1], the sign of Size is negative, which is consistent with the idea that smaller firms suffer from greater information asymmetry problems and eventually pay higher transaction costs when they have external financing; hence, they hold a large quantity of cash on hand. The MB and R&D expense variables measure firms' greater growth and investment opportunities. Because the value of cash holdings is higher for high market-to-book ratio and R&D firms, they are expected to hold a larger amount of cash. In contrast, NWC acts as a substitute for cash reserves and we expect that the sign of this coefficient will be negative. CAPEX can be considered a measure of a firm's investment level and we expect these firms to accumulate less cash. Constrained firms with high leverage will use cash reserves to pay off or reduce their debt. Therefore, leverage is negatively associated with cash holdings. Firms that pay dividends are considered non-financially constrained and have greater access to capital markets, and thus, we expect these firms have less motivation to hold large cash reserves. Lastly, firms spend cash reserves on their merger and acquisition activities, and we expect the sign of this coefficient to be negative.

2.4.2 Product market competition

The results show that a firm's high industry risk exposure leads the firm to hold more cash. The question remains—what about industry competition? Industry competition, which is a popular topic in corporate finance, can be considered as one kind of industry risk. To investigate how a firm's industry risk exposure affects its cash holdings in situations of industry competition, we borrow existing industry competition measures from the current literature. We use three proxies—the Herfindahl-Hirschman Index (HHI), the number of peers, and the PctComp—to measure industry competition. Fama-French 48-industry classifications are used to define the HHI and the number of peers. There is high competition as the number of peers and PctComp measures increase, but low competition in the market as HHI increases.

Table 2.3 presents the regression results for models including the industry competition measure and its interaction with industry risk in our baseline model. The interacted industry competition variables in Models [1], [2], and [3], are HHI, number of peers, and PctComp. As shown in Panel A in Table 2.3, we find that the positive association between industry risk and corporate cash holding is more pronounced in industries with high competition. Specifically, the coefficient of the interaction between industry risk, $\widehat{\beta_2}$, and HHI is negative, and the coefficients are all positive for the interactions between industry risk, $\widehat{\beta_2}$, and the number of peers, and

PctComp. We find that each of the three interaction terms is statistically significant. A firm with more competition–related words in the annual 10-K reports, and a lower HHI in the same industry, tends to hold more cash for the industry effects.

As explained in the introduction, our results are consistent with Dixit and Pindyck's (1994) argument that during industry downturns there is little gain from asset sales in a competitive industry. Drops in asset prices also signal that investment in those assets is a bad investment decision and accordingly, distressed firms would have more difficulty selling the assets. Moreover, our results are consistent with another strand of literature that suggests large cash reserves help to protect firms from predatory behavior and improve market share in a competitive market (Bolton and Scharfstein (1990), Haushalter, Klasa, and Maxwell (2007), Fresard (2010), and Hoberg, Phillips, and Prabhala (2014)). Intuitively, if a firm is highly exposed to industry risk, an unexpected negative industry shock will affect it much more negatively. At the same time, more competitors are waiting for the chance to attack this vulnerable firm and acquire it to increase their market power. In other words, this firm becomes an easy target for M&A from peers, if not prepared, and this will motivate a firm to hold more cash to survive in a competitive market. Lastly, our results contribute to the argument made by Morellec, Nikolove, and Zucchi (2013). However, while they show the effects of competition on cash holdings, we show that competition affects cash holding via industry risk. In sum, our results confirm that industry risk is more pronounced in industries with more competition, thus contributing to a culture of precautionary cash holding behavior.

2.4.3 Leverage, percentage of short-term debt, and asset tangibility

We further analyze the effect of the firm's debt financing flexibility on the relationship between positive cash holdings and industry risk. Firms with huge outstanding debt or a significant amount of short-term debt maturing in the near future should be subject to the greatest refinancing risk **(**Harford, Klasa, and Maxwell (2014))**,** and as a result, they will be much more vulnerable to the exposure of industry risk. Moreover, if firms have high tangible assets, their new debt contracts may depend on collateral values (e.g., fixed assets) they pledge, which would provide a buffer to industry shock. Or, firms may choose to sell their fixed assets as alternative financing sources during industry downturns. Thus, we predict that firms that have relatively 1) higher leverage, 2) a higher percentage of debt due within three years, and 3) fewer fixed assets will be more sensitive to their industry risk exposure on corporate cash holdings.

Panel A in Table 2.4 presents sensitivity analysis regressions based on debt financing status (Models [1] and [2]) and fixed asset % (Model [3]). We interact X variable—leverage, % of maturing within 3 years, and PP&E/AT—with each individual risk factor: economy-wide risk, industry-wide risk, and idiosyncratic risk. As shown in Model [1] from Table 2.4, individual risk $\widehat{\beta_2}$ is statistically significant. The interaction term with the leverage variable has a positive coefficient (0.055) and is statistically significant, which suggests that firms with high leverage are sensitive to industry risk exposure and hold more cash. Meanwhile, the interactions between the leverage variable and economy-wide and idiosyncratic risk are not statistically significant. In Model [2], the coefficient for the interaction between industry risk and the % of debt maturing within 3 years is positive, which suggests that firms that have more debt due within 3 years react more sensitively to industry risk exposure by saving more cash. In Model [3], the coefficient on industry risk interacted with the PP&E/AT is negative. Thus, the results show that a high level of fixed assets can provide a buffer against industry shock and allow firms to save less cash.

2.4.4 Financial constraints

Our main results (Table 2.2) show that industry risk is positively related to corporate cash holdings. However, cash holdings might be more valuable for financially constrained or bank-dependent firms which often have high information asymmetry problems and face higher costs for obtaining external funds. To test this hypothesis further, we examine whether this association is stronger for financially constrained firms than for financially unconstrained firms in Table 2.5.

Following Almeida, Campello, and Weisbach (2004), we partition the sample into the unconstrained and constrained subsamples based on the existence of bond ratings, payout policy, and asset size. First, we assume that non-rated firms are more likely to depend on bank loans because they do not have a credit rating and cannot issue public bonds, and thus they are more likely to be financially constrained by lenders during industry downturns. Thus, we predict that the cash holdings of non-rated firms will be more sensitive to industry risk. As we predicted, Models [1] and [2] in Table 2.5 show that the cash holdings of non-rated firms react more sensitively to industry risk exposure. While rated firms' coefficient of industry risk is 0.025, non-rated firms' coefficient of industry risk is 0.054, and the two coefficients are significantly different at the 1% significance level (see *p*-value is 0.002).

Second, we assume that non-dividend paying firms are financially constrained and they are more concerned about industry risk exposure due to limited internal cash flow to fund investments from the beginning, which means they have to rely on external sources (Fazzari, Hubbard, and Peterson (1988)). The estimates reported in Models [3] and [4] suggest that industry risk is a strong driver of corporate cash holdings for non-dividend paying firms. The coefficient of industry risk for dividend paying firms is 0.022, while it is 0.051 for the non-dividend paying firms, and the difference is significant at the 1% level.

Finally, small-size firms are typically young, less known to the public, and thus more vulnerable to capital market imperfections. Moreover, because of high information asymmetries, they are likely to face higher costs when obtaining external funds. Therefore, we predict that the cash holdings of small-size firms are more sensitive to industry risk. We find the coefficient of industry risk is 0.027 for large-size firms and 0.055 for small-size firms, and they are significantly different at the 1% significance level.

Overall, our results show that a positive relation between industry risk and cash holdings is more pronounced for bank-dependent or financially constrained firms such as non-rated, non-dividend paying and small-size firms.

2.4.5 Single-segment versus multi-segment

Up to this point, we have primarily assumed that a firm operates only in one industry based on the 4-digit SIC code. But what if this is not the case? As pointed out by Denis, Denis, and Yost (2002), many U.S. firms diversify their operations either through industrial diversification or global diversification, or both. In particular, multi-segment firms are less likely to experience simultaneous adverse shocks across different divisions due to diversification effects among multiple segments, which reduces the precautionary demand for cash (Duchin (2010)). Furthermore, multi-segment firms are better candidates for debt finance than single-segment firms of the same size because they tend to have a lower risk of default and the option of selling assets in different industries where their assets are in liquid industries (Shleifer and Vishny (1992)). Thus, we predict that the cash holdings – industry risk relation is more pronounced for undiversified firms.

We test our hypothesis by dividing samples into single-segment and multi-segment firms in Table 2.6. As predicted, we find that the cash holdings of single-segment firms are more sensitive to industry risk (0.054), while multi-segment firms have a smaller coefficient on industry risk (0.024) in Models [1] and [2], respectively. These two coefficients are significantly different at the 1% level and the *p*-value is 0.003. This suggests that when firms have multiple segments, they can benefit from industry diversification effects and industry shocks do not strongly influence their cash holding activities.

2.5 Robustness of the Results

2.5.1 Changes in cash holdings

Lastly, we use change regressions to examine the effect of a change in a firm's industry risk exposure on the change in the firm's cash holdings. If the firm-specific omitted characteristics that jointly affect industry risk and cash holding are constant over time, examining changes control for time invariance factors that would be driving the results. Table 2.7 presents the change regression results. Controlling for changes in other firm characteristics and other risk factors, the change in industry risk exposure is positively related to the change in the firm's cash holdings. The coefficient of the change in industry risk variable is 0.015 and the effect remains statistically significant at the 1% level. Our results are highly robust.

2.5.2 Local risk

Our main hypothesis considers industry and economy-wide risk as macroeconomic impacts on corporate cash holdings but does not control for local risk. However, as emphasized by Pirinksy and Wang (2006), Chaney, Sraer, and Thesmar (2012), Tuzel and Zhang (2013), and Dougal, Parsons, and Titman (2014)[41], local risk is also an important factor that influences a firm's stock performance and investment located in the same areas. Thus, a firm's local risk exposure may increase a firm's precautionary demand for cash. To account for local risk exposure, along with economy and industry return, we include local return in equation (2). Our stock return model is written as follows:

$$R_{it} = \beta_0 + \beta_1 ECONOMY\ RETURN_t + \beta_2 INDUSTRY\ RETURN_{it} + \beta_3 LOCAL\ RETURN_{it} + \epsilon_{it}, \quad (5)$$

We define Local $\mathrm{Return_i} = \sum_{i \neq k} \omega_k\, r_k$ as the market value weighted average return of firms in the same headquarters (STATE). Note that firm (i) itself is excluded from the construction of the local index. Using regression results (5), we compute two industry risk proxies as before and run cash regressions.

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[41] Market risk and industry risk are well-known factors that influence a firm's stock market performance (see, Campbell, Lettau, Malkiel, and Xu (2001)). However, local risk is also an important factor that influences a firm's stock performance. For example, Pirinksy and Wang (2006) find that there is strong comovement in the stock returns of firms from the same geographic area. Moreover, Chaney, Sraer, and Thesmar (2012) document that firms with greater collateral values are able to invest more, where firms' collateral values are highly affected by local real estate market conditions. Similarly, Tuzel and Zhang (2013) construct a theoretical model and empirically show that local market risk affects firms located in the same areas. Dougal, Parsons, and Titman (2014) document that a firm's investments are sensitive to the investments of other firms headquartered in the same area theoretically and empirically.

Table 2.8 reports the regressions of a firm's cash holdings on the firm's market, industry, and local risk exposure and firm characteristics. In Model [1], the regression reveals that along with economy-wide and industry-wide risk, a firm's local risk has a strong positive effect on cash holdings, while idiosyncratic risk has a negative effect on cash holdings. Meanwhile, in Model [2], a firm's local risk has a positive effect on cash holdings and is not statistically significant. As we show in Table 2.2, the positive effect of industry risk on cash holdings is not only statistically significant, but also economically significant. Specifically, in Models [1] and [2], a one standard deviation increase in a firm's industry risk exposure increases cash holdings by 7.93% and 8.73%, respectively, after controlling for other cash holding determinants including industry sigma, a firm's idiosyncratic risk, market risk, and local risk. Moreover, in Models [1] and [2], a one standard deviation increase in a firm's local risk exposure increases cash holdings by 6.27% and 0.60%, respectively. Overall, the economic impact of industry risk on corporate cash holdings is the highest among the types of risk we examine, which confirms that firms stockpile more cash when they have high industry-risk exposure.

2.5.3 Natural experiment in airline industries

Although our evidence suggests that a firm's sensitivity to industry shocks (i.e., industry-wide risk) increases the firm's demand for cash as a precautionary motive, our conclusion would be strengthened if we could demonstrate a positive relation between the industry risk and the cash holdings under the industry-specific exogenous shocks. We posit that the September 11 attacks in 2001 in the U.S. brought a major and unexpected change in the airline industry. The 9/11 attacks negatively affected the airline industry more than any other industry, and they suffered from reduction in passenger demand, bankruptcy and large-scale layoffs, and indirect effects of new air security procedures, which forced airlines to tighten their belts.[42]

[42] Gabi Logan, "The Effects of 9/11 on the Airline Industry," USA Today, March 18, 2013.

To test for the effect of the 9/11 attacks in the airline industry and a firm's cash holdings-industry risk sensitivity, we use the differences-in-differences method. The basic regression that we estimate is specified as follows:

$$CASH\ HOLDING_{it} = \alpha_t + \beta_j + \gamma X_{it} + \varphi INDUSTRY\ RISK * AIR_i * AFT_t + \epsilon_{it}, \quad (6)$$

where *i* indexes firm and *t* indexes time. α_t and β_j are year and industry fixed effects, respectively. X_{it} is a vector of control variables. AIR_i is a dummy variable, which equals one if firm *i* is in the airline industry[43] as of the sample year. AFT_t is a dummy variable indicating that the observation is in or after 2001. ϵ_{it} is an error term. We hypothesize that φ will be positive and statistically significant. Table 2.9 presents the results using the above specification. The coefficients on *Industry Risk***AIR*$_i$**AFT*$_t$ are positive and statistically significant (e.g., 0.085 and 0.078 in Models [2] and [3]). This indicates that the effect of industry risk on cash holdings tends to be more positive for firms in the airline industry than for firms in non-airline industries after the 9/11 airline industry shocks. Therefore, a firm's exposure to industry risk motivates cash holdings, and this effect is significantly increased when the firm's industry is suffering from downturn or experiencing a shock.

2.5.4 Firm's high exposure to industry-market risk

Finally, we investigate whether a firm's high exposure to co-movement between industry and market risks affect our results. We posit that if a firm is in cyclical industries, then they are doubly exposed to industry risk as well as aggregate risk. To measure how overall industry risks co-vary with those of market risks, we calculate the correlation of industry stock returns with market stock returns. Our stock return model is written as follows:

$$INDUSTRY\ RETURN = \rho * MARKET\ RETURN + \epsilon_{it}, \quad (7)$$

where industry and market returns are the value weighted average return of the index (economy- and industry-wide) and industry return is computed based on firms in the same 4-digit SIC code.

[43] SIC codes for the airline industries are 4512 or 4513.

ϵ_{it} is an error term. We posit that ρ is capturing co-movement between the market and industry risks. Therefore, higher ρ values indicate that businesses or stock performances in a particular industry fluctuate widely according to variations in the economy. To test whether cyclicality affects a firm's cash holdings-industry risk sensitivity, we define a dummy variable, High ρ, which equals to one if the firm's ρ in a sample year is above its sample median, and 0 otherwise. We hypothesize that the interaction term between ρ and industry risk will be positive and statistically significant. Table 2.10 presents the results. The coefficients on *Industry Risk*High ρ* are positive and statistically significant (e.g., 0.032 in Model [2]). This indicates that the effect of industry risk on cash holdings tends to be more positive for firms in the cyclical industries than for firms in non-cyclical industries. Consequently, a firm's cash holding motivation due to industry risk exposure significantly increases when its industry performance is highly sensitive to overall market uncertainty.

2.6 Conclusions

This paper examines how a firm's industry risk exposure influences corporate cash holdings. While the existing literature tends to use overall systematic risk to address a firm's liquidity management, we first attempt to decompose risk into market, industry, local, and residual components. Accordingly, we simultaneously regress a firm's stock returns based on market returns and industry returns, applying two methods to measure a firm's industry risk exposure: a beta coefficient method and a variance decomposition method.

We find that a firm's industry risk exposure is positively related to corporate cash holdings. The positive effect of industry risk on cash holdings is not only statistically significant, but also economically significant. A one standard deviation increase in a firm's industry risk exposure increases cash holdings by 7.93%. Industry risk has a greater effect on corporate cash holdings than other kinds of risk, including economy-wide risk, local risk, and idiosyncratic risk. The effect of industry risk exposure on corporate cash holdings is greater among firms in highly competitive industries, as well as for firms with high leverage, a greater amount of short term debt, and few tangible assets. Moreover, we find that the positive relation is stronger for financially constrained firms such as non-rated, non-dividend paying and small-sized firms and for single-segment firms.

Overall, our study sheds light on the risk channel coming from competitors in the same industry. Our evidence is consistent with Shleifer and Vishny’s (1992) claim that asset markets are less liquid during an economic and industry downturn, and that this motivates firms to hold more cash in order to meet their debt payments during these times.

Table 2.1: Descriptive Statistics: 1980-2013

This table presents the descriptive statistics for the sample. The dataset comprises 19,548 firm-year observations from 1980 to 2013 and includes only U.S. companies with positive sales revenues and book value of assets. β_1: Economy Wide and β_2: Industry Wide are a firm's systematic risks over the economy- and industry-wide and are estimated based on equation (1). Idiosyncratic Risk is the standard deviation of the regression residuals from (1) and captures firm-specific risk. Explained σ_1: Economy Wide and Explained σ_2: Industry Wide are a firm's economy- and industry-wide systematic risks and are estimated using a variance decomposition method (Type I sum of squares method from the ANOVA table). Each systematic risk is sequentially considered: economy-wide risk first and then industry-wide risk and captures "incremental systematic risks". Unexplained σ_3 is estimated by the squared root of [variance of a firm's stock return*(1-R^2)] from equation (1). Vega/TC is the ratio of vega to total compensation. Vega is the change in the value of the CEO's option grant in a year and any accumulated option holdings for a 0.01 change in the annualized standard deviation of stock returns. Delta/TC is the ratio of delta to total compensation. Delta is the change in the value of the option or restricted stock grants in a year, shareholdings, and any accumulated restricted stock and option holdings for a 1% change in the stock price. Industry Sigma is the average of the standard deviations of cash flow over the past 10 years for firms in the same industry, as defined by two-digit SIC code. Cash Holding is cash and short-term investments (che) divided by assets (at). MB is the market value (at - ceq + prcc_f*csho) divided by assets (at). Size is the natural logarithm of book assets (at) in 2004 dollars. Cashflow is the earnings after interest, dividends, and taxes but before depreciation (oibdp - xint - txt - dvc), divided by assets (at). NWC is working capital (wcap) minus cash (che), divided by assets (at). Capex is capital expenditures (capx) divided by assets (at). Leverage is long-term debt (dltt) plus debt in current liabilities (dlc), divided by assets (at). R&D is the ratio of R&D expenses (xrd) over sales (sale), set equal to zero when it is missing. Dividend is a dummy variable equal to one in years in which a firm pays a common dividend (dvc), and 0 otherwise. Acquisition is acquisitions (acq) divided by assets (at). *I*(Credit Rating) is a dummy variable equal to one in years in which a firm has S&P Domestic Long-Term Issuer Credit Rating (splticrm) as investment grade or speculative grade, and 0 if missing. All continuous variables are winsorized at the top and bottom 1 percentiles. (1) $R_i = \beta_0 + \beta_1$*economy return + β_2*industry return$_i + \epsilon$, where each X variable stands for the value weighted average return of the index (economy- and industry-wide).

Table 2.1: Continued

Variable	N	Mean	Median	Std Dev	Min	Max	5th Pct.	25th Pct.	Median	75th Pct.	95th Pct.
β_1 : Economy Wide	19548	0.656	0.611	0.485	-0.359	2.045	-0.065	0.308	0.611	0.950	1.552
β_2 : Industry Wide	19548	0.387	0.307	0.374	-0.268	1.465	-0.081	0.098	0.307	0.612	1.118
Idiosyncratic Risk	19548	0.024	0.021	0.012	0.008	0.071	0.010	0.015	0.021	0.030	0.049
Explained σ_1 : Economy Wide	19548	0.012	0.010	0.008	0.001	0.041	0.003	0.006	0.010	0.015	0.029
Explained σ_2 : Industry Wide	19548	0.005	0.003	0.005	0.000	0.026	0.000	0.001	0.003	0.007	0.016
Unexplained σ_3	19548	0.024	0.021	0.012	0.008	0.071	0.010	0.015	0.021	0.030	0.048
Firm Specific $\sigma(r_i)$	19548	0.029	0.026	0.013	0.010	0.078	0.013	0.019	0.026	0.035	0.056
Vega (thousands of dollars)	19548	104.813	39.757	179.185	0.000	1109.216	0.000	11.744	39.757	111.417	448.415
Delta (thousands of dollars)	19548	611.744	185.742	1407.388	2.997	10485.966	15.209	71.917	185.742	510.154	2451.839
Vega/TC	19548	0.026	0.017	0.031	0.000	0.197	0.000	0.008	0.017	0.033	0.082
Delta/TC	19548	0.349	0.069	1.161	0.002	9.396	0.010	0.033	0.069	0.161	1.368
Cash Holding	19548	0.150	0.080	0.172	0.001	0.746	0.004	0.024	0.080	0.218	0.537
Industry Sigma	19548	0.311	0.178	0.386	0.026	2.086	0.041	0.081	0.178	0.339	1.029
MB	19548	2.039	1.623	1.302	0.752	8.197	0.930	1.242	1.623	2.321	4.750
Size	19548	7.082	6.931	1.482	3.970	10.914	4.837	6.024	6.931	8.010	9.805
Cashflow	19548	0.086	0.089	0.080	-0.306	0.273	-0.030	0.056	0.089	0.125	0.200
NWC	19548	0.089	0.078	0.147	-0.280	0.477	-0.137	-0.009	0.078	0.180	0.350
Capex	19548	0.061	0.044	0.056	0.004	0.307	0.009	0.024	0.044	0.077	0.179
Leverage	19548	0.211	0.198	0.170	0.000	0.707	0.000	0.056	0.198	0.323	0.526
R&D	19548	0.053	0.003	0.123	0.000	0.913	0.000	0.000	0.003	0.052	0.226
Dividend	19548	0.490	0.000	0.500	0.000	1.000	0.000	0.000	0.000	1.000	1.000
Acquisition	19548	0.030	0.000	0.064	-0.002	0.346	0.000	0.000	0.000	0.026	0.171
***I*(Credit Rating)**	19548	0.476	0.000	0.499	0.000	1.000	0.000	0.000	0.000	1.000	1.000
PP&E/AT	19543	0.292	0.231	0.220	0.017	0.895	0.038	0.119	0.231	0.410	0.759
HHI_{FF48}	19548	0.082	0.060	0.060	0.026	0.383	0.033	0.047	0.060	0.091	0.209
# of $peers_{FF48}$	19548	265.21	187.00	247.95	4	1323	31	103	187	345	840
ProdMktFluid	14311	6.307	5.694	3.253	1.311	16.927	2.158	3.886	5.694	8.045	12.838
PctComp	9229	0.498	0.363	0.428	0.036	2.267	0.080	0.200	0.363	0.659	1.369
% of debt maturing within 3 years	15885	0.340	0.247	0.338	0.000	1.000	0.000	0.023	0.247	0.547	1.000

Table 2.2: Pearson Correlation Coefficients

This table presents a correlation matrix for the final samples. The dataset comprises 19,548 firm-year observations from 1980 to 2013 and includes only U.S. companies with positive sales revenues and book value of assets. The variables are defined in the legend for Table 2.1. Bold text indicates significance at the 0.05 level.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	β_1 : Economy Wide	1.000																										
2	β_2 : Industry Wide	**-0.517**	1.000																									
3	Idiosyncratic Risk	**0.174**	-0.002	1.000																								
4	Explained σ_1 : Economy Wide	**0.310**	**0.301**	**0.384**	1.000																							
5	Explained σ_2 : Industry Wide	**-0.409**	**0.813**	**0.205**	**0.451**	1.000																						
6	UnExplained σ_3	**0.174**	-0.003	**1.000**	**0.384**	**0.205**	1.000																					
7	Firm Specific $\sigma(r_i)$	**0.161**	**0.168**	**0.942**	**0.634**	**0.413**	**0.942**	1.000																				
8	Vega/TC	**-0.069**	**0.057**	**-0.142**	**-0.028**	0.014	**-0.142**	**-0.128**	1.000																			
9	Delta/TC	**0.025**	-0.013	**0.018**	-0.005	-0.002	**0.018**	0.007	**0.108**	1.000																		
10	Cash Holding	**0.107**	**0.106**	**0.261**	**0.214**	**0.104**	**0.261**	**0.273**	**0.034**	**0.092**	1.000																	
11	Industry Sigma	**0.064**	**0.071**	**-0.022**	**0.172**	**-0.033**	**-0.023**	**0.026**	**0.042**	**-0.033**	**0.191**	1.000																
12	MB	**0.053**	**0.066**	**0.056**	**0.019**	**0.040**	**0.056**	**0.043**	**0.052**	**0.231**	**0.390**	**0.064**	1.000															
13	Size	**-0.198**	**0.241**	**-0.490**	0.001	**0.162**	**-0.490**	**-0.379**	**0.191**	-0.009	**-0.324**	**-0.018**	**-0.151**	1.000														
14	Cashflow	**-0.079**	**0.052**	**-0.281**	**-0.074**	0.011	**-0.280**	**-0.256**	**0.037**	**0.094**	**-0.151**	**-0.038**	**0.240**	**0.092**	1.000													
15	NWC	**0.126**	**-0.240**	0.009	**-0.073**	**-0.157**	0.009	**-0.031**	**-0.116**	0.007	**-0.228**	**-0.184**	**-0.104**	**-0.239**	**0.097**	1.000												
16	Capex	**-0.178**	**0.221**	**-0.020**	**-0.063**	**0.209**	**-0.020**	-0.002	**-0.055**	**0.068**	**-0.195**	**-0.103**	**0.053**	-0.005	**0.232**	**-0.157**	1.000											
17	Leverage	**-0.094**	**0.026**	**-0.032**	**-0.063**	**0.015**	**-0.032**	**-0.036**	-0.003	**-0.106**	**-0.404**	**-0.080**	**-0.273**	**0.297**	**-0.147**	**-0.141**	**0.050**	1.000										
18	R&D	**0.062**	**0.111**	**0.278**	**0.159**	**0.094**	**0.278**	**0.276**	**0.051**	**-0.018**	**0.548**	**0.155**	**0.263**	**-0.205**	**-0.416**	**-0.191**	**-0.130**	**-0.161**	1.000									
19	Dividend	**-0.100**	**-0.107**	**-0.440**	**-0.215**	**-0.152**	**-0.440**	**-0.428**	**0.016**	**-0.024**	**-0.316**	**-0.135**	**-0.088**	**0.364**	**0.060**	**0.055**	0.005	**0.090**	**-0.261**	1.000								
20	Acquisition	**0.017**	**-0.055**	**-0.052**	**-0.031**	**-0.065**	**-0.052**	**-0.060**	-0.009	**-0.025**	**-0.132**	**0.057**	**-0.026**	**0.022**	**0.020**	-0.011	**-0.146**	**0.130**	-0.009	**-0.019**	1.000							
21	*I* (Credit Rating)	**-0.138**	**0.152**	**-0.282**	**-0.034**	**0.118**	**-0.282**	**-0.221**	**0.099**	**-0.062**	**-0.322**	**-0.064**	**-0.188**	**0.662**	**-0.017**	**-0.153**	**0.019**	**0.451**	**-0.179**	**0.248**	**0.016**	1.000						
22	PP&E/AT	**-0.252**	**0.232**	**-0.154**	**-0.115**	**0.201**	**-0.154**	**-0.120**	**-0.036**	-0.010	**-0.408**	**-0.206**	**-0.174**	**0.197**	**0.141**	**-0.229**	**0.677**	**0.278**	**-0.266**	**0.187**	**-0.141**	**0.208**	1.000					
23	HHI_{FF48}	0.006	**-0.014**	**-0.081**	-0.004	-0.004	**-0.081**	**-0.058**	**-0.032**	**-0.027**	**-0.022**	**0.021**	**-0.037**	**0.063**	**-0.028**	**-0.026**	**-0.031**	**0.023**	**-0.025**	**0.097**	-0.001	**0.061**	0.004	1.000				
24	# of $peers_{FF48}$	**0.030**	**0.038**	**0.240**	**0.069**	**0.027**	**0.240**	**0.206**	**0.040**	**0.100**	**0.254**	**0.241**	**0.223**	**-0.121**	-0.012	**-0.123**	**-0.032**	**-0.188**	**0.190**	**-0.228**	**0.029**	**-0.169**	**-0.244**	**-0.346**	1.000			
25	ProdMktFluid	**-0.043**	**0.236**	**0.181**	**0.153**	**0.183**	**0.181**	**0.209**	**0.047**	**0.027**	**0.293**	**0.206**	**0.178**	**-0.026**	**-0.116**	**-0.272**	**0.083**	-0.005	**0.376**	**-0.328**	**0.026**	**-0.047**	**-0.029**	**-0.037**	**0.195**	1.000		
26	PctComp	0.000	**-0.093**	**0.246**	**-0.069**	**-0.047**	**0.246**	**0.161**	**-0.057**	**0.158**	**0.151**	**-0.146**	**0.196**	**-0.206**	**0.044**	**0.101**	**0.048**	**-0.117**	**0.132**	**-0.109**	0.006	**-0.198**	**-0.075**	**-0.111**	**0.195**	**0.134**	1.000	
27	% of debt maturing within 3 years	**0.023**	**-0.085**	**0.070**	**-0.024**	**-0.046**	**0.069**	**0.046**	**-0.022**	**-0.021**	**-0.130**	**-0.030**	**-0.027**	**-0.054**	0.013	**0.020**	**-0.033**	**-0.045**	**-0.048**	0.012	**-0.018**	**-0.127**	**-0.053**	-0.005	-0.003	**-0.069**	**0.030**	1.000

Table 2.3: Multivariate Analysis of Cash Holdings, and Systematic Risks in Economy and Industry

This table presents regressions of firms' cash holdings on systematic economy- and industry-wide risks, firm characteristics, industry (Fama-French 48), and year fixed effect controls. The sample includes only U.S. companies with positive sales revenues and book value of assets during the period from 1980 to 2013. The samples are restricted to have credit rating information or non-rated; 0 ≤ leverage ≤ 1; and % of daily stock trading volume a year ≥ 90 % to exclude outliers. The dependent variable is defined as cash and short-term investments (che) divided by assets (at). Model [1] is the baseline regression from Bates, Kahle, and Stulz (2009) and Liu and Mauer (2011) and systematic risks (economy- and industry-wide risk) are estimated using the beta coefficient method from a firm's stock return regression. Model [2] uses systematic risks (economy- and industry-wide risk) estimated by the variance decomposition method using the Type I sum of squares method. The bottom of the table reports economic significance of determinants of cash holdings based on our two systematic risk measures and idiosyncratic risk. It reports the percentage changes in cash holdings relative to its sample mean as each risk measure (e.g., β_1: Economy Wide, β_2: Industry Wide and idiosyncratic risk) increases by 1 standard deviation, while all other regressors are kept as their sample means for the full sample. All other variables are defined in the legend for Table 2.1. All continuous variables are winsorized at the top and bottom 1 percentiles. The standard errors of the coefficients are adjusted for clustering of observations at the firm level. Robust t-statistics are presented in parentheses. We use ***, **, and * to denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: Cash holdings	**[1] Beta Coefficients**			**[2] Variance Decomposition**	
Intercept	0.369	***	**Intercept**	0.390	***
	(19.82)			(20.7)	
β_1: Economy Wide	0.013	***	**Explained σ_1 : Economy Wide**	1.330	***
	(3.55)			(4.58)	
β_2: Industry Wide	0.041	***	**Explained σ_2 : Industry Wide**	2.276	***
	(7.68)			(6.17)	
Idiosyncratic risk	-0.165		**UnExplained σ_3**	-0.468	**
	(-0.85)			(-2.23)	
Vega/TC	0.006		**Vega/TC**	0.014	
	(0.13)			(0.3)	
Delta/TC	0.006	***	**Delta/TC**	0.006	***
	(3.54)			(3.51)	
Industry Sigma	0.0002		**Industry Sigma**	0.001	
	(0.05)			(0.21)	
MB	0.022	***	**MB**	0.022	***
	(12.85)			(12.85)	
Size	-0.027	***	**Size**	-0.028	***
	(-14.6)			(-15.15)	
Cashflow	-0.029		**Cashflow**	-0.027	
	(-1.12)			(-1.05)	
NWC	-0.320	***	**NWC**	-0.326	***
	(-20.3)			(-20.65)	
Capex	-0.588	***	**Capex**	-0.597	***
	(-16.37)			(-16.58)	
Leverage	-0.206	***	**Leverage**	-0.202	***
	(-16.5)			(-16.21)	
R&D	0.342	***	**R&D**	0.339	***
	(12.73)			(12.57)	
Dividend	-0.021	***	**Dividend**	-0.020	***
	(-4.78)			(-4.72)	
Acquisition	-0.322	***	**Acquisition**	-0.322	***
	(-21.27)			(-21.34)	
Year FE	Yes		**Year FE**	Yes	
Industry FE	Yes		**Industry FE**	Yes	
SE Clustered by firm	Yes		**SE Clustered by firm**	Yes	
Adjusted R-squared	0.597		**Adjusted R-squared**	0.599	
Number of Observations	19,548		**Number of Observations**	19,548	
Economic Significance: % changes in cash holdings as one standard deviation increase	4.23% 10.30% -1.32%		**Economic Significance: % changes in cash holdings as one standard deviation increase**	7.10% 7.59% -3.75%	

Table 2.4: Product Market Competition

This table presents the sensitivity analysis of cash holdings on economy- and industry-wide systematic risks over the industry competitions. The dependent variable is defined as cash and short-term investments (che) divided by assets (at). We use three measures, HHI, # of peers, and PctComp to capture the industry competition. The HHI is defined as the sum of squared market shares, where s_{ijt} is the market share of firm i in industry j in year t. Market shares are computed from Compustat based on firms' sales.

$$HHI_{jt} := \sum_{i=1}^{N_j} s_{ijt}^2$$

# of peers is defined as total number of firms in the same industry. HHI and # of peers are computed based on Fama-French 48 industry codes. PctComp is defined by 1000*(the number of competition-related words / the total number of words) from the 10-K filing. As PctComp increases, there is more competition in the market (Li, Lundholm, and Minnis, (2013, JAR)). PctComp information is downloaded from the referenced paper's authors' websites. Other variables are defined in the legend for Table 2.1. To save space, we use label X to stand for continuous or ordinal variables of {HHI, # of peers, PctComp}.

Table 2.4: Continued

Panel A: Beta Coefficients

	[1] X= HHI	[2] X= # of peers	[3] X= PctComp
Intercept	0.325 ***	0.384 ***	0.350 ***
	(7.79)	(10.47)	(8.27)
β_1: Economy Wide	0.015 **	0.006	0.010
	(2.41)	(1.09)	(1.47)
β_2: Industry Wide	0.061 ***	0.010	0.032 ***
	(6.78)	(1.34)	(3.77)
Idiosyncratic risk	0.057	-0.490 **	-0.831 ***
	(0.21)	(-1.97)	(-3.01)
β_1: Economy Wide*X	-0.021	0.00003 *	0.014
	(-0.32)	(1.9)	(1.51)
β_2: Industry Wide*X	-0.254 ***	0.0001 ***	0.022 *
	(-2.89)	(5.03)	(1.92)
Idiosyncratic risk*X	-2.861	0.001	0.943 ***
	(-1.08)	(1.31)	(3.33)
X	0.180	-0.00003	-0.024 **
	(1.46)	(-0.9)	(-2.42)
Control Variables	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
SE Clustered by firm	Yes	Yes	Yes
Adjusted R-squared	0.598	0.600	0.535
Number of Observations	19,548	19,548	9,229

Panel B: Variance Decomposition

	[1] X= HHI	[2] X= # of peers	[3] X= PctComp
Intercept	0.353 ***	0.392 ***	0.349 ***
	(8.44)	(10.66)	(8.29)
Explained σ_1 : Economy Wide	1.351 ***	0.854 **	0.921 **
	(3.46)	(2.27)	(2.19)
Explained σ_2 : Industry Wide	3.438 ***	1.378 **	2.109 ***
	(5.96)	(2.56)	(4.07)
UnExplained σ_3	-0.372	-0.683 **	-1.054 ***
	(-1.27)	(-2.45)	(-3.46)
Explained σ_1 : Economy Wide*X	-0.471	0.001	1.085 *
	(-0.16)	(1.18)	(1.74)
Explained σ_2 : Industry Wide*X	-15.258 ***	0.003 **	-0.122
	(-2.93)	(2.23)	(-0.17)
UnExplained σ_3*X	-1.081	0.001	0.817 **
	(-0.37)	(0.9)	(2.51)
X	0.115	0.00001	-0.016 *
	(1.2)	(-0.32)	(-1.86)
Control Variables	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
SE Clustered by firm	Yes	Yes	Yes
Adjusted R-squared	0.600	0.601	0.537
Number of Observations	19,548	19,548	9,229

Table 2.5: Leverage, Percentage of Short-Term Debt, and Asset Tangibility

This table presents the sensitivity analysis of cash holdings on economy- and industry-wide systematic risks over firm's debt financing and fixed asset %. The dependent variable is defined as cash and short-term investments (che) divided by assets (at). Fixed asset % is defined by property, plant and equipment (ppent) divided by assets (at). Leverage is long-term debt (dltt) plus debt in current liabilities (dlc), divided by assets (at). % Maturing within 3 years is percentage of debt due within three years: the debt in current liabilities (dlc) plus long-term debt payable in the second year (dd2) plus long-term debt payable in the third year (dd3), divided by long-term debt (dltt) plus debt in current liabilities (dlc). Other variables are defined in the legend for Table 2.1. To save space, we use label X to stand for continuous or ordinal variables of {Leverage, % Maturing within 3 years}.

Table 2.5: Continued

Panel A: Beta Coefficients

	Debt Financing				Fixed Asset %	
	X= Leverage		X= % Maturing within 3 years		X= PP&E/AT	
	[1]		[2]		[3]	
Intercept	0.354	***	0.418	***	0.384	***
	(9.08)		(11.92)		(9.65)	
β1: Economy Wide	0.009		0.003		0.021	***
	(1.63)		(0.51)		(3.19)	
β2: Industry Wide	0.029	***	0.034	***	0.066	***
	(3.59)		(4.89)		(7.21)	
Idiosyncratic risk	0.087		0.727	***	0.168	
	(0.31)		(2.83)		(0.63)	
β1: Economy Wide*X	0.016		0.020	**	-0.031	**
	(0.92)		(2.29)		(-2.04)	
β2: Industry Wide*X	0.055	**	0.023	*	-0.063	***
	(2.26)		(1.9)		(-3.32)	
Idiosyncratic risk*X	-1.025		-1.416	***	-1.911	***
	(-1.55)		(-4.25)		(-3.41)	
X	-0.210	***	-0.050	***	-0.125	***
	(-7.13)		(-4.24)		(-4.85)	
Control Variables	Yes		Yes		Yes	
Year FE	Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes	
Adjusted R-squared	0.598		0.622		0.619	
Number of Observations	19,548		15,885		19,543	

Panel B: Variance Decomposition

	Debt Financing				Fixed Asset %	
	X= Leverage		X= % Maturing within 3 years		X= PP&E/AT	
	[1]		[2]		[3]	
Intercept	0.368	***	0.430	***	0.412	***
	(9.72)		(12.72)		(10.69)	
β1: Economy Wide	1.612	***	0.852	**	1.482	***
	(3.93)		(2.29)		(3.69)	
β2: Industry Wide	1.632	***	2.296	***	3.196	***
	(2.73)		(4.69)		(4.98)	
Idiosyncratic risk	-0.264		0.444		-0.172	
	(-0.85)		(1.56)		(-0.59)	
β1: Economy Wide*X	-1.268		0.359		-1.003	
	(-1.25)		(0.72)		(-1.48)	
β2: Industry Wide*X	2.889	*	1.110		-1.402	
	(1.75)		(1.23)		(-1.13)	
Idiosyncratic risk*X	-0.819		-1.453	***	-1.765	***
	(-1.12)		(-3.96)		(-2.91)	
X	-0.179	***	-0.038	***	-0.153	***
	(-7.67)		(-3.98)		(-7.55)	
Control Variables	Yes		Yes		Yes	
Year FE	Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes	
Adjusted R-squared	0.599		0.623		0.620	
Number of Observations	19,548		15,885		19,543	

Table 2.6: Financial Constraints

This table presents regressions of a firm's cash holdings on systematic economy- and industry-wide risks, firm characteristics, industry (Fama-French 48), and year fixed effect controls by subgroups based on credit rating, dividend paying, and firm size (asset size) information. The sample includes only U.S. companies with positive sales revenues and book value of assets during the period from 1980 to 2013. The dependent variable is defined as cash and short-term investments (che) divided by assets (at). We define sample as a rated firm if S&P Domestic Long-Term Issuer Credit Rating (splticrm) is nonmissing and has a letter rating; otherwise, we define sample as a non-rated firm. Ratings equal to “SD", “N.M.", "D" and “Suspended" are not included. Dividend Paying Firm means that a firm pays a common dividend (dvc). A firm is deemed to be Large Size Firm if Size is above its sample median and Small Size Firm, otherwise. Other variables are defined in the legend for Table 2.1.

Panel A: Beta Coefficients

Dependent Variable: Cash holdings	**[1] Non-Rated Firms**		**[2] Rated Firms**		**[3] Non-Dividend Paying Firms**		**[4] Dividend Paying Firms**		**[5] Small Size Firms**		**[6] Large Size Firms**	
Intercept	0.368	***	0.218	***	0.295	***	0.298	***	0.363	***	0.262	***
	(5.73)		(6.55)		(6.36)		(6.37)		(5.15)		(7.38)	
β_1: Economy Wide	0.016	***	0.008	**	0.024	***	-0.003		0.018	***	0.005	
	(3.19)		(1.98)		(5.13)		(-0.65)		(3.6)		(1.14)	
β_2: Industry Wide	0.054	***	0.025	***	0.051	***	0.022	***	0.055	***	0.027	***
	(6.97)		(4.34)		(7.07)		(3.22)		(6.72)		(4.4)	
Idiosyncratic risk	-0.859	***	0.587	***	-0.676	***	0.430		-0.777	***	0.543	**
	(-3.18)		(2.97)		(-2.84)		(1.45)		(-3.11)		(2.2)	
Vega/TC	-0.102		0.089	*	-0.051		0.017		-0.160	**	0.131	**
	(-1.4)		(1.68)		(-0.83)		(0.27)		(-1.98)		(2.56)	
Delta/TC	0.004	*	0.010	***	0.007	***	0.005	**	0.005	**	0.007	***
	(1.85)		(3.27)		(3.24)		(2.05)		(2.15)		(2.73)	
Industry Sigma	0.002		-0.004		0.001		0.002		0.002		-0.003	
	(0.21)		(-0.91)		(0.1)		(0.35)		(0.26)		(-0.65)	
MB	0.021	***	0.024	***	0.022	***	0.021	***	0.018	***	0.030	***
	(10.08)		(9.75)		(11.17)		(6.53)		(8.92)		(11.06)	
Size	-0.031	***	-0.014	***	-0.031	***	-0.021	***	-0.031	***	-0.018	***
	(-9.13)		(-7.08)		(-11.52)		(-8.82)		(-6.83)		(-7.3)	
Cashflow	-0.007		-0.041		-0.007		-0.098	**	-0.003		-0.051	

	(-0.21)		(-1.26)		(-0.21)		(-2.38)		(-0.11)		(-1.22)	
NWC	-0.404	***	-0.173	***	-0.396	***	-0.226	***	-0.387	***	-0.214	***
	(-19.09)		(-9.96)		(-19.62)		(-9.41)		(-18.79)		(-10.39)	
Capex	-0.750	***	-0.325	***	-0.628	***	-0.487	***	-0.676	***	-0.456	***
	(-14.92)		(-8.73)		(-13.33)		(-9.8)		(-15.44)		(-9.84)	
Leverage	-0.261	***	-0.110	***	-0.199	***	-0.203	***	-0.262	***	-0.123	***
	(-13.9)		(-7.35)		(-11.93)		(-12.68)		(-16.02)		(-6.66)	
R&D	0.299	***	0.405	***	0.292	***	0.590	***	0.334	***	0.331	***
	(9.57)		(8.66)		(10.44)		(5.14)		(10.81)		(6.53)	
Dividend	-0.024	***	-0.017	***	0.000	***	0.000	***	-0.024	***	-0.019	***
	(-3.82)		(-3.8)		(0)		(0)		(-3.91)		(-3.51)	
Acquisition	-0.440	***	-0.184	***	-0.381	***	-0.237	***	-0.393	***	-0.231	***
	(-18.25)		(-12.29)		(-18.82)		(-11.79)		(-17.44)		(-12.8)	
Year FE	Yes		Yes		Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes		Yes		Yes		Yes	
Adjusted R-squared	0.598		0.492		0.597		0.480		0.602		0.539	
Number of Observations	10,242		9,306		9,972		9,576		9,774		9,774	

χ^2- TEST p-Value			
H_0: $\beta_{\text{Financially Constrained}}(\beta_1) = \beta_{\text{Unconstrained}}(\beta_1)$	0.201	0.000***	0.067*
H_0: $\beta_{\text{Financially Constrained}}(\beta_2) = \beta_{\text{Unconstrained}}(\beta_2)$	0.002***	0.003***	0.007***

Table 2.6: Continued

Panel B: Variance Decomposition

Dependent Variable: Cash holdings	[1] Non-Rated Firms	[2] Rated Firms	[3] Non-Dividend Paying Firms	[4] Dividend Paying Firms	[5] Small Size Firms	[6] Large Size Firms
Intercept	0.397 ***	0.234 ***	0.340 ***	0.304 ***	0.392 ***	0.275 ***
	(6.34)	(7.1)	(7.31)	(6.53)	(5.67)	(7.87)
Explained σ_1 : Economy Wide	1.569 ***	0.921 ***	2.117 ***	0.248	1.874 ***	0.733 **
	(3.75)	(3.17)	(5.7)	(0.63)	(4.42)	(2.33)
Explained σ_2 : Industry Wide	2.770 ***	1.800 ***	1.873 ***	2.439 ***	2.618 ***	2.165 ***
	(4.9)	(4.38)	(3.94)	(4.65)	(4.49)	(5.23)
UnExplained σ_3	-1.175 ***	0.319	-0.988 ***	0.116	-1.107 ***	0.186
	(-4.06)	(1.55)	(-3.88)	(0.36)	(-4.13)	(0.67)
Vega/TC	-0.094	0.095 *	-0.045	0.021	-0.151 *	0.135 ***
	(-1.28)	(1.78)	(-0.72)	(0.33)	(-1.85)	(2.65)
Delta/TC	0.004 *	0.010 ***	0.007 ***	0.005 **	0.005 **	0.007 ***
	(1.93)	(3.21)	(3.17)	(2.1)	(2.13)	(2.74)
Industry Sigma	0.003	-0.004	0.001	0.003	0.003	-0.002
	(0.34)	(-0.79)	(0.18)	(0.5)	(0.36)	(-0.47)
MB	0.021 ***	0.024 ***	0.022 ***	0.021 ***	0.019 ***	0.030 ***
	(10.24)	(9.58)	(11.23)	(6.53)	(8.96)	(11.08)
Size	-0.032 ***	-0.015 ***	-0.033 ***	-0.022 ***	-0.033 ***	-0.018 ***
	(-9.49)	(-7.69)	(-12.16)	(-8.99)	(-7.21)	(-7.62)
Cashflow	-0.002	-0.037	-0.003	-0.102 **	0.001	-0.048
	(-0.08)	(-1.15)	(-0.1)	(-2.47)	(0.04)	(-1.15)
NWC	-0.409 ***	-0.178 ***	-0.401 ***	-0.229 ***	-0.393 ***	-0.219 ***
	(-19.25)	(-10.33)	(-19.99)	(-9.48)	(-19.03)	(-10.65)
Capex	-0.754 ***	-0.338 ***	-0.637 ***	-0.496 ***	-0.678 ***	-0.472 ***
	(-15)	(-9.17)	(-13.5)	(-10)	(-15.45)	(-10.1)
Leverage	-0.256 ***	-0.106 ***	-0.195 ***	-0.198 ***	-0.257 ***	-0.119 ***
	(-13.59)	(-7.1)	(-11.7)	(-12.33)	(-15.7)	(-6.43)

R&D	0.300	***	0.391	***	0.288	***	0.603	***	0.334	***	0.324	***
	(9.6)		(8.46)		(10.22)		(5.22)		(10.8)		(6.44)	
Dividend	-0.025	***	-0.015	***					-0.024	***	-0.018	***
	(-3.94)		(-3.53)						(-3.96)		(-3.38)	
Acquisition	-0.438	***	-0.185	***	-0.382	***	-0.239	***	-0.395	***	-0.230	***
	(-18.17)		(-12.55)		(-18.9)		(-11.84)		(-17.49)		(-12.88)	
Year FE	Yes		Yes		Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes		Yes		Yes		Yes	
Adjusted R-squared	0.599		0.496		0.599		0.482		0.604		0.543	
Number of Observations	10,242		9,306		9,972		9,576		9,774		9,774	

H_0: β_{Non_Rated} (σ_2) = β_{Rated} (σ_2)
χ^2-*test* *p-Value:* 0.154

H_0: $\beta_{Non\ DIV}$ (σ_2) = β_{DIV} (σ_2)
χ^2-*test* *p-Value:* 0.414

H_0: β_{Small_Size} (σ_2) = β_{Large_Size} (σ_2)
χ^2-*test* *p-Value:* 0.510

Table 2.7: Single-Segment versus Multi-Segment Firms

This table presents regressions of a firm's cash holdings on systematic economy- and industry-wide risks, firm characteristics, industry (Fama-French 48), and year fixed effect controls based on subgroups—single segment vs. multi-segment firms—and this information is from the Compustat Historical Business Segments database. The sample includes only U.S. companies with positive sales revenues and book value of assets during the period from 1980 to 2013. The dependent variable is defined as cash and short-term investments (che) divided by assets (at). We define sample as a single-segment firm if a firm has only one segment ID and a multi-segment firm if a firm has more than two district segment IDs in a particular year. Other variables are defined in the legend for Table 2.1.

Panel A: Beta Coefficients

	[1]		[2]	
	Single-Segment Firms		**Multi-Segment Firms**	
Intercept	0.422	***	0.307	***
	(15.95)		(12.99)	
β_1: Economy Wide	0.020	***	0.005	
	(3.74)		(0.96)	
β_2: Industry Wide	0.054	***	0.024	***
	(6.65)		(3.5)	
Idiosyncratic risk	-0.486	*	-0.091	
	(-1.68)		(-0.39)	
Vega/TC	-0.027		-0.007	
	(-0.39)		(-0.11)	
Delta/TC	0.005	**	0.007	***
	(2.23)		(2.73)	
Industry Sigma	0.007		0.002	
	(0.8)		(0.41)	
MB	0.021	***	0.021	***
	(9.76)		(7.91)	
Size	-0.031	***	-0.021	***
	(-10.82)		(-9.53)	
Cashflow	-0.014		-0.083	**
	(-0.43)		(-2.24)	
NWC	-0.370	***	-0.262	***

Panel B: Variance Decomposition

	[1]		[2]	
	Single-Segment Firms		**Multi-Segment Firms**	
Intercept	0.453	***	0.318	***
	(16.73)		(13.44)	
Explained σ_1 : Economy Wide	1.937	***	0.793	**
	(4.27)		(2.15)	
Explained σ_2 : Industry Wide	2.720	***	1.346	***
	(4.99)		(2.95)	
UnExplained σ_3	-0.825	***	-0.319	
	(-2.68)		(-1.28)	
Vega/TC	-0.020		-0.001	
	(-0.29)		(-0.02)	
Delta/TC	0.005	**	0.007	***
	(2.27)		(2.66)	
Industry Sigma	0.008		0.003	
	(0.92)		(0.48)	
MB	0.021	***	0.021	***
	(9.84)		(7.82)	
Size	-0.033	***	-0.021	***
	(-11.38)		(-9.8)	
Cashflow	-0.008		-0.083	**
	(-0.23)		(-2.23)	
NWC	-0.377	***	-0.267	***

	(-16.49)		(-12.88)	
Capex	-0.679	***	-0.464	***
	(-14.29)		(-9.44)	
Leverage	-0.205	***	-0.187	***
	(-11.53)		(-10.85)	
R&D	0.270	***	0.460	***
	(8.75)		(9.1)	
Dividend	-0.015	**	-0.020	***
	(-2.2)		(-3.88)	
Acquisition	-0.402	***	-0.260	***
	(-15.67)		(-14.87)	
Year FE	Yes		Yes	
Industry FE	Yes		Yes	
SE Clustered by firm	Yes		Yes	
Adjusted R-squared	0.628		0.526	
Number of Observations	8,768		9,428	

H_0: β_{Single_Seg} (β_2) = β_{Multi_Seg} (β_2)

χ^2-*test* *p-Value:* 0.003***

	(-16.8)		(-13.1)	
Capex	-0.690	***	-0.472	***
	(-14.5)		(-9.59)	
Leverage	-0.200	***	-0.185	***
	(-11.2)		(-10.77)	
R&D	0.268	***	0.456	***
	(8.61)		(9.02)	
Dividend	-0.014	**	-0.020	***
	(-2.09)		(-3.89)	
Acquisition	-0.398	***	-0.262	***
	(-15.49)		(-15.01)	
Year FE	Yes		Yes	
Industry FE	Yes		Yes	
SE Clustered by firm	Yes		Yes	
Adjusted R-squared	0.631		0.527	
Number of Observations	8,768		9,428	

H_0: β_{Single_Seg} (β_2) = β_{Multi_Seg} (β_2)

χ^2-*test* *p-Value:* 0.045**

Table 2.8: Changes in Cash Holdings

This table presents regressions of a firm's changes in cash holdings on changes in economy- and industry-wide systematic risks, and firm characteristics. We define $\Delta X = X_t - X_{t-1}$ and X stands for regressors and ΔCash holdings = Cash $Holdings_t$ - Cash $Holdings_{t-1}$.

Dependent Variable: Δ Cash holdings	**[1] Beta Coefficients**			**[2] Variance Decomposition**	
Intercept	-0.003	***	**Intercept**	-0.003	***
	(-6.15)			(-6.22)	
$\Delta\beta_1$: Economy Wide	0.010	***	**ΔExplained σ_1 : Economy Wide**	0.481	***
	(4.77)			(4.35)	
$\Delta\beta_2$: Industry Wide	0.015	***	**ΔExplained σ_2 : Industry Wide**	0.592	***
	(4.59)			(2.88)	
ΔIdiosyncratic risk	-0.447	***	**ΔUnExplained σ_3**	-0.669	***
	(-5.06)			(-6.42)	
ΔVega/TC	-0.080	***	**ΔVega/TC**	-0.079	***
	(-3.41)			(-3.37)	
ΔDelta/TC	0.003	**	**ΔDelta/TC**	0.003	**
	(2.4)			(2.4)	
ΔIndustry Sigma	0.004		**ΔIndustry Sigma**	0.005	*
	(1.32)			(1.79)	
ΔMB	0.009	***	**ΔMB**	0.009	***
	(6.83)			(7.52)	
ΔSize	0.001		**ΔSize**	0.001	
	(0.28)			(0.17)	
ΔCashflow	0.007		**ΔCashflow**	0.005	
	(0.42)			(0.29)	
ΔNWC	-0.348	***	**ΔNWC**	-0.349	***
	(-20.73)			(-20.74)	
ΔCapex	-0.421	***	**ΔCapex**	-0.428	***
	(-19.49)			(-19.89)	
ΔLeverage	-0.035	**	**ΔLeverage**	-0.036	**
	(-2.36)			(-2.43)	
ΔR&D	-0.053	**	**ΔR&D**	-0.056	**
	(-2.04)			(-2.18)	
ΔDividend	-0.004		**ΔDividend**	-0.004	
	(-1.17)			(-1.14)	
ΔAcquisition	-0.268	***	**ΔAcquisition**	-0.267	***
	(-22.51)			(-22.49)	
Year FE	No		**Year FE**	No	
Industry FE	No		**Industry FE**	No	
SE Clustered by firm	Yes		**SE Clustered by firm**	Yes	
Adjusted R-squared	0.190		**Adjusted R-squared**	0.190	
Number of Observations	17,371		**Number of Observations**	17,371	

Table 2.9: Multivariate Analysis of Cash Holdings, and Systematic Risks in Economy, Industry, and Local Wide

This table presents regressions of firms' cash holdings on systematic economy-wide, industry-wide, and local-wide risks, firm characteristics, industry (Fama-French 48), and year fixed effect controls. The sample includes only U.S. companies with positive sales revenues and book value of assets during the period from 1980 to 2013. The samples are restricted to have credit rating information or non-rated; 0 ≤ leverage ≤ 1; % of daily stock trading volume a year ≥ 90 % to exclude outliers. The dependent variable is defined as cash and short-term investments (che) divided by assets (at). Model [1] is the baseline regression from Bates, Kahle and Stulz (2009) and Liu and Mauer (2011) and systematic risks (economy-, industry-, and local-wide risk) are estimated using the beta coefficient method from a firm's stock return regression. Model [2] uses systematic risks (economy-, industry-, and local-wide risk) estimated by the variance decomposition method using the Type I sum of squares method. The bottom of the table reports economic significance of determinants of cash holdings based on our two systematic risk measures and idiosyncratic risk. It reports the percentage changes in cash holdings relative to its sample mean as each risk measure (e.g., β_1: Economy Wide, β_2: Industry Wide, β_3: Local Wide, and idiosyncratic risk) increases by 1 standard deviation, while all other regressors are kept as their sample means for the full sample. All other variables are defined in the legend for Table 2.1. All continuous variables are winsorized at the top and bottom 1 percentiles. The standard errors of the coefficients are adjusted for clustering of observations at the firm level. Robust t-statistics are presented in parentheses. We use ***, **, and * to denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: Cash holdings	**[1] Beta Coefficients**			**[2] Variance Decomposition**	
Intercept	0.367	***	**Intercept**	0.382	***
	(-19.70)			(20.59)	
β_1: Economy Wide	0.007	**	**Explained σ_1 : Economy Wide**	1.234	***
	(2.04)			(4.34)	
β_2: Industry Wide	0.032	***	**Explained σ_2 : Industry Wide**	2.620	***
	(6.35)			(6.08)	
β_3: Local Wide	0.016	***	**Explained σ_3 : Local Wide**	0.448	
	(4.02)			(0.63)	
Idiosyncratic risk	-0.087		**UnExplained σ_4**	-0.528	**
	(-0.45)			(-2.31)	
Vega/TC	0.004		**Vega/TC**	0.019	
	(0.08)			(0.42)	
Delta/TC	0.006	***	**Delta/TC**	0.006	***
	(3.56)			(3.47)	
Industry Sigma	0.000		**Industry Sigma**	0.001	
	(0.00)			(0.21)	
MB	0.023	***	**MB**	0.023	***
	(13.02)			(13.22)	
Size	-0.026	***	**Size**	-0.026	***
	(-14.28)			(-14.83)	
Cashflow	-0.029		**Cashflow**	-0.026	
	(-1.10)			(-0.99)	
NWC	-0.320	***	**NWC**	-0.325	***
	(-20.22)			(-20.54)	
Capex	-0.582	***	**Capex**	-0.593	***
	(-16.26)			(-16.58)	
Leverage	-0.206	***	**Leverage**	-0.205	***
	(-16.49)			(-16.37)	
R&D	0.342	***	**R&D**	0.334	***
	(12.82)			(12.42)	
Dividend	-0.021	***	**Dividend**	-0.021	***
	(-4.85)			(-4.78)	
Acquisition	-0.322	***	**Acquisition**	-0.322	***
	(-21.21)			(-21.34)	
Year FE	Yes		**Year FE**	Yes	
Industry FE	Yes		**Industry FE**	Yes	
SE Clustered by firm	Yes		**SE Clustered by firm**	Yes	

Adjusted R-squared	0.596
Number of Observations	19,548
Economic Significance: % changes in cash holdings as one standard deviation increase	3.40% 7.93% 6.27% -0.69%

Adjusted R-squared	0.599
Number of Observations	19,548
Economic Significance: % changes in cash holdings as one standard deviation increase	6.58% 8.73% 0.60% -4.22%

Table 2.10: The Effect of the 9/11 Attacks on Cash Holdings-Industry Risk Sensitivity in the Airline Industry

This table presents regressions of a firm's cash holdings-industry risk sensitivity changes in the airline industry in response to the 9/11 attacks. Panel A uses systematic risks (economy- and industry-wide risk) estimated by the beta coefficient method from a firm's stock return regression, and Panel B uses systematic risks (economy- and industry-wide risk) estimated by the variance decomposition method using the Type I sum of squares method. The data set comprises 19,548 firm-year observations for all firms covered in ExecuComp during the period 1980-2013 with non-missing values for all required variables. AIR is a dummy variable equal to one if the firm is in the airline industry (SIC code is 4512 or 4513) as of the sample year. We have 200 firm-year observations with 18 unique firms in the airline industry. AFT is a dummy variable equal to one if the firm-year observation is during the period 2001-2013 (i.e. datadate information is after September 11, 2001). Model [1] shows baseline results from our main regression. Models [2] and [3] are results from the differences-in-differences panel regression estimations. Models [4] and [5] are results from the differences-in-differences matching estimation. To find control firms, we match each firm in the treatment group with firms in the overall sample, where both of them should have the same fiscal year but not in the same industry, and the size (i.e. at) for the treatment firms should be between 70% and 130% of the matching firms' size. We then rank control firms based on the differences in sales ratio (sales/at) and select the four closest firms as control firms.

Table 2.10: Continued

Panel A: Beta Coefficients

	Base		Differences-in-Differences in panel regression				Differences-in-Differences in matching estimation			
	[1]		[2]		[3]		[4]		[5]	
Intercept	0.369	***	0.354	***	0.360	***	0.282	***	0.346	***
	(19.82)		(9.31)		(8.57)		(4.17)		(4.45)	
β_1: Economy Wide	0.013	***	0.013	***	0.013	***	0.0001		0.001	
	(3.55)		(3.6)		(3.43)		(0.01)		(0.07)	
β_2: Industry Wide	0.041	***	0.040	***	0.044	***	0.035	**	0.029	
	(7.68)		(7.46)		(6.83)		(2.09)		(1.4)	
Idiosyncratic risk	-0.165		-0.189		-0.210		0.955	*	0.881	
	(-0.85)		(-0.98)		(-1.09)		(1.74)		(1.62)	
β_2: Industry Wide*AIR*AFT			0.085	***	0.078	**	0.060	***	0.056	
			(3.63)		(2.24)		(2.88)		(1.23)	
β_2: Industry Wide*AIR					-0.072	*			-0.024	
					(-1.93)				(-0.62)	
β_2: Industry Wide*AFT					-0.006				0.019	
					(-0.94)				(0.89)	
AIR*AFT					-0.026				-0.003	
					(-0.89)				(-0.08)	
AIR					0.121	***			0.103	**
					(2.91)				(2.39)	
AFT					-0.003				-0.073	**
					(-0.22)				(-2.02)	
Control Variables	Yes		Yes		Yes		Yes		Yes	
Year FE	Yes		Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes		Yes		Yes	
Adjusted R-squared	0.597		0.598		0.599		0.572		0.577	
Number of Observations	19,548		19,548		19,548		1,000		1,000	

Table 2.10: Continued

Panel B: Variance Decomposition

	Base		Differences-in-Differences in panel regression				Differences-in-Differences in matching estimation			
	[1]		[2]		[3]		[4]		[5]	
Intercept	0.390	***	0.374	***	0.374	***	0.292	***	0.345	***
	(20.7)		(10.02)		(9.1)		(4.35)		(4.54)	
Explained σ_1 : Economy Wide	1.330	***	1.343	***	1.370	***	0.382		0.271	
	(4.58)		(4.63)		(4.71)		(0.44)		(0.32)	
Explained σ_2 : Industry Wide	2.276	***	2.116	***	2.699	***	1.871	*	2.192	*
	(6.17)		(5.66)		(5.89)		(1.91)		(1.66)	
UnExplained σ_3	-0.468	**	-0.478	**	-0.518	**	0.795		0.712	
	(-2.23)		(-2.28)		(-2.46)		(1.32)		(1.2)	
Explained σ_2 : Industry Wide*AIR*AFT			3.757	***	5.265	**	2.525	**	4.492	*
			(3.24)		(2.33)		(2.37)		(1.78)	
Explained σ_2 : Industry Wide*AIR					-5.948	***			-3.422	
					(-2.9)				(-1.48)	
Explained σ_2 : Industry Wide*AFT					-0.934	**			0.062	
					(-1.97)				(0.04)	
AIR*AFT					-0.025				-0.012	
					(-0.75)				(-0.33)	
AIR					0.125	***			0.119	***
					(3.38)				(2.93)	
AFT					0.003				-0.060	*
					(0.22)				(-1.8)	
Control Variables	Yes		Yes		Yes		Yes		Yes	
Year FE	Yes		Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes		Yes		Yes	
Adjusted R-squared	0.599		0.600		0.601		0.567		0.573	
Number of Observations	19,548		19,548		19,548		1,000		1,000	

Table 2.11: The Effect of the Co-movement between Market and Industry Returns on Cash Holdings-Industry Risk Sensitivity

This table presents regressions of a firm's cash holdings-industry risk sensitivity changes among cyclical industries and non-cyclical industries. Panel A uses systematic risks (economy- and industry-wide risk) estimated by the beta coefficient method from a firm's stock return regression, and Panel B uses systematic risks (economy- and industry-wide risk) estimated by the variance decomposition method using the Type I sum of squares method. The dataset comprises 18,780 firm-year observations for all firms covered in ExecuComp during the period 1980-2013 with non-missing values for all required variables. Based on a firm's daily stock returns over the fiscal year, we estimate the following equation: Industry return = ρ*economy return + ϵ, where economy and industry returns are the value weighted average return of the index (economy- and industry-wide), and industry return is computed based on firms in the same 4-digit SIC code. We posit that ρ is capturing co-movement between the market and industry risks. If ρ is higher, we assume that the industry is cyclical and if ρ is lower, we assume that the industry is non-cyclical. Model [1] shows baseline results from our main regression. In Model [2], *I*(high ρ) is a dummy variable equal to one if the firm's ρ in a sample year is above its sample median, and 0 otherwise. In Models [3] and [4], we separate samples into two groups: below median ρ vs. above median ρ.

Panel A: Beta Coefficients

	Base		Interaction with dummy variable		Low ρ vs. High ρ			
	[1]		[2]		[3]		[4]	
Intercept	0.369	***	0.343	***	0.333	***	0.379	***
	(19.82)		(7.89)		(6)		(8.78)	
β₁: Economy Wide	0.013	***	0.013	***	0.008		0.015	***
	(3.55)		(3.27)		(1.32)		(3.34)	
β₂: Industry Wide	0.041	***	0.023	***	0.017	**	0.054	***
	(7.68)		(4.11)		(2.58)		(7.13)	
Idiosyncratic risk	-0.165		-0.281		-0.136		-0.553	**
	(-0.85)		(-1.38)		(-0.48)		(-2.19)	
β₂: Industry Wide*_I_(High ρ)			0.032	***				
			(4.65)					
***I*(High ρ)**			0.0004					
			(0.11)					
Control Variables	Yes		Yes		Yes		Yes	
Year FE	Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes		Yes	
Adjusted R-squared	0.597		0.601		0.581		0.601	
Number of Observations	19,548		18,780		9,390		9,390	

Panel B: Variance Decomposition

	Base		Interaction with dummy variable		Low ρ vs. High ρ			
	[1]		[2]		[3]		[4]	
Intercept	0.390	***	0.360	***	0.336	***	0.402	***
	(20.7)		(8.5)		(6.12)		(9.5)	
β₁: Economy Wide	1.330	***	0.886	***	0.791	*	1.084	***
	(4.58)		(2.88)		(1.73)		(2.81)	
β₂: Industry Wide	2.276	***	0.963	**	0.607		2.935	***
	(6.17)		(2.32)		(1.33)		(5.95)	
Idiosyncratic risk	-0.468	**	-0.449	**	-0.198		-0.754	***
	(-2.23)		(-2.06)		(-0.67)		(-2.82)	
β₂: Industry Wide*_I_(High ρ)			2.109	***				
			(4.21)					
***I*(High ρ)**			-0.001					
			(-0.22)					
Control Variables	Yes		Yes		Yes		Yes	
Year FE	Yes		Yes		Yes		Yes	
Industry FE	Yes		Yes		Yes		Yes	
SE Clustered by firm	Yes		Yes		Yes		Yes	
Adjusted R-squared	0.599		0.602		0.581		0.602	
Number of Observations	19,548		18,780		9,390		9,390	

CHAPTER 3
DOES MANAGERIAL INCENTIVE INFLUENCE A FIRM'S BORROWING DIVERSITY?

3.1 Introduction

Incentive compensation should encourage managers to make sound corporate decisions and maximize shareholder value. To assess whether existing compensation arrangements achieve this goal, a large body of literature has examined the relationship between executive compensation and companies' investment decisions and financial policies.[44] Many of these studies focus on whether compensation structure affects risk-taking behavior and debt policy, such as leverage, cost of debt, and debt maturity. For example, studies in financial economics suggest that stronger equity incentives are associated with less risk-taking, while convexity in executives' portfolios due to stock options is correlated with more risk-taking[45] and higher leverage (Cohen, Hall, and Viceira (2000) and Coles, Daniel, and Naveen (2006)). However, there has not been much research into the effect of executive compensation on determining corporate borrowing diversity. In this paper, we empirically investigate whether the structure of managerial compensation and corresponding incentives affect borrowing diversity. We also explore which type of debt allows a CEO to take more risks and to have more discretion in business decisions.

To answer these research questions, we use compensation data from Execucomp to compute two proxies of risk-taking incentives based on a CEO's stock and option holdings. The primary characteristic of compensation that we consider is the sensitivity of CEO wealth to the firm's stock return volatility (vega). Because managers with higher vega may benefit from higher firm risk, vega provides a reasonable, straightforward measure of managers' risk-increasing incentives (Chava and Purnanandam (2010)). The second characteristic of compensation that we

[44] Review papers for CEO compensation research: refer to Frydman and Jenter (2010).

[45] See, for example, John and John (1993), Tufano (1996), Guay (1999), Rajgopal and Shevlin (2002), Knopf, Nam, and Thornton (2002), Lewellen (2006), and Coles, Daniel, and Naveen (2006).

consider is the sensitivity of CEO wealth to the firm's stock price (delta). Risk-averse and under-diversified managers have strong incentives to adopt risk-reducing policy choices if their compensations have high pay-for-performance sensitivity (alignment effect), and therefore delta provides a reasonable measure of managers' risk-reducing incentives.

After computing these measures, we match this data with Compustat data, which results in a sample of 18,081 firm-year observations over the period of 1992 to 2014. After controlling for firm characteristics and delta, we find that borrowing channels are negatively related to vega. In other words, companies with higher vega have lower borrowing diversity. Because vega is a measure of CEO risk-taking incentives, these firms are more likely to have higher risk, and this negative relationship is expected. This supports other studies which have shown that firms that provide managers with high vega compensation tend to be riskier, cash constrained, and smaller firms. As pointed out by Brockman, Martin, and Unlu (2010), creditors understand these risk incentives and rationally price them[46] (e.g., Strock Bagnani, Milonas, Saunders, and Travlos (1994) and Ortiz-Molina (2006)); thus, they include strong covenant restrictions in contracts and provide short-term maturity debt, which restricts firms' access to these debt sources. In other words, firms with high vega tend to have limited access to a smaller number of borrowing sources.

In light of these findings we also examine how the recent change in accounting standards (FAS 123R) related to executive compensation influences the effect of vega on debt borrowing channels. It is also important to consider this change because it directly affects firms' usages of options and our vega measure. Before the FAS 123R implementation, firms were allowed to expense employee stock options at intrinsic value. Because most firms granted stock options at-the-money, no expenses for option-based compensation were generally reported on the income statement. However, the implementation of FAS 123R eliminated the ability to expense options at

[46] Strock Bagnani, Milonas, Saunders, and Travlos (1994) and Ortiz-Molina (2006) provide evidence relating managerial incentive structures to the agency costs of debt finance. In particular, managers' higher risk-taking incentives increase borrowing costs.

their intrinsic value and instead required firms to begin expensing stock-option compensation at its fair value—which is not zero, and would have had a larger accounting impact on their profitability measure—thus, this change effectively eliminated any accounting advantages associated with stock options, and it became costly to provide stock-options in the compensation contract (Hayes, Lemmon and Qiu (2012)). According to Hayes, Lemmon and Qiu (2012), firms dramatically decrease their usage of stock options after the adoption of FAS 123R and the decline in option use is strongly associated with a proxy for accounting costs. Also, the convexity (vega) decreases significantly following the adoption of FAS 123R; meanwhile, pay-performance sensitivity (delta) increases. Therefore, implementation of FAS 123R has brought huge changes in accounting treatment and changes in firms' reliance on stock options related to executive compensation contracts.

We find that a CEO's average vega has decreased since 2003, and decreased more rapidly after the accounting rule changes (FAS 123R). The effect of vega on lowering borrowing diversity has increased following the change in the accounting standards, which suggests that firms with high vega may have become more selective in choosing borrowing channels that can be harmonized with high vega structure after the implementation of FAS 123R. Another explanation may be that creditors are more likely to recognize risky positions from a firm's financial statements and penalize them by cutting their lending options. This gives rise to the question of how high vega firms increase their leverage. Are there debt instruments that are flexible enough to provide funds even with this incentive structure?

To identify the effect of CEO compensation structure on the determinants of debt sources, it is therefore important to estimate this relation in a multivariate setting, while controlling for firm characteristics. Consequently, we employ discrete choice models that estimate the likelihood of a firm issuing a specific debt type. Overall, we find that companies with high CEO vega increase the likelihood of capitalized leases and convertible debt issuances, relative to bank debt borrowing. After changes in the accounting standards (FAS 123R), the influence of vega on capitalized leases has become stronger. Also, firms with higher CEO vega issue more bonds-and-notes, but less convertible debt, relative to bank debt. These results are consistent with arguments that capitalized leases and convertible debt have fewer restrictions on corporate policy decisions with no provisions or few covenant restrictions (Barclay and Smith (1995), Kahan and Yermack (1998), and Billett, King, and Mauer (2007)). This evidence strongly suggests that capitalized leases and convertible debt are flexible debt sources that are friendly to higher CEO vega firms.

Our paper makes several contributions to the literature. First, we provide evidence that a CEO's compensation incentive structure is an important determinant of a firm's diversified debt borrowing, and secondly, we show that the flexibility of debt instruments plays an important role when high vega managers choose different types of debt to diversify their borrowing sources.

The remainder of our paper is organized as follows. Section 2 reviews existing literature that leads to the development of our hypotheses. Section 3 describes our sample construction, variables, descriptive statistics, and the estimation method. Section 4 presents the empirical results of our tests and discusses the findings in the context of previous studies. Finally, Section 5 offers concluding remarks.

3.2 Hypotheses Development

Our first hypothesis tests the connection between corporate borrowing diversity and CEO compensation incentives. Regarding firms' borrowing diversifications, Colla, Ippolito, and Li (2013) show that while most of the firms in the U.S. concentrate their borrowing in only one debt type, large firms with high profitability, low risk, low growth opportunities, and high leverage borrow through multiple debt types. In particular, holding multiple debt sources is especially important and beneficial for firms during economic downturn. For instance, using the 2007-2009 financial crises as adverse credit supply shocks, Tengulov (2015) shows empirically that companies with lower borrowing diversity reduce their investment and debt financing significantly more than otherwise similar companies with many debt sources, and they pay a higher cost for debt.

In their paper (Colla, Ippolito, and Li (2013)), they do not consider CEO compensation incentives to explain a firm's diversified debt structure. But according to Coles, Daniel, and Naveen (2006), the CEO's compensation structure (vega) motivates managers to make riskier investments and to hold higher leverage. We argue that CEOs have strong motivations to diversify their companies' borrowing sources to provide better access to capital and allow them to actively take advantage of good investment opportunities in a timely fashion. We posit that a CEO with high vega compensation structure will have the strongest motivation to secure several borrowing sources so that they have more opportunities to maximize profits and increase their compensation.

However, firms that provide managers with high vega compensation tend to be riskier, cash constrained, and smaller. Riskier firms with high growth opportunities tend to have a smaller number of borrowing sources because financial institutions and investors are less willing to lend to them. This would suggest an inverse relation between vega and borrowing channels. As addressed by Brockman, Martin, and Unlu (2010), when creditors see causal connections between executive compensation and managerial risk-seeking behavior, they become more conservative, providing short-term debt and including strong covenant provisions in contracts. In the same vein, outside investors may be unwilling to invest their money in these firms due to managers' risk-seeking behavior; therefore, they might cut the existing debt channels when companies have high vega compensation structure, which will lower a firm's borrowing diversity. Ultimately, it is an empirical question as to whether the degree of executive's high vega compensation structure is positively or negatively related to a firm's borrowing diversity.

Hypothesis 1a*: Companies with higher vega have higher borrowing diversity.*

Hypothesis 1a'*: Companies with higher vega have lower borrowing diversity.*

The existing literature suggests that short-term debt and strong covenant protections can help to mitigate agency costs of debt (Brockman, Martin, and Unlu (2010) and Billett, King, and Mauer (2007)). However, there will be always conflicts in principal-agent relationships because ownership of most public companies in the U.S. is widely dispersed, and shareholders have few incentives to monitor management directly (Hart (1995)). Therefore, managers sometimes pursue their own objectives, such as excessive firm growth, at the expense of shareholders' interests. The question is how managers increase a firm's leverage to start risky projects and if there are particular debt instruments that can provide managers with more flexibility.

We posit that managers will choose debt types which provide them the discretion that fits their management style and attract less monitoring by creditors. Specifically, we conjecture that if a firm has high vega compensation structure, managers are more likely to choose convertible bonds or capitalized leases. With these debt types, creditors have less power to restrict a firm's policy decisions, and therefore the firm has more flexibility and managers have more discretion.

While bank lenders restrict managerial discretions with strong covenants, creditors issuing convertible debt and lease contracts set looser conditions for those debt types. Since capitalized leases generally have the highest priority in bankruptcy, lease contracts do not include provisions restricting the firm's financing, investment, or payout policies as other debt contracts do (Barclay and Smith (1995)). Convertible debt also includes less covenant protection (Kahan and Yermack (1998) and Billett, King, and Mauer (2007)). Most recently, Dong, Dutordoir, and Veld (2013) have surveyed top corporate executives to examine why companies issue convertible bonds. Their findings suggest that firms use convertibles "as sweetened debt, in order to avoid high coupons or heavy covenants (p.37)." These studies suggest that convertible debt and capitalized lease contracts have few covenant restrictions, which means that they preserve managers' flexibility in terms of investment and financing decisions. Moreover, they also support our hypothesis that managers are more likely to issue convertible debt or choose capitalized leases in firms with high vega compensation structure. Given the correlation between managers' compensation and risk-taking behavior, we suggest that managers' compensation incentives (vega) are positively correlated to convertible bond or lease contract choices due to the discretion these choices afford to managers.

Hypothesis 2*: Companies with higher vega have higher issuance of convertible debt or choices of lease contracts.*

3.3 Data and Research Design

3.3.1 Data

We use the ExecuComp database as our source of CEO compensation data. Our sample includes annual compensation information from fiscal year 1992 through 2014. Consistent with previous literature, we remove financial service firms (SIC code 6000-6999) and regulated utility firms (SIC codes 4900-4949). We also remove (1) firm-years with missing or zero values for total assets and total debt; (2) firm-years with market or book leverage outside the unit interval, where book leverage is the ratio of total debt (DLTT+DLC) to total asset (AT) and market leverage is the ratio of total debt to sum of the total debt plus market value of equity (PRCCF_F*CSHPRI); (3) firm-years with Herfindahl-Hirschman Index (HHI) outside the unit interval to exclude outliers, where HHI captures a firm's borrowing diversity and its definition is described below in Section 3.3.2. In addition, we require sample firm-years to have the necessary data to compute CEO delta and vega incentives. After we exclude samples with missing information, this leaves 2,193 firms and a total of 18,081 firm-year observations. All continuous firm characteristic variables are winsorized at the 1st and 99th percentiles. A table in Appendix provides a detailed description of the variables used in our analysis.

Table 3.1 reports descriptive statistics for variables used in our borrowing diversity and security choice regressions. To investigate how CEO incentives affect a firm's borrowing diversity, we borrow existing measures from the current literature. The variables are defined as follows.

3.3.2 Variables

Borrowing diversity: To measure the different degree of borrowing diversity across firms, we adopt two measures, *HHI* and *Excl90*, used in Colla, Ippolito, and Li (2013). First, we calculate

$$HHI_{i,t} = \left(\frac{Bank\ Debt_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{Capitalized\ Leases_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{Convertible\ Debt_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{Bonds\ and\ Notes_{i,t}}{TD_{i,t}}\right)^2, \quad (1)$$

where $HHI_{i,t}$ is the sum of the squared debt type ratios for firm i in year t; and TD refers to total debt. We also compute a normalized Herfindahl-Hirschman Index (*HHI**) of debt type usage as follows.

$$HHI^*_{i,t} = \frac{HHI_{i,t} - 1/4}{1 - 1/4}, \quad (2)$$

If a firm employs exclusively one single debt type, *HHI** equals one, while if a firm simultaneously employs all four debt types in equal proportion, *HHI** equals zero. Higher *HHI* values indicate firms' lower borrowing diversity and lower values of *HHI* indicate firms' higher borrowing diversity.

As an alternative measure of borrowing diversity to *HHI*, we define for firm i in year t the dummy variable *Excl90* as follows:

$Excl90_{i,t}$ = 1 if a firm obtains at least 90% of its debt from one debt type.

= 0 otherwise. (3)

Compensation incentives: To compute delta and vega of the CEO's portfolio of stocks and options, we follow the algorithm developed by Guay (1999) and Core and Guay (2002). Vega is the dollar change in the value of the CEO's option grants and any option holdings for a 0.01 change in the annualized standard deviation of stock returns. Delta is the dollar change in the value of the option or restricted stock grants, share holdings, and any restricted stock and option holdings for a 1% change in the stock price. In our regressions, we take the natural log of the vega and delta, where the dollar values are transformed into millions of dollars (e.g., Brockman, Martin, and Unlu (2010)).

Control variables: The control variables in the borrowing diversity regressions are based on the variables used in Colla, Ippolito, and Li (2013). Firm size is the natural log of the book value of total assets, where the book value of total assets is measured in constant 2008 dollars using the CPI. M/B is the market-to-book ratio, which is computed as the sum of the total debt, plus the market value of common stock (PRCC_F*CSHPRI), plus preferred stock liquidation value (PSTKL), minus deferred taxes and investment tax credit (TXDITC), all divided by the book value of total assets. Profitability is the ratio of operating income before depreciation (OIBDP) to the book value of total assets. *I*(Dividend Payer) is a dummy variable equal to one if the firm pays a common dividend in a given year, and zero otherwise. Tangibility is the ratio of net property, plant and equipment (PPENT) to the book value of total assets. CF Volatility is the standard deviation of quarterly operating income (OIBDP) over the previous 12 quarters, scaled by total assets. R&D expense is the research and development expenditure to the book value of total assets (i.e., Max (0, XRD)/AT)). *I*(Unrated) is a dummy variable equal to one if the firm has no existing debt rating, and zero otherwise. Book leverage is the ratio of sum of short-term (DLC) and long-term debt (DLTT) to the book value of total assets. In addition, the control variables in the multinomial logit regressions are based on the variables used in Denis and Mihov (2003). Amount Issued is the natural log of the (1+ amount issued), where the amount issued is measured as max (0, ΔBank Debt, ΔCapitalized Leases, ΔConvertible Debt, ΔBonds and Notes) to capture the dominant debt borrowing source. ΔX denotes the change in corresponding individual outstanding debt variable from year *t-1* to year *t*. *I*(Investment Grade) is a dummy variable equal to one if the firm has an existing debt rating of BBB or higher, and zero otherwise. *I*(Altman's Z < 1.81) is a dummy variable equal to one when Altman’s Z-score < 1.81 (a proxy for financial distress), and zero otherwise. Altman's Z-score is calculated as Z = 3.3 * OIADP / total assets + 1.0 * sales / total assets + 1.4 * retained earnings / total assets + 1.2 * working capital (ACT-LCT) / total assets + 0.6 * market value equity (PRCC_F*CSHO) / total debt. To account for possible differences and changes in a firm's debt structure through time and across industries, we also control for year and industry fixed effects in our analyses. Industry fixed effects are based on the Fama-French 48 industries classification. All continuous variables are winsorized at the 1st and 99th percentiles.

3.3.3 Sample description

Table 3.1 provides descriptive statistics of the variables used in the study. The dataset comprises 18,081 firm-year observations for 2,193 unique firms. The average HHI (HHI*) is 0.764 (0.685), which indicates that many firms concentrate their borrowing in few debt types (Colla, Ippolito, and Li (2013)). CEOs in the sample appear to have nontrivial vega and delta incentives. In particular, a 0.01 increase in the firm's stock return volatility increases the average (median) CEO's wealth by about $115,000 ($42,000); and a 1% increase in the stock price increases the average (median) CEO's wealth by about $623,000 ($193,000). To remove skewness, we use log (1+ vega) and log (1+ delta) as explanatory variables in the regression models. We add one to all vega and delta to ensure that we do not lose observations that have zero values. Finally, 46.2% of our sample firms do not have S&P Credit rating information available. Further, Table 3.2 presents the Pearson correlation coefficients between the variables used in our regression.

3.3.4 Research design

To examine the relation between the firm's CEO's compensation structure and borrowing diversity, we include all explanatory variables in the model following Colla, Ippolito, and Li (2013). Moreover, in an attempt to overcome endogeneity concerns, we exploit the stock option expensing regulation change in the year 2004. In 2004, the Financial Accounting and Standards

Board issued accounting rule FAS 123R, which requires all public corporations to expense their stock options grants a fair value, which reduces current earnings. Because of increased accounting costs, firms dramatically decrease their usage of option-based compensation and convexity (vega) in executive compensation following the implementation of FAS 123R (Hayes, Lemmon, and Qiu (2012)). Since vega is our main interest variable, we also examine how a firm's borrowing diversity is affected following the adoption of FAS 123R. SFAS (R) went into effect from fiscal years ending after June 2005,[47] therefore, we define fiscal year 2005 as the beginning of the post-FAS 123R period. The baseline regression model is specified as follows:

$$
\begin{aligned}
H_{it} = {} & \alpha_1 VEGA_{it} * POST_{FAS123R} + \alpha_2 DELTA_{it} * POST_{FAS123R} + \alpha_3 VEGA_{it} + \alpha_4 DELTA_{it} \\
& + POST_{FAS123R} + \alpha_5 SIZE_{it} + \alpha_6 MB_{it} + \alpha_7 PROFITABILITY_{it} \\
& + \alpha_8 DIVIDEND\ PAYER_{it} + \alpha_9 TANGIBILITY_{it} + \alpha_{10} CF\ VOLATILITY_{it} \\
& + \alpha_{11} R\&D\ EXPENSE_{it} + \alpha_{12} UNRATED_{it} + \alpha_{13} BOOK\ LEVERAGE_{it} \\
& + \sum_j INDUSTRY_j + \sum_t YEAR_t \\
& + \epsilon_{it}\ , \qquad (4)
\end{aligned}
$$

Multivariate Analysis of Security Choice

To identify the effect of CEO compensation structure on the determinants of the source of debt, it is important to estimate this relation in a multivariate setting, while controlling for firm characteristics. Consequently, we employ discrete choice models that estimate the likelihood of a firm issuing a specific debt type. Multinomial logit models provide one way to estimate systems in which independent variables affect the choice among a finite number of alternative outcomes. Thus, it provides a natural way of modeling a firm's choice of how to issue one debt type, given the alternative other debt sources—bank debt, capitalized leases, convertible debt, and bonds-and-notes. Specifically, we estimate the following model:

[47] These new accounting rules, however, were known and debated for years in advance and some papers argue that FAS 123R is not an effective instrument to be considered as a natural experiment. For example, Aboody, Barth, and Kasznik (2004) highlight that more than one hundred firms voluntarily expensed stock options as early as 2002 in anticipation of the 2005 adoption of FAS 123R.

$$\Pr\ (\text{debt type} = j\ ) = \frac{e^{\beta_j' x}}{\sum_{k=1}^{4} e^{\beta_k' x}}, \tag{5}$$

where j equals 1 for a bank debt, 2 for a capitalized leases, 3 for convertible debt, 4 for bonds-and-notes. β_j is a vector of coefficients for outcome j, and X is a vector of explanatory variables.

3.4 Empirical Results

3.4.1 CEO compensation incentives trends

Table 3.3 reports the averages of leverage, HHI, delta, and vega over our sample period, where both delta and vega measures are inflation-adjusted to 2008 dollars using the CPI. We measure the vega and delta following methods in the literature (Guay (1999), Core and Guay (2002), and Coles, Daniel, and Naveen (2006)). To visualize this information in Table 3.3, we include Figure 3.1 to capture vega and delta trends. The delta increases dramatically from $564,000 in 1994 to $1,079,000, reaching a peak in 2000, and then decreases to $680,000 in 2002, and decreases further to $409,000, reaching its lowest value in 2008. While delta trends have more ups and downs, vega trends are steady, and change slowly over time. Specifically, vega increases from $49,000 in 1992 to $194,000 in 2003, and then decreases to $132,000 in 2014. In summary, we find that a CEO's average vega has decreased since 2003, and decreased further after the accounting rule changes (FAS 123R). Therefore, we also account for this accounting rule change on option valuations for later analyses.

To examine a firm's debt structure (leverage and borrowing diversity) across low and high CEO vega firms, we sort firms into quartiles based on the CEO's vega. Table 3.4 reports the average leverage ratios and borrowing diversity for the 1st and 4th quartiles from 1992 to 2014. Leverage is defined as total debt (DLTT+DLC)/AT and borrowing diversity is defined as HHI. Figure 3.2 illustrates the average leverage and 1-HHI for the vega quartiles over our sample period. For illustration purposes, we only include lowest and highest vega quartiles in Figure 3.2.

We find that the highest vega CEO firms have a relatively wide range of leverage ratios ([0.22, 0.29], mostly) compared to the lowest vega CEO firms ([0.22, 0.26]). We do not find specific patterns in borrowing diversity among the lowest CEO vega firms. However, there is a pattern of decreasing diversity among the highest CEO vega firms: the 1-HHI measure drops steadily from 0.31 in 1992 to 0.15 in 2014, and the rate of decrease starts to accelerate from year 2002 onward. Interestingly, the highest vega firms tend to have a relatively higher leverage ratio than the lowest vega firms; their debt borrowing source is concentrated. Our evidence suggests that a CEO's vega is negatively associated with borrowing diversity. We again regress the borrowing diversity on a constant and time (measured in years) for each vega quartiles and find a negative and significant slope coefficient for each quartile except for the lowest. Given this evidence, we conclude that the overall decrease in borrowing diversity is not driven by the lowest vega firms in our sample and is markedly more pronounced in larger vega firms.

3.4.2 Borrowing diversity and CEO compensation incentives

To further investigate the determinants of borrowing diversity in a multivariate setting, Table 3.5 reports regressions of borrowing diversity on CEO compensation incentives and controls. The dependent variables are HHI in Models [1], [2], [5] and [6], Excl90 in Models [3]-[4], and *HHI** in Models [7]-[8]. Higher *HHI (Excl90)* values indicate firms' lower borrowing diversity and lower values of HHI indicate firms' higher borrowing diversity. The control variables in all regression models are based on Colla, Ippolito, and Li (2013), and these include firm size, market-to-book ratio, profitability, *I*(Dividend payer), tangibility, CF volatility, R&D expense, *I*(Unrated), and book leverage. All of the regressions include industry fixed effects (based on Fama-French 48 industry classifications) and year fixed effects. The t-statistics in parenthesis below the parameter estimates are computed using robust standard errors that are clustered at the firm level. Models [1], [3], [5], [7] include only vega and delta, and Models [2], [4], [6], [8] include an indicator (FAR 123R) equal to one for the post-FAS 123R period (which is defined as the fiscal years 2005 through 2014) and zero otherwise, and its interaction terms with vega and delta.

Models [1]-[4] in Table 3.5 report the contemporaneous relation between borrowing diversity and managerial incentives. The regression reveals that *HHI (Excl90)* is positively related to vega. In other words, borrowing channels are negatively related to vega, which suggests that firms that encourage CEO risk-taking tend to have lower borrowing diversity and depend on fewer debt sources, all things being equal. Furthermore, as can be seen in Models [2] and [4], the effect of vega on lowering borrowing diversity becomes stronger after the change in the accounting standards (FAS 123R). The negative relation between borrowing diversity and vega is not only statistically significant, but also reasonably economically significant. For instance, using the coefficient estimate on Log (vega) in Model [2], we examine whether the drop in debt borrowing channels is different for periods in after and before the accounting standard changes (FAS 123R). The interaction term between the Log (vega) and dummy variable FAS 123R has a coefficient of 0.201 (t-statistics of 4.78), which implies that the drop in debt borrowing channels is larger after the accounting standard changes (FAS 123R). As for the economic magnitude of the effect, an increase in the vega by one standard deviation is associated with a drop in debt borrowing channels of $0.201 \times 0.144 = 0.029$ or about 3.8% (based on regression sample mean for *HHI* of about 0.764) after the FAS 123R changes.

The literature suggests, the higher sensitivity of CEO wealth to stock return volatility (vega) provides managers with a stronger motive for risk-taking behavior. These risk incentives are recognized and priced by creditors (Strock Bagnani, Milonas, Saunders, and Travlos (1994) and Ortiz-Molina (2006)), which potentially affects firms' credit ratings.[48] Therefore, we argue that managers' risk-taking incentives eventually restrict firms' borrowing channels because

[48] For instance, according to a 2007 Moody's Investors Service Special Comment, the link between managerial compensation structure and risk-taking behavior potentially affects evaluating firms' credit quality. In the same vein, Bolton and Scharfstein (1996) predict that firms with low credit quality maximize liquidation value by borrowing from one creditor; meanwhile firms with high credit quality minimize the likelihood of default by borrowing from multiple creditors.

rational creditors are more likely to evaluate high vega firms as risky and cut their lending channels. Although high vega motivates CEO's risk taking behavior to enhance firms' stock price, the opportunity costs can be very large due to firms' having few borrowing channels, which results from a CEO's risk-taking incentives. Having multiple borrowing channels helps to decrease the overall cost of debt (Park (2000), Demarzo and Fishman (2007), and Tengulov (2015)), provide an effective hedge against adverse liquidity shocks, and positively affects companies' investment and financing policies (Tengulov (2015)).

Apart from incentive variables, the regression coefficients for the control variables are generally consistent with Colla, Ippolito, and Li (2013). They offer three possible explanations for the observed pattern of debt specialization: lowering expected bankruptcy costs, economizing on information collection and monitoring costs, and constrained access to capital. Like Colla, Ippolito, and Li (2013), we find that small firms with higher growth opportunity, few tangible assets, high CF volatility, high R&D expenditures, without a bond rating, and low leverage tend to concentrate their borrowings. Unlike Colla, Ippolito, and Li (2013), we find that firms with high profitability and dividend payments tend to have a smaller number of borrowing sources.

To control for potential endogeneity of compensation incentives, Models [5]-[8] in Table 3.5 report the relation between borrowing diversity and CEO incentives, where all the right-hand side variables are lagged. We continue to find that a positive and statistically significant effect of vega on lowering borrowing diversity.

3.4.3 Determinants of the source of new debt and CEO compensation incentives

To examine the relation between the firm's CEO's compensation structure and the determinants of the source of debt in a multivariate setting, we estimate multinomial logit models. Table 3.6 reports estimates of equation (5). The dependent variable includes four debt types: bank debt (debt type = 1), capitalized leases (debt type = 2), convertible debt (debt type = 3), and bonds-and-notes (debt type = 4), and the base outcome is issuing bank debt for Panel A and bonds-and-notes for Panel B in Table 3.6. This multinomial logit approach allows us to distinguish and derive simultaneous comparisons among the determinants of bank debt, capitalized leases, convertible debt, and bonds-and-notes as well as CEO's compensation incentives. The control variables in all regression models are based on Denis and Mihov (2003), and these include firm size, amount issued, market-to-book ratio, tangibility, *I*(investment grade rating), *I*(Unrated), *I*(Altman's Z-score <1.81), profitability, and book leverage. Finally, all equations include industry fixed effects.

Models [1]-[3] in Table 3.6 include only vega and delta, and Models [4]-[6] include an indicator (FAR123R) equal to one for the post-FAS 123R period (which is defined as the fiscal years 2005 through 2014) and zero otherwise, and its interaction terms with vega and delta. Models [1] and [4] analyze the probability of issuing capitalized leases relative to bank debt, Models [2] and [5] analyze the probability of issuing convertible debt relative to bank debt, and Models [3] and [6] analyze the probability of issuing bonds-and-notes relative to bank debt.

From Models [1] and [2] in Panel A of Table 3.6, the coefficient on vega is positive and statistically different from zero for capitalized leases and convertible debt, which is consistent with our second hypothesis. These results indicate that a CEO's vega incentives increase the likelihood of capitalized leases and convertible debt issuances, relative to bank debt borrowing. We conjecture that a CEO with high-risk taking incentives prefers convertible debt or capitalized leases rather than bank debt because these provide more discretion to managers due to fewer covenant restrictions. In particular, "lease contracts generally restrict corporate decisions only with respect to the leased assets …[these] normally would not include provisions restricting the firm's financing or payout policies, meanwhile other debt contracts typically contain covenants that restrict the firm's investment, payout, and financial policies" (Barclay and Smith (1995)). Moreover, convertible debt has fewer covenant restrictions on debt contracts (Kahan and Yermack (1998) and Billett, King, and Mauer (2007)), which allows corporate executives to avoid high coupons or heavy covenants **(**Dong, Dutordoir, and Veld (2013)). Consistent with this view, Coles, Daniel, and Naveen (2006) find that higher sensitivity of CEO wealth to stock volatility (vega) is related to riskier policy choices.[49] Existing research suggests that the use of convertible debt can mitigate risk-shifting by making the security's value less sensitive to the volatility of cash flows (Brennan and Schwartz (1988)), which may strongly motivate managers to choose convertible debt.

As can be seen from Models [4]-[6] in Panel A of Table 3.6, after the change in the accounting standards (FAS 123R), firms with higher CEO vega have a higher issuance of capitalized leases and bonds and notes, but less issuance of convertible debt, relative to bank debt borrowing. Interestingly, we find that high CEO vega firms dramatically reduce their reliance on convertible debt after the adoption of FAS 123R. The decline in convertible debt use may be strongly associated with accounting costs. We posit that relative costs of vega have become greater than benefits of convertible debt after the adoption of FAS 123R. Under FAS 123R, all stock option grants are required to be evaluated at fair value, which results in compensation expense on the income statement. As a result, it is more expensive to use stock options to motivate managers to make sound corporate decisions.

3.5 Conclusions

This study analyzes how a CEO's compensation incentives affect a firm's borrowing diversity and debt choices. We test two hypotheses using the CEO's vega and delta measures of U.S firms in the Execucomp database. Our results indicate that firms with higher CEO vega are more likely to have lower borrowing diversity and that this pattern has become stronger since the change in the accounting standards (FAS 123R). Our results suggest either that these firms selectively choose a small number of borrowing channels or that creditors recognize managers'

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[49] For example, riskier policy choices include taking more investments in R&D, less investments in fixed assets, more focus, and higher leverage.

risk-taking behavior based on their compensation structure and limit these firms' access to one or two borrowing sources.

We next explore potential borrowing sources for the firms with high CEO vega. We find that companies with high CEO vega increase the likelihood of capitalized leases and convertible debt issuances, relative to bank debt borrowing. Our findings suggest that capitalized leases and convertible debt are less likely to constrain managerial discretion than bank debt because there are no such provisions restricting corporate policies in capitalized leases and few covenant restrictions in convertible debt contracts.

Our study contributes to the literature with further insights on the effects of a CEO's compensation incentives. We provide additional evidence of the consequences of CEO's risk-taking incentives in the context of debt borrowing channels, which are one of the most important corporate resources but are not widely explored in the existing literature. In particular, we highlight the debt borrowing sources that can provide more flexibility to CEO with risk-taking incentives.

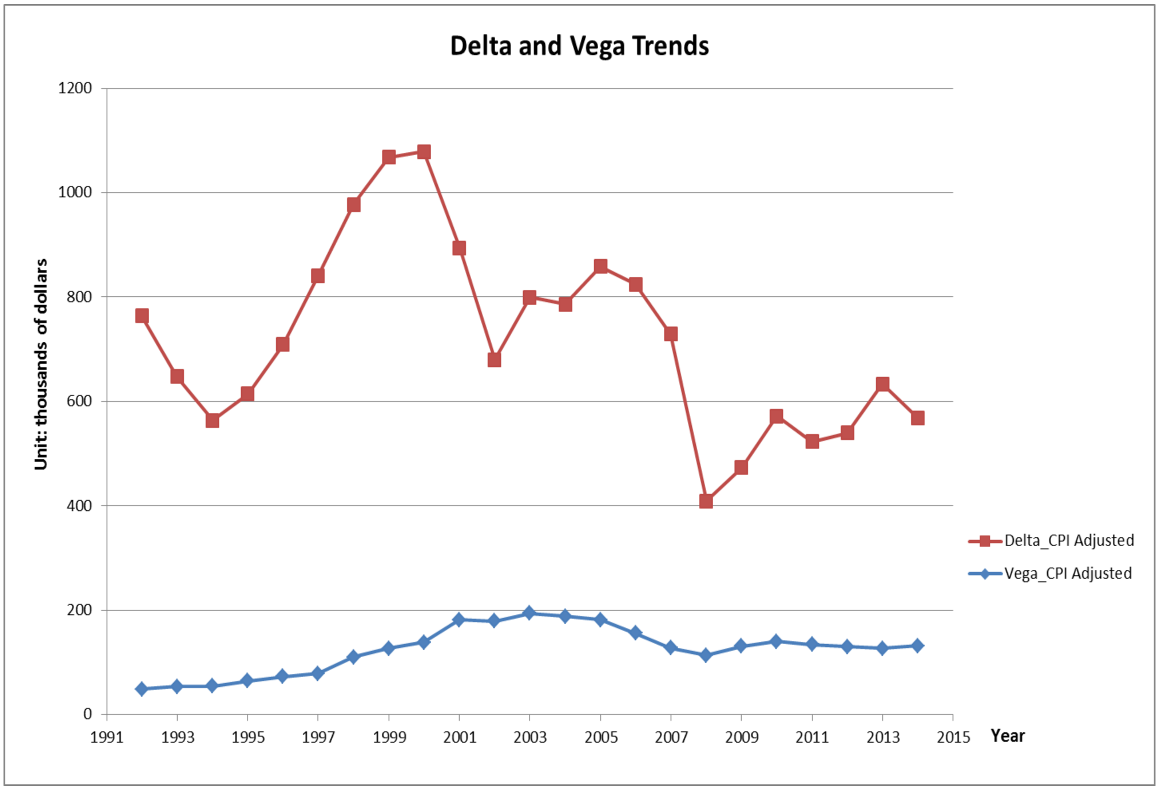
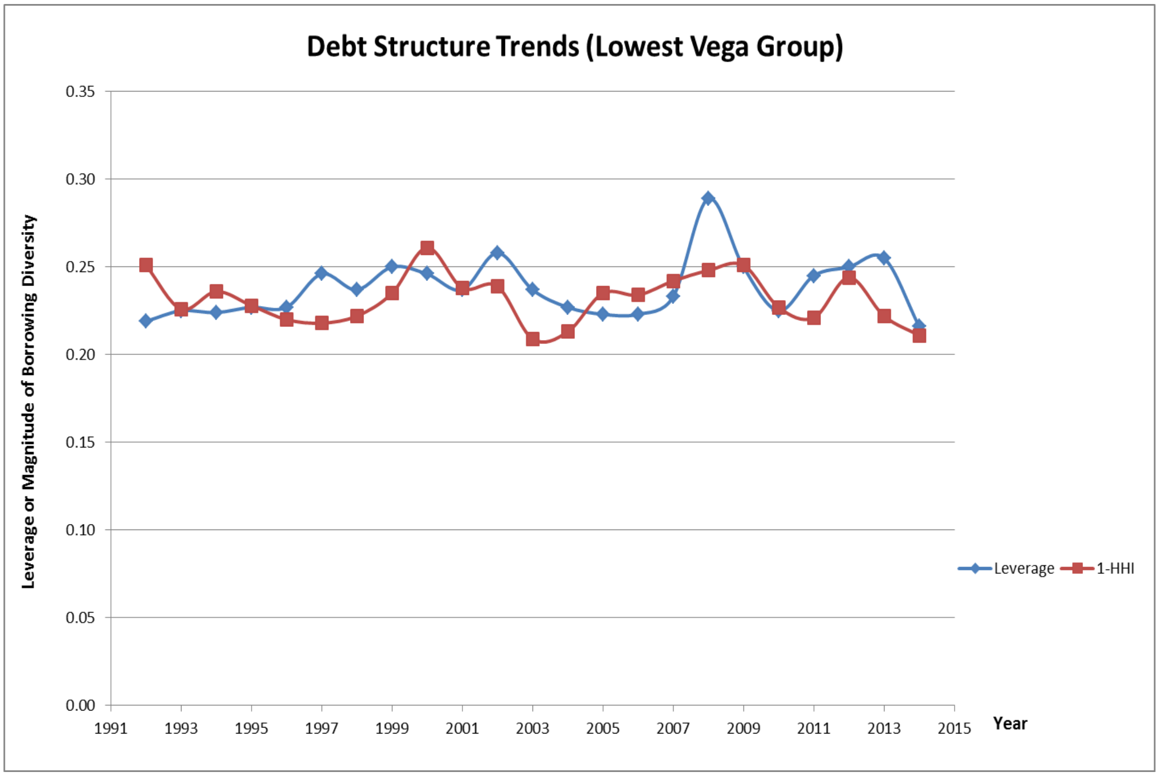


Figure 3.1: Average delta and vega from 1992 to 2014

The figure exhibits the averages of delta and vega over our sample period: 1992-2014, where both delta and vega measures are inflation-adjusted to 2008 dollars using the CPI.



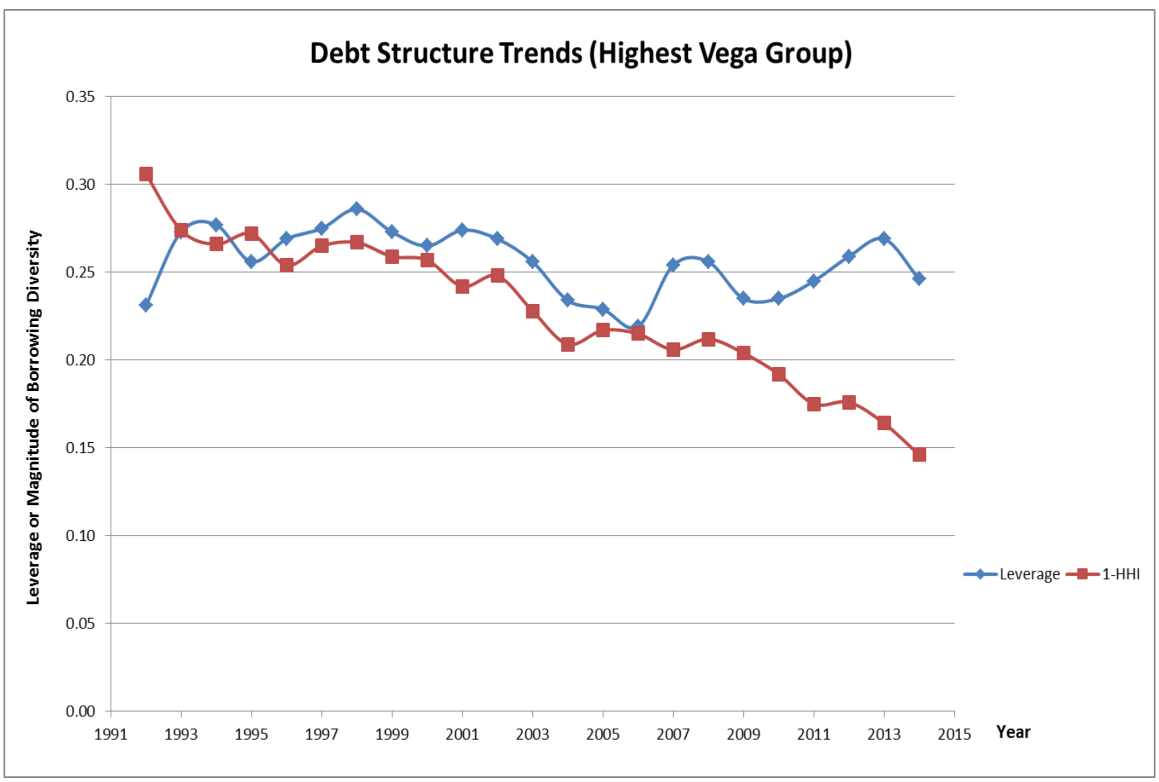


Figure 3.2: Average leverage ratios and 1-HHI by vega quartiles from 1992 to 2014

This figure illustrates the average leverage and 1-HHI for the CEO's vega quartiles over our sample period. We only include lowest and highest vega quartiles in this figure. To improve interpretability and for illustrative purposes, we use 1-HHI measure instead of HHI, where lower values of 1-HHI indicate firms' lower borrowing diversity and higher values of 1-HHI indicate firms' higher borrowing diversity.

Table 3.1: Descriptive Statistics: 1992-2014

This table presents the descriptive statistics for the sample. The sample consists of S&P 1500 firms covered in the COMPUSTAT and Executive Compensation databases from 1992 to 2014, which contains 18,081 firm-year observations for 2,193 unique firms. Vega is the change in the value of the CEO's option grant in a year and any accumulated option holdings for a 0.01 change in the annualized standard deviation of stock returns. Delta is the change in the value of the option or restricted stock grants in a year, share holdings, and any accumulated restricted stock and option holdings for a 1% change in the stock price. Log (Vega), Log (Delta) are the natural log of (1+ vega) and (1+ delta), where the dollar values of vega and delta are converted into million dollars from thousand dollars. Option vega and delta are computed using the dividend-adjusted Black and Scholes model. HHI is calculated as [[Bank Debt/Total Debt]^2 + [Capitalized Leases/Total Debt]^2 + [Convertible Debt/Total Debt]^2 + [Bonds and Notes/Total Debt]^2], where total debt = DLC + DLTT. HHI* is normalized HHI and calculated as [HHI-(1/4)]/[1-(1/4)]. Bank debt is imputed from Compustat as the category other long-term debt (DLTO) minus commercial paper (CMP). Capitalized leases are the capitalized lease obligations (DLCO). Convertible debt is the convertible debt (DCVT). Bonds and notes is total debt minus bank debt minus capitalized leases minus convertible debt minus commercial paper. Missing values for commercial paper is replaced with zero before constructing relevant sub-debt categories variables. Excl90 is a dummy variable equal to one if the firm obtains at least 90% of its debt from one debt type, and zero otherwise. Firm Size is the natural log of the book value of total assets, where the book value of total assets is measured in constant 2008 dollars using the CPI. MB is the market-to-book ratio, which is computed as the sum of the total debt plus the market value of common stock (PRCC_F*CSHPRI) plus preferred stock liquidation value (PSTKL) minus deferred taxes and investment tax credit (TXDITC) all divided by the book value of total assets. Profitability is the ratio of operating income before depreciation (OIBDP) to the book value of total assets. *I*(Dividend) is a dummy variable equal to one if the firm pays dividends in a given year, and zero otherwise. Tangibility is the ratio of net property, plant and equipment (PPENT) to the book value of total assets. CF Volatility is the standard deviation of quarterly operating income (OIBDP) over previous 12 quarters, scaled by total assets. R&D Expense is the research and development expenditure to the book value of total assets = Max (0, XRD)/AT. *I*(Unrated) is a dummy variable equal to one if the firm has no existing debt rating, and zero otherwise. *I*(Investment Grade) is a dummy variable equal to one if the firm has an existing debt rating of BBB or higher, and zero otherwise. *I*(Altman's Z < 1.81) is a dummy variable equal to one when Altman's Z-score < 1.81 (a proxy for financial distress), and zero otherwise. Altman's Z-score is calculated as Z = 3.3 * OIADP / total assets + 1.0 * sales / total assets + 1.4 * retained earnings / total assets + 1.2 * working capital (ACT-LCT) / total assets + 0.6 * market value equity (PRCC_F*CSHO) / total debt. Book Leverage is the ratio of sum of short-term (DLC) and long-term debt (DLTT) to the book value of total assets. Log (Amount Issued) is the natural log of the (1+ amount issued), where the amount issued is measured as max (0, ΔBank Debt, ΔCapitalized Leases, ΔConvertible Debt, ΔBonds and Notes) to capture the dominant debt borrowing source. ΔX denotes the change in corresponding individual outstanding debt variable from year t-1 to year t. All continuous variables are winsorized at the top and bottom 1 percentiles.

Table 3.1: Continued

Variable	N	Mean	Std Dev	25th Pct.	Median	75th Pct.
CEO Compensations						
Vega ($000s)	18081	115	199	12	42	123
Delta ($000s)	18081	623	1481	74	193	518
Log (Vega)	18081	0.097	0.144	0.012	0.041	0.116
Log (Delta)	18081	0.336	0.438	0.072	0.177	0.417
Borrowing Diversity						
HHI	18081	0.764	0.209	0.556	0.795	0.983
HHI*	18081	0.685	0.279	0.407	0.726	0.978
Excl90	18081	0.476	0.499	0.000	0.000	1.000
Firm Characteristics						
Firm Size	18081	7.407	1.478	6.361	7.257	8.317
MB	18081	1.577	1.145	0.861	1.229	1.871
Profitability	18081	0.140	0.088	0.095	0.138	0.188
***I*(Dividend Payer)**	18081	0.504	0.500	0	1	1
Tangibility	18081	0.313	0.228	0.131	0.250	0.450
CF Volatility	18081	0.014	0.012	0.006	0.010	0.016
R&D Expense	18081	0.026	0.048	0.000	0.000	0.031
***I*(Unrated)**	18081	0.462	0.499	0	0	1
***I*(Investment Grade Rating)**	18081	0.309	0.462	0	0	1
***I*(Altman's Z < 1.81)**	18081	0.109	0.311	0	0	0
Book Leverage	18081	0.246	0.167	0.117	0.231	0.346
Log (Amount Issued)	12919	3.795	2.113	2.197	3.981	5.365

Table 3.2: Pearson Correlation Coefficients

This table presents a correlation matrix for the final samples. The dataset comprises 18,081 firm-year observations from 1992 to 2014. The variables are defined in the legend for Table 3.1. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Log (Vega)	1														
2	Log (Delta)	0.509***	1													
3	HHI	0.050***	0.035***	1												
4	Firm Size	0.558***	0.361***	-0.058***	1											
5	MB	0.117***	0.318***	0.103***	-0.158***	1										
6	Profitability	0.117***	0.196***	0.069***	0.095***	0.373***	1									
7	*I* (Dividend Payer)	0.169***	0.069***	0.058***	0.357***	-0.083***	0.202***	1								
8	Tangibility	-0.068***	-0.035***	-0.114***	0.158***	-0.170***	0.128***	0.132***	1							
9	CF Volatility	-0.119***	-0.058***	0.047***	-0.287***	0.167***	-0.097***	-0.179***	0.007	1						
10	R&D Expense	0.016**	-0.020***	0.079***	-0.205***	0.322***	-0.223***	-0.222***	-0.296***	0.245***	1					
11	*I* (Unrated)	-0.292***	-0.147***	0.112***	-0.633***	0.175***	-0.024***	-0.220***	-0.168***	0.161***	0.181***	1				
12	*I* (Investment Grade Rating)	0.413***	0.231***	0.030***	0.628***	-0.016**	0.158***	0.445***	0.097***	-0.190***	-0.108***	-0.619***	1			
13	*I* (Altman's Z < 1.81)	-0.060***	-0.106***	-0.123***	0.077***	-0.196***	-0.277***	-0.140***	0.185***	0.056***	-0.022***	-0.165***	-0.107***	1		
14	Book Leverage	0.009	-0.070***	-0.177***	0.196***	-0.205***	-0.112***	-0.007	0.210***	-0.090***	-0.187***	-0.372***	0.051***	0.467***	1	
15	Log (Amount Issued)	0.304***	0.209***	-0.059***	0.612***	-0.127***	0.001	0.184***	0.137***	-0.187***	-0.157***	-0.417***	0.349***	0.160***	0.408***	1

Table 3.3: Average Delta and Vega from 1992 to 2014

This table presents the averages of leverage, HHI, vega, and delta over time. The sample includes all S&P 1500 firms covered in the COMPUSTAT and Executive Compensation databases from 1992 to 2014 with positive values for the book value of total assets and total debt for firms incorporated in the United States. Financial firms (SIC code 6000-6999) and regulated utility firms (SIC codes 4900-4949) are excluded from the sample, yielding a panel of 18,081 observations for 2,193 unique firms. Detailed sample selection procedures are described in Section 3.3.1. Both vega and delta are measured in constant 2008 dollars using the CPI and units are presented in thousands of dollars. Variable definitions are provided in the Appendix C.1.

Year	N	Leverage	HHI	$Delta\_{CPI\ Adjusted}$	$Vega\_{CPI\ Adjusted}$
1992	411	0.233	0.734	763	49
1993	655	0.233	0.753	647	54
1994	748	0.234	0.748	564	55
1995	790	0.242	0.740	614	65
1996	808	0.238	0.741	709	73
1997	834	0.250	0.750	841	79
1998	844	0.264	0.745	977	111
1999	847	0.271	0.743	1068	127
2000	825	0.262	0.750	1079	138
2001	817	0.258	0.764	894	182
2002	826	0.252	0.771	680	179
2003	894	0.239	0.779	800	194
2004	870	0.230	0.783	787	188
2005	817	0.226	0.773	858	181
2006	814	0.229	0.766	824	156
2007	934	0.244	0.766	729	128
2008	935	0.265	0.755	409	114
2009	882	0.237	0.769	473	131
2010	864	0.231	0.774	572	140
2011	868	0.243	0.788	523	134
2012	839	0.252	0.780	540	131
2013	816	0.260	0.797	633	127
2014	143	0.234	0.798	568	132

Table 3.4: Average Leverage and Borrowing Diversity by Vega Quartiles from 1992 to 2014

This table presents the averages of leverage and borrowing diversity by vega quartiles from 1992 to 2014. From the final sample (a panel of 18,081 observations for 2,193 unique firms), we only include firms with outstanding debt information (i.e., non-missing values in bank debt, capitalized leases, convertible debt, and bonds and notes): 17,666 firm-year observations. The leverage is measured as the ratio of sum of short-term and long-term debt to the book value of total assets. The borrowing diversity is measured as the HHI, in which HHI is [[Bank Debt/Total Debt]^2 + [Capitalized Leases/Total Debt]^2 + [Convertible Debt/Total Debt]^2 + [Bonds and Notes/Total Debt]^2], where total debt = DLC + DLTT. Firms are sorted into quartiles based on the CEO's vega. We only present results in two groups. The first quartile (Q1, N = 4,416) comprises the smallest vega firms in the sample, while the fourth quartile (Q4, N = 4,416)) comprises the largest vega firms in the sample. To improve interpretability and illustrative purposes in Figure 3.2, we use 1-HHI measure in this table.

	1st Quartile Vega		**4th Quartile Vega**	
Year	**Leverage**	**1-HHI**	**Leverage**	**1-HHI**
1992	0.219	0.251	0.231	0.306
1993	0.225	0.226	0.273	0.274
1994	0.224	0.236	0.277	0.266
1995	0.227	0.228	0.256	0.272
1996	0.227	0.220	0.269	0.254
1997	0.246	0.218	0.275	0.265
1998	0.237	0.222	0.286	0.267
1999	0.250	0.235	0.273	0.259
2000	0.246	0.261	0.265	0.257
2001	0.237	0.238	0.274	0.242
2002	0.258	0.239	0.269	0.248
2003	0.237	0.209	0.256	0.228
2004	0.227	0.213	0.234	0.209
2005	0.223	0.235	0.229	0.217
2006	0.223	0.234	0.219	0.215
2007	0.233	0.242	0.254	0.206
2008	0.289	0.248	0.256	0.212
2009	0.250	0.251	0.235	0.204
2010	0.225	0.227	0.235	0.192
2011	0.245	0.221	0.245	0.175
2012	0.250	0.244	0.259	0.176
2013	0.255	0.222	0.269	0.164
2014	0.216	0.211	0.246	0.146

Table 3.5: Regressions of Borrowing Diversity on CEO Incentives

This table presents regression results to examine the relation between CEO incentives and debt borrowing diversity. The sample consists of S&P 1500 firms covered in the COMPUSTAT and Executive Compensation databases from 1992 to 2014, which contains 18,081 firm-year observations for 2,193 unique firms. The dependent variables are three measures of debt borrowing diversity: HHI (HHI*) and Excl90. Models [1] – [2] are pooled time-series cross-sectional Tobit regressions of borrowing diversity in year t on year t CEO incentives and firm characteristics. Models [3] – [4] are pooled time-series cross-sectional Probit regressions of borrowing diversity in year t on year t CEO incentives and firm characteristics. Models [5] – [8] are pooled time-series cross-sectional Tobit regressions of borrowing diversity in year t+1 on year t CEO incentives and firm characteristics. In other words, all right-hand side variables are lagged. The independent variables in the regressions include an indicator (FAR123R) equal to one for the post-FAS 123R period (which is defined as the fiscal yeast 2005 through 2014) and zero otherwise. Log (Vega) and Log (Delta) are natural logarithm of Vega and Delta. Definitions of the other variables are provided in Appendix C.1. All specifications include (Fama-French 48) industry fixed effects and year fixed effects. Robust standard errors are clustered at the firm level and reported. The t-statistics are in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Table 3.5: Continued

Independent Variable	Contemporaneous Dependent Variable				Lead Dependent Variable			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
	HHI_t	HHI_t	$Excl90_t$	$Excl90_t$	HHI_{t+1}	HHI_{t+1}	HHI^*_{t+1}	HHI^*_{t+1}
FAS123R*Log (Vega)$_t$		0.201***		1.059***		0.180***		0.241***
		(4.78)		(4.69)		(4.13)		(4.15)
FAS123R*Log (Delta)$_t$		-0.018		-0.065		-0.001		-0.001
		(-1.16)		(-0.80)		(-0.07)		(-0.07)
Log (Vega)$_t$	0.078***	-0.031	0.456***	-0.125	0.062**	-0.040	0.084**	-0.052
	(2.63)	(-0.91)	(3.04)	(-0.69)	(2.01)	(-1.11)	(2.05)	(-1.09)
Log (Delta)$_t$	0.005	0.013	-0.030	-0.002	0.005	0.006	0.007	0.008
	(0.54)	(1.14)	(-0.61)	(-0.03)	(0.50)	(0.50)	(0.49)	(0.49)
FAS123R		0.060**		0.304**		0.050**		0.066**
		(2.57)		(2.41)		(2.05)		(2.03)
Firm Size$_t$	-0.014***	-0.013***	-0.049**	-0.046**	-0.016***	-0.015***	-0.021***	-0.020***
	(-3.44)	(-3.29)	(-2.37)	(-2.22)	(-3.73)	(-3.57)	(-3.73)	(-3.56)
MB$_t$	0.004	0.004	0.015	0.016	0.008**	0.009**	0.011**	0.012**
	(1.12)	(1.16)	(0.85)	(0.93)	(2.25)	(2.36)	(2.25)	(2.36)
Profitability$_t$	0.166***	0.164***	0.692***	0.674***	0.130***	0.125***	0.173***	0.167***
	(3.79)	(3.72)	(3.37)	(3.27)	(2.85)	(2.74)	(2.87)	(2.75)
***I*(Dividend Payer)$_t$**	0.040***	0.040***	0.184***	0.180***	0.045***	0.044***	0.060***	0.059***
	(4.95)	(4.87)	(4.66)	(4.56)	(5.39)	(5.28)	(5.39)	(5.28)
Tangibility$_t$	-0.073***	-0.073***	-0.393***	-0.392***	-0.071***	-0.071**	-0.095***	-0.095***
	(-2.73)	(-2.73)	(-3.06)	(-3.05)	(-2.58)	(-2.57)	(-2.59)	(-2.58)
CF Volatility$_t$	0.682**	0.683**	1.987	1.976	1.058***	1.047***	1.406***	1.392***
	(2.34)	(2.34)	(1.50)	(1.49)	(3.44)	(3.40)	(3.43)	(3.39)
R&D expense$_t$	0.143	0.141	0.353	0.334	0.275**	0.270**	0.367**	0.360**
	(1.43)	(1.41)	(0.76)	(0.72)	(2.57)	(2.53)	(2.57)	(2.53)
***I*(Unrated)$_t$**	0.029***	0.028***	0.117**	0.115**	0.028***	0.027***	0.037***	0.036***
	(2.92)	(2.88)	(2.47)	(2.41)	(2.80)	(2.76)	(2.79)	(2.74)
Book Leverage$_t$	-0.196***	-0.197***	-0.776***	-0.781***	-0.189***	-0.189***	-0.252***	-0.253***
	(-8.38)	(-8.44)	(-6.55)	(-6.61)	(-8.11)	(-8.18)	(-8.12)	(-8.19)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE Clustered by firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.237	0.244	0.047	0.049	0.191	0.196	0.097	0.099
Model	Tobit	Tobit	Probit	Probit	Tobit	Tobit	Tobit	Tobit
Number of Observations	18,081	18,081	18,081	18,081	18,081	18,081	18,081	18,081

Table 3.6: Multinomial Logistic Model of Debt Source

This table reports coefficient estimates for a multinomial logit model. The sample consists of S&P 1500 firms covered in the COMPUSTAT and Executive Compensation databases from 1992 to 2014, which contains 18,081 firm-year observations for 2,193 unique firms. The dependent variable includes four different types of debt issuance: bank debt, capitalized leases, convertible debt, and bonds and notes. The base outcome for Panel A is issuing bank debt and the base outcome for Panel B is issuing bonds and notes or convertible debt. For example, the dependent variable in models [1] and [4] in Panel A is the log-odds ratio of the probability of issuing capitalized leases relative to bank debt. The independent variables in the regressions include an indicator (FAR 123R) equal to one for the post-FAS 123R period (which is defined as the fiscal yeast 2005 through 2014) and zero otherwise. Log (Vega) and Log (Delta) are natural logarithm of Vega and Delta. Amount issued is the natural log of the (1+ amount issued), where the amount issued is measured as max (0, ΔBank Debt, ΔCapitalized Leases, ΔConvertible Debt, ΔBonds and Notes) to capture the dominant debt borrowing source. ΔX is notation for the one-year change, X_t - X_{t-1}, where t (t-1) denotes end of fiscal year t (t-1). Definitions of the other variables are provided in Appendix C.1. All regressions include (Fama-French 48) industry fixed effects. The t-statistics are in parentheses below the parameter estimates. We use ***, **, and * to denote significance at the 1% level, 5% level, and 10% level, respectively.

Table 3.6: Continued

Panel A:

Independent Variable	[1] Capitalized Leases vs. Bank Debt	[2] Convertible Debt vs. Bank Debt	[3] Bonds and Notes vs. Bank Debt	[4] Capitalized Leases vs. Bank Debt	[5] Convertible Debt vs. Bank Debt	[6] Bonds and Notes vs. Bank Debt
FAS123R*Log (Vega)$_t$				1.516**	-1.588**	1.027***
				(2.43)	(-2.47)	(3.08)
FAS123R*Log (Delta)$_t$				-0.202	-0.110	0.158
				(-0.93)	(-0.48)	(1.42)
Log (Vega)$_t$	1.608***	0.797**	0.293	0.665	1.494***	-0.289
	(4.44)	(2.31)	(1.54)	(1.32)	(3.62)	(-1.15)
Log (Delta)$_t$	-0.289**	-0.087	-0.008	-0.135	-0.115	-0.074
	(-2.45)	(-0.79)	(-0.13)	(-0.91)	(-0.87)	(-1.00)
FAS123R				0.402***	-0.073	-0.190***
				(3.91)	(-0.71)	(-3.46)
Firm Size$_t$	0.451***	0.044	0.078***	0.409***	0.057	0.087***
	(9.46)	(0.91)	(2.99)	(8.44)	(1.17)	(3.33)
Log (Amount Issued)$_t$	-0.749***	0.054**	-0.095***	-0.742***	0.061**	-0.095***
	(-28.92)	(2.05)	(-6.74)	(-28.64)	(2.30)	(-6.77)
MB$_t$	0.238***	0.284***	0.163***	0.256***	0.275***	0.167***
	(5.94)	(7.31)	(6.33)	(6.37)	(7.04)	(6.43)
Tangibility$_t$	0.676***	-1.112***	-0.180	0.954***	-1.263***	-0.210
	(2.64)	(-4.49)	(-1.40)	(3.65)	(-5.00)	(-1.61)
***I*(Investment Grade Rating)$_t$**	-0.382***	-0.638***	0.322***	-0.287**	-0.677***	0.296***
	(-2.86)	(-5.42)	(5.02)	(-2.11)	(-5.64)	(4.52)
***I*(Unrated)$_t$**	-0.251**	-0.791***	-0.225***	-0.256**	-0.772***	-0.238***
	(-2.08)	(-7.56)	(-3.63)	(-2.11)	(-7.38)	(-3.82)
***I*(Altman's Z < 1.81)$_t$**	-0.077	-0.430***	0.115	-0.092	-0.421***	0.127*
	(-0.46)	(-3.28)	(1.53)	(-0.54)	(-3.22)	(1.69)
Profitability$_t$	-2.531***	-3.971***	-1.019***	-2.735***	-3.841***	-1.055***
	(-5.08)	(-8.61)	(-3.42)	(-5.47)	(-8.28)	(-3.53)
Book Leverage$_t$	-1.026***	1.498***	-0.702***	-0.979***	1.476***	-0.728***
	(-3.19)	(5.26)	(-4.26)	(-3.03)	(5.16)	(-4.40)
Pseudo R^2		0.099			0.103	
Number of Observations		12,919			12,919	

Table 3.6: Continued

Panel B:

Independent Variable	[1] Capitalized Leases vs. Bonds and Notes	[2] Convertible Debt vs. Bonds and Notes	[3] Capitalized Leases vs. Convertible Debt	[4] Capitalized Leases vs. Bonds and Notes	[5] Convertible Debt vs. Bonds and Notes	[6] Capitalized Leases vs. Convertible Debt
FAS123R*Log (Vega)$_t$				0.489	-2.615***	3.104***
				(0.83)	(-4.23)	(3.81)
FAS123R*Log (Delta)$_t$				-0.360*	-0.268	-0.092
				(-1.74)	(-1.20)	(-0.32)
Log (Vega)$_t$	1.316***	0.504	0.811*	0.954**	1.783***	-0.829
	(3.84)	(1.53)	(1.80)	(1.98)	(4.51)	(-1.41)
Log (Delta)$_t$	-0.282**	-0.080	-0.202	-0.062	-0.042	-0.020
	(-2.49)	(-0.75)	(-1.36)	(-0.43)	(-0.33)	(-0.11)
FAS123R				0.592***	0.117	0.475***
				(5.94)	(1.15)	(3.56)
Firm Size$_t$	0.373***	-0.034	0.407***	0.322***	-0.030	0.352***
	(8.18)	(-0.71)	(6.59)	(6.94)	(-0.64)	(5.62)
Log (Amount Issued)$_t$	-0.655***	0.148***	-0.803***	-0.647***	0.156***	-0.803***
	(-26.48)	(5.84)	(-23.91)	(-26.16)	(6.07)	(-23.75)
MB$_t$	0.074**	0.121***	-0.047	0.090**	0.108***	-0.018
	(2.06)	(3.41)	(-1.00)	(2.46)	(3.03)	(-0.39)
Tangibility$_t$	0.856***	-0.932***	1.788***	1.164***	-1.052***	2.216***
	(3.44)	(-3.83)	(5.42)	(4.57)	(-4.23)	(6.57)
***I*(Investment Grade Rating)$_t$**	-0.704***	-0.960***	0.257	-0.583***	-0.973***	0.390**
	(-5.44)	(-8.40)	(1.57)	(-4.44)	(-8.34)	(2.34)
***I*(Unrated)$_t$**	-0.026	-0.566***	0.540***	-0.018	-0.535***	0.516***
	(-0.22)	(-5.52)	(3.70)	(-0.15)	(-5.21)	(3.52)
***I*(Altman's Z < 1.81)$_t$**	-0.191	-0.544***	0.353*	-0.218	-0.548***	0.330*
	(-1.16)	(-4.25)	(1.78)	(-1.32)	(-4.27)	(1.66)
Profitability$_t$	-1.512***	-2.952***	1.440**	-1.680***	-2.786***	1.106*
	(-3.23)	(-6.83)	(2.46)	(-3.58)	(-6.41)	(1.87)
Book Leverage$_t$	-0.324	2.200***	-2.524***	-0.251	2.204***	-2.454***
	(-1.04)	(7.93)	(-6.44)	(-0.80)	(7.89)	(-6.23)
Pseudo R^2		0.099			0.103	
Number of Observations		12,919			12,919	

APPENDIX A

Appendix A.1: Variable Definitions

The sample consists of non-financial and non-utility firms from COMPUSTAT for 1980-2013.

Variable Name	Definition
<u>**Dependent Variables**</u>	
Total Debt	is the ratio of total debt (long-term debt plus debt in current liabilities) to total book capital, where total book capital is total debt plus equity at book value.
Bank Debt	is the ratio of bank debt to total book capital, where bank debt is imputed from Compustat as other long-term debt (DLTO) minus commercial paper (CMP).
Capitalized Leases	is the ratio of capitalized lease obligations (DLCO) to total book capital.
Convertible Debt	is the ratio of convertible debt (DCVT) to total book capital.
Bonds-and-Notes	is the ratio of total debt minus bank debt minus capitalized leases minus convertible debt minus commercial paper over total book capital.
<u>**Control Variables**</u>	
Profitability	is the ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to the book value of total assets.
Tangibility	is the ratio of net property, plant and equipment (PPENT) to the book value of total assets.
MB	is the market-to-book ratio, which is computed as the sum of the book value of total assets, plus the market value of common stock, minus the book value of common stock, divided by the book value of total assets.
Firm Size	is the natural log of the book value of total assets, where the book value of total assets is measured in constant 2008 dollars using the CPI.
CF Volatility	is the standard deviation of the first difference in EBITDA over the five years preceding and including the year in which a dependent variable is measured, scaled by the average book value of assets during this period.
***I*(Dividend)**	is a dummy variable equal to one if the firm pays dividends in a given year, and zero otherwise.
Log (Firm Age)	is the natural log of the number of years the firm is listed with a non-missing stock price in Compustat.
<u>**Instrument Variables**</u>	
Tax Rate	is marginal tax rate based on income before interest expense has been deducted. The tax rates are available on John Graham's website: http://www.duke.edu/~jgraham. Years with missing tax rates are filled in using piecewise linear interpolation where possible; otherwise, or if the firm is not in the dataset, we can use the firm's effective tax rate, which

	is computed as the ratio of income tax paid to pretax income.
Abnormal Earnings	is the difference between earnings per share (EPS) in year t+1 minus EPS in year t, divided by the year t share price.
Cash Holdings	is the ratio of cash plus marketable securities to the book value of total assets.
***I*(Altman's Z < 1.81)**	is a dummy variable equal to one when Altman's Z-score < 1.81 (a proxy for financial distress), and zero otherwise. Altman's Z-score is calculated as Z = 3.3 * EBIT / total assets + 1.0 * sales / total assets + 1.4 * retained earnings / total assets + 1.2 * working capital / total assets + 0.6 * market value equity / total debt.
***I*(Tax Loss Carry-Forward)**	is a dummy variable equal to one if the firm has any tax loss carry-forwards (TLCF) in a given year, and zero otherwise.
***I*(Investment Tax Credit)**	is a dummy variable equal to one if the firm has any investment tax credits (ITC) in a given year, and zero otherwise.
***I*(Bond Rated)**	is a dummy variable equal to one if the firm has a bond rating and zero otherwise.
***I*(Commercial Paper Rated)**	is a dummy variable equal to one if the firm has a commercial paper rating and zero otherwise.

Appendix A.2: Sample Selection Procedures

The sample consists of non-financial and non-utility firms from COMPUSTAT for 1980-2013. Data on accounting figures are taken from the COMPUSTAT files.

Initial number of firm-years data from COMPUSTAT, 1980-2013		357,228	
Less:			
Firms are incorporated in the United States. Financial firms and utility firms are excluded.	(146,741)	210,487	19,091 firms
Firm-years with missing total assets and leverage;			
Firm-years that are unlevered;			
Firm-years with market or book leverage outside the unit interval;			
Firm-years with less than 0 percent or more than 100 percent of their total debt maturing after more than three years;			
Firm-years that have missing or negative values for any of our debt types;			
Firm-years that have zero or negative book values of equity (seq);			
Firm-years with less than 0 percent or more than 100 percent of total book capital;			
Firm-years that have S&P Domestic Long-Term Issuer Credit Ratings equal to "SD (Selective Default)," "N.M. (Not Meaningful)," "D (Default)," or "Suspended."			
Firm-years that have missing values for volatility, M/B, profitability and tangibility;			
Firms that have less than five years of valid data from 1980-2013.		64,865	5,832 firms
Exclude if independent or dependent variables information is missing.	(7,221)	57,644	5,741 firms
Number of firm-years available for regression analysis, 1980-2013		57,644	

Note: Number of unique firms in the sample for 57,644 firm-year observations: 5,741

APPENDIX B

Appendix B.1: Variable Definitions

The sample consists of non-financial and non-utility firms from COMPUSTAT for 1980-2013. Data on accounting figures are taken from COMPUSTAT files. Based on equations (1) or (2), we decompose the daily stock returns of firm i into an economy-, industry-, and local-wide risks and firm-specific or idiosyncratic component as follows. We use estimated coefficients β_1: Economy Wide, β_2: Industry Wide and β_3: Local Wide to capture systematic risks and standard deviation of the regression residuals to capture idiosyncratic risk.

(1) $R_i = \beta_0 + \beta_1$*economy return + β_2*industry return$_i$ + ϵ, where each X variable stands for value weighted average return of the index (economy- and industry-wide).

(2) $R_i = \beta_0 + \beta_1$*economy return + β_2*industry return$_i$ + β_3*local return$_i$ + ϵ, where each X variable stands for value weighted average return of the index (economy-, industry-, and local-wide).

Variable Name	Definition
β_1: Economy Wide	is the estimated beta coefficient of Economy wide return in the firm's stock return regression from (1) if using a two-factor model; from (2) if using a three-factor model.
β_2: Industry Wide	is the estimated beta coefficient of Industry wide return in the firm's stock return regression from (1) if using a two-factor model; from (2) if using a three-factor model.
β_3: Local Wide	is the estimated beta coefficient of Local wide return in the firm's stock return regression from (2) if using a three-factor model.
Idiosyncratic Risk	is the standard deviation of residuals in the firm's return regression (1) or (2). It is defined as $\sqrt{\frac{\sum (r_i - \hat{r}_i)^2}{n-k-1}}$, where n is the number of sample size (from return observation), and k =3 if using a three-factor model; and k=2 if using a two-factor model.
Vega/TC	is the ratio of vega to total compensation. Vega is the change in the value of the CEO's option grant in a year and any accumulated option holdings for a 0.01 change in the annualized standard deviation of stock returns.
Delta/TC	is the ratio of delta to total compensation. Delta is the change in the value of the option or restricted stock grants in a year, share holdings, and any accumulated restricted stock and option holdings for a 1% change in the stock price.
Industry Sigma	is the average of the standard deviations of cash flow over the past 10 years for firms in the same industry, as defined by two-digit SIC code.
Cash Holding	is cash and short-term investments (che) divided by assets (at).
MB	is the market value (at - ceq + prcc_f*csho) divided by assets (at).
Size	is the natural logarithm of book assets (at) in 2004 dollars.
Cashflow	is the earnings after interest, dividends, and taxes but before depreciation (oibdp - xint - txt - dvc), divided by assets (at).
NWC	is working capital (wcap) minus cash (che), divided by assets (at).
Capex	is capital expenditures (capx) divided by assets (at).
Leverage	is long-term debt (dltt) plus debt in current liabilities (dlc), divided by assets (at).
R&D	is the ratio of R&D expenses (xrd) over sales (sale), set equal to zero when it is missing.
Dividend	is a dummy variable equal to one in years in which a firm pays a common dividend (dvc), and 0 otherwise.
Acquisition	is acquisitions (acq) divided by assets (at).
***I*(Credit Rating)**	is a dummy variable equal to one if the S&P long-term rating (splticrm) is available on Compustat

Appendix B.2: Sample Selection Procedures

The sample consists of non-financial and non-utility firms from COMPUSTAT for 1980-2013. Data on accounting figures are taken from the COMPUSTAT files and our final data samples are an intersection of COMPUSTAT, CRSP, and ExecuComp.

Initial number of firm-years data from COMPUSTAT, 1980-2013 as of 05/10/2013		350,933	
Less:			
Incorporated in the United States and with positive sales revenue and book value of asset. Financial firms and utility firms are excluded. Independent variables are constructed from Compustat database.	(171,443)	179,490	17,503 firms
Combine estimated systematic risks (β_1, β_2, β_3), idiosyncratic risk from CRSP & Compensation data from ExecuComp	(155,574)	23,916	
Exclude if variable (independent, dependent variable) information is missing.	(3,938)	**19,978**	2,201 firms
Number of firm-years available for regression analysis		19,978	
Less:			
Include if firms are {investment grade, speculative grade, non-rated}			
Include samples only if $0 \leq$ leverage ≤ 1			
Include samples only if % of daily stock trading volume a year $\geq$ 90%	(430)	**19,548**	2,177 firms

Note: Number of unique firms in the sample for 19,548 firm-year observations: 2,177

APPENDIX C

Appendix C.1: Variable Definitions

The sample consists of S&P 1500 firms covered in the COMPUSTAT and Executive Compensation databases from 1992-2014.

Variable Name	Definition
<u>**Debt Structure**</u>	
Total Debt	is the sum of short-term (DLC) and long-term debt (DLTT).
Bank Debt	is imputed from Compustat as the category other long-term debt (DLTO) minus commercial paper (CMP).
Capitalized Leases	is the capitalized lease obligations (DLCO)
Convertible Debt	is the convertible debt (DCVT).
Bonds and Notes	is the total debt minus bank debt minus capitalized leases minus convertible debt minus commercial paper.
HHI	$[[\text{Bank Debt/Total Debt}]^2 + [\text{Capitalized Leases/Total Debt}]^2 + [\text{Convertible Debt/Total Debt}]^2 + [\text{Bonds and Notes/Total Debt}]^2]$, where total debt = DLC + DLTT.
HHI*	[HHI- (1/4)]/[1-(1/4)]
Excl90	is a dummy variable equal to one if the firm obtains at least 90% of its debt from one debt type, and zero otherwise.
<u>**Control Variables**</u>	
Firm Size	is the natural log of the book value of total assets, where the book value of total assets is measured in constant 2008 dollars using the CPI.
MB	is the market-to-book ratio, which is computed as the sum of the total debt plus the market value of common stock (PRCC_F*CSHPRI) plus preferred stock liquidation value (PSTKL) minus deferred taxes and investment tax credit (TXDITC) all divided by the book value of total assets.
Profitability	is the ratio of operating income before depreciation (OIBDP) to the book value of total assets.
***I*(Dividend Payer)**	is a dummy variable equal to one if the firm pays dividends in a given year, and zero otherwise.
Tangibility	is the ratio of net property, plant and equipment (PPENT) to the book value of total assets.
CF Volatility	is the standard deviation of quarterly operating income (OIBDP) over previous 12 quarters, scaled by total assets.
R&D Expense	is the research and development expenditure to the book value of total assets = Max (0, XRD)/AT

***I*(Unrated)**	is a dummy variable equal to one if the firm has no existing debt rating, and zero otherwise.
***I*(Investment Grade)**	is a dummy variable equal to one if the firm has an existing debt rating of BBB or higher, and zero otherwise.
***I*(Altman's Z < 1.81)**	is a dummy variable equal to one when Altman's Z-score < 1.81 (a proxy for financial distress), and zero otherwise. Altman's Z-score is calculated as Z = 3.3 * OIADP / total assets + 1.0 * sales / total assets + 1.4 * retained earnings / total assets + 1.2 * working capital (ACT-LCT) / total assets + 0.6 * market value equity (PRCC_F*CSHO) / total debt.
Book Leverage	is the ratio of sum of short-term (DLC) and long-term debt (DLTT) to the book value of total assets.
Log (Amount Issued)	is the natural log of the (1+ amount issued), where the amount issued is measured as max (0, ∆Bank Debt, ∆Capitalized Leases, ∆Convertible Debt, ∆Bonds and Notes) to capture the dominant debt borrowing source. ∆X denotes the change in corresponding individual outstanding debt variable from year t-1 to year t.

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