THREE ESSAYS ON CORPORATE DEBT MIX, MATURITY STRUCTURE, AND INSIDE DEBT COMPENSATION

by

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ABSTRACT

HUNG VIET NGUYEN. Three essays on corporate debt mix, maturity structure, and inside debt compensation (Under the direction of DR. TAO-HSIEN DOLLY KING)

In Chapter 1, we use a large sample of new debt to examine the determinants of corporate debt mix and to test the substitute/complement effects among debt sources. We find that both firm-level factors and macroeconomic variables are important determinants of debt mix. In addition, the set of determinants varies across time and economic conditions. In general, we find evidence for a substitution effect between public debt and private debt, both at rating downgrades and new issuance events.

In Chapter 2, we examine the impacts of product market competition and corporate governance on debt maturity. We find that firms in less competitive industries use more short-term maturity than firms in more competitive industries, while firms with weak corporate governance use less short-term maturity. However, there is mixed evidence on the impact of the interaction between product market competition and corporate governance on maturity.

In Chapter 3, we study the relations between inside debt compensation and corporate policies. We find a positive relationship between inside debt and leverage, indicating that CEOs with higher inside debt holdings tend to use higher leverage. We also find strong (weak) evidence on the negative relationship between inside debt and R&D activities (capital expenditures). We provide the first evidence about the relationship between inside debt and debt maturity. In one direction, short-term maturity increases in inside debt. However, in other direction, inside debt decreases in short-term maturity. Additionally, we document new evidence about the determinants of inside debt.

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CHAPTER 1: THE DETERMINANTS OF CORPORATE DEBT MIX

1.1 Introduction

The pecking order theory (Myers and Majluf, 1984) predicts that firms use internal capital first, and seek external capital in the form of debt and equity if internal funds are insufficient. The theory implies the preference of debt over equity in a firm's financing decisions. For external debt financing, firms can borrow from public, bank, and non-bank private lenders.[1] An important question is what factors drive a firm's choice of debt when external debt financing is used.

The literature contains a large body of theoretical models on the determinants of new debt financing. One group of theories argues that the choice of new debt type relates to the degree asymmetric information. Diamond (1984), Fama (1985), and Nakamura (1989) predict that, due to greater information asymmetry, small and young firms prefer private debt, while their counterparts use more public debt. Diamond's life cycle theory (1991) implies that firms borrow from private sources first and access public sources when they become more established. The work of Berlin and Loyes (1988), Berlin and Mester (1992), and Chemmanur and Fulghieri (1994) argue that the choice of debt mix depends on how easy and efficient it is for borrowers to negotiate with lenders to avoid inefficient liquidation in default situations. They predict that firms with a low likelihood of distress (a high credit quality) prefer public debt, but firms with a high credit risk (a

[1] Similar to Johnson (1997) and Denis and Mihov (2003), we define non-bank private debt as 144A debt and use these terms interchangeably. 144A debt is issued under SEC Rule 144A which allows low credit quality firms to issue debt to private lenders. This type of debt shares some features of bank debt and low grade public debt. See Denis and Mihov (2003) for more discussions on the characteristics of 144A debt.

low credit quality) prefer private debt. The last group of theories argues that firms with high costs of asset substitution and underinvestment find bank monitoring valuable, and thus prefer private to public debt. Hoshi et al. (1993) predict that firms with valuable assets in place and low leverage prefer public debt financing.

Empirical studies on debt mix suggest findings that are generally consistent with theoretical claims. Large, profitable, and older firms with high proportions of tangible assets, and high or stable cash flows borrow from the public bond markets (Cantillo and Wright (2000), Houston and James (1996), Johnson (1997), Denis and Mihov (2003), and Arena (2010)). Credit rating is a major determinant of debt sources: firms with highest rating borrow from public source, while the middle and lowest rating quality firms use bank loans and non-bank private debt, respectively (Denis and Mihov (2003) and Rauh and Sufi (2010)). Firms are likely to choose private debt when disclosure costs, earnings volatility, market-to-book ratio, or the probability of financial distress is high (see Dhaliwal et al. (2004), Johnson (1997), Krishaswami et al. (1999), and Denis and Mihov (2003)). Conversely, Hoshi et al. (1993) find that market-to-book ratio and leverage have a negative effect on the probability of choosing private debt.

The empirical literature suggests a set of firm characteristics that are major determinants of corporate debt mix. However, three important issues remain unexplored. First, given the rich evidence on the importance of firm level factors, such as firm size, asset tangibility, profitability, and credit rating quality, there is little evidence on whether the impacts of these factors vary over time as macroeconomic conditions fluctuate. Using incremental new debt issues in the period of 1995-1996, Denis and Mihov (2003) find that firm-level factors such as credit rating are important determinants of a company's debt mix. However, they question if these determinants change over time and suggest examining this issue under different market conditions. Theoretically, Diamond (1991) predicts that high-rated firms prefer public debt but they switch to bank loans if uncertainty about interest rates and profitability is high. This implies that macroeconomic variables are important when analyzing the debt mix of corporations. Julio et al. (2008) and Khang and King (2012) provide evidence on the impacts of economic conditions on the structure of public and bank debt. We hypothesize that the pattern and determinants of the choice between bank debt, non-bank private debt, and public debt are time-variant. We emphasize that macroeconomic variables affect firms' debt mix choices. Previous studies use snapshots of firms at a given point in time and focus on the determinants for the cross-sectional variation in debt mix (e.g., Houston and James (1996) and Denis and Mihov (2003)). Second, Denis and Mihov (2003) and Rauh and Sufi (2010) find that credit rating quality is a major determinant of the debt mix, but there is little evidence on how firms choose among debt sources under the dynamics of ratings upgrades and downgrades. Rauh and Sufi (2010) find that fallen angels rely heavily on subordinated bonds, which is inconsistent with the theoretical prediction that low credit quality firms do not use arm's length debt.

Third, theoretical models assume the choice between public and private debt is discrete, thus implying substitution between the two types of debt. For example, Detragiache (1994) assumes that public and private debt are perfect substitutes, and argues that the choice depends on the costs of renegotiation in the case of default. In addition, moral hazard models such as Park (2000) suggest that firms choose debt priority structures to solve the manager-creditor incentive problems.[2] These models imply that the substitute effect among different debt sources depends on the severity of these problems. However, in practice firms often issue debt from different sources simultaneously at a given point of time. In a recent study, Rauh and Sufi (2010) find evidence of complement effects between public debt and bank loans for a small sample of firms with credit rating downgrades. In particular, they discover that firms do not reduce both public and private debt when their credit quality deteriorates. Instead, in these cases the use of secured bank debt and subordinated bonds both increase. There has been limited research on the substitute/complement effect between public and private debt, and it remains an important issue to examine if such effects exist among debt financing sources.

Based on a large sample of new debt (bank loan, 144A debt, and public debt) issued by 988 firms in the period of 1993-2007, we examine the determinants of debt mix across distinct economic periods, explore how debt mix changes for firms that experience rating changes and have new debt issues, and test the substitute/complement effects among debt types. In particular, we develop an incremental new issues sample and an outstanding debt mix sample to perform the analyses. We have several important and interesting findings. First, firm age and firm size are significant drivers of corporate debt mix. Larger and older firms prefer public debt to private debt, and choose bank over non-bank private if private debt is considered. This finding is consistent with the information asymmetry explanation. Asset tangibility, probability of distress, and earnings volatility have significant impacts on corporate debt mix. A higher fixed asset ratio or lower earnings volatility leads to more public than private debt. Profitable firms prefer bank

[2] See Rauh and Sufi (2010) for detailed discussions on these models.

debt out of all debt types. Firms with a higher probability of distress prefer non-bank private to bank debt. Consistent with Denis and Mihov (2003), we find that issuers with a higher credit rating are more likely to borrow from public sources, while they prefer bank to non-bank private when private sources are considered. In addition, we show that firms who are novice to the debt markets are more likely to start with non-bank private debt. On the other hand, experienced borrowers with a high percentage of public debt typically choose public over private debt, and prefer bank to non-bank private. Most importantly, we are the first to document that macroeconomic factors including prime interest rate, yield curve slope, interest rate volatility, and GDP growth are major factors of corporate debt mix, which is consistent with Diamond (1991).

Second, we find that the set of determinants of corporate debt mix changes over time. In particular, firm age is an important consideration during poor economic conditions, but not in favorable ones. The early period of 1993-1997 is unique in terms of having the least number of significant factors among the three periods. Credit quality, earnings volatility, prior issuance behavior, and macroeconomic factors have very limited or no impacts on corporate debt mix in this period, while they are important drivers in the two later periods of 1998-2002 and 2003-2007. We also find that the set of drivers differ by interest rate volatility. When market uncertainty is high, firm age and earnings volatility matter much more to borrowers when deciding on corporate debt mix.

Third, we find evidence for a general substitution effect between public and private debt over time. In other words, for a given firm there is a strong and negative relation between public debt and bank debt. Furthermore, based on a sample of 513 firms that experience rating downgrades we find that public debt and non-bank private debt are substitutes before the downgrade event. After the downgrade, there is a substitute effect between bank and non-bank private debt. However, the analysis of the 446 firms with rating upgrades provides little evidence of a substitute/complement effect. Finally, we extend the substitute/complement effect to new debt issuance events and find support for the substitute effect among the three types of debt sources. Specifically, at a new issue of non-bank private or public debt, the percentage outstanding of the other two debt types declines significantly after the issuance. For the sample of bank loan issuance, we find evidence consistent with a substitution effect between private (both bank and non-bank private) and public debt.

Our study contributes to the literature in several ways. First, we use a large sample of new debt issues and the issuers' outstanding debt mix over an extended period of time to examine the determinants of debt type. We find that debt mix varies significantly across different economic conditions, macroeconomic variables are major determinants of corporate debt mix, and the set of determinants varies across time and economic uncertainty. Previous studies such as Johnson (1997), Denis and Mihov (2003), and Arena (2010) document the factors determining new debt choices, but they do not examine the pattern of debt mix over time and across economic conditions. Nor did they examine the role played by macroeconomic factors. Second, we extend the literature by providing important evidence on the substitute/complement effect among debt financing sources. Rauh and Sufi (2010) are one of the first to provide evidence for a complement effect between bank loan and public convertible debt when an issuer is downgraded from investment to speculative grade. However, their evidence is based on the balance sheet data and a small sample of fallen angels. We test the substitute/complement effect for a large sample of firms with credit rating upgrades and downgrades.

The structure of the rest of the chapter proceeds as follows. Section 1.2 reviews the literature on corporate debt mix. Section 1.3 describes the data and presents the characteristics of new debt issues. Section 1.4 presents the empirical analyses of the determinants of new debt sources. In section 1.5 we test the substitute/complement effect hypothesis. Section 1.6 concludes.

1.2 Literature Review

In this section, we review the existing theories and empirical evidence on corporate debt mix. In particular, we present literature on three groups of determinants: firm characteristics and quality, industry factors, and macroeconomic conditions.

1.2.1 Firm Characteristics and Quality

Previous theories show that a firm's characteristics and quality are important determinants of its choice of debt financing sources. We follow the approaches of Denis and Mihov (2003) and Kale and Meneghetti (2010) and classify debt mix theories into three theoretical frameworks including information asymmetry, efficiency of renegotiation and liquidation of debt contracts, and agency costs associated with asset substitution and underinvestment problems.[3]

Information asymmetry: Theories predict a relation between the level of asymmetric information and the likelihood of borrowing from a specific source of debt. Diamond (1984), Fama (1985), Nakamura (1989) argue that firms' choices between

[3] In fact, Kale and Meneghetti (2010) classify debt mix theories into smaller groups: information production models, proprietary information models, moral hazard models, and liquidation and renegotiation models. Johnson (1997) groups these theories based on the demand and supply side of capital.

private and public debt are based on the level of asymmetric information and the related cost of monitoring and producing information. Smaller and younger firms with greater information asymmetry have relatively higher costs of monitoring and producing information than older and larger firms. Therefore, it is predicted that smaller and younger firms prefer private debt (e.g., bank loans), while their counterparts choose to borrow from public sources. In addition, Diamond's life cycle theory (1991) shows that firms borrow from private sources first in order to build their reputation, then switch to public sources when they have sufficient reputation in the capital markets. His model implies that younger firms are likely to use more private debt. Furthermore, theories indicate that firm quality is an important factor driving firms' choices of debt sources. Diamond's (1991) model implies that firms with high (middle) credit ratings rely on public (bank) debt, while very low rated firms are rationed. Yosha (1995) theoretically shows that firms with high quality projects prefer private to public debt due to the high cost of disclosing their proprietary information. However, Rajan (1992) argues that because bank monitoring might distort a borrower's incentives, firms with low quality projects are more likely borrow from banks.

In general, empirical evidence is consistent with the above theories. Cantillo and Wright (2000) find evidence that large, profitable firms with high proportions of tangible assets, and high or stable cash flows borrow from bond markets. Houston and James (1996), Johnson (1997), Denis and Mihov (2003), and Arena (2010) find a positive association between firm size and the use of public debt. The work of Johnson (1997) and Arena (2010) provide evidence in support of Diamond's (1991) model prediction of a positive relation between firm age and public debt. Denis and Mihov (2003) find that credit rating is a major determinant of debt sources: firms with highest rating borrow from public source, while middle and lowest rating quality firms use bank loans and non-bank private debt, respectively. However, evidence on the relation between project quality and the use of debt is mixed. Denis and Mihov (2003) find no relation between R&D expenditure and the probability of using bank loans, while Dhaliwal et al. (2004) find evidence consistent with Yosha (2005) that firms are more likely to issue private debt when disclosure costs are high.

Efficiency of renegotiation and liquidation: The work of Berlin and Loyes (1988), Berlin and Mester (1992), and Chemmanur and Fulghieri (1994) argue that firms' choice of debt sources depends on the ease and value of renegotiations with lenders in order to avoid the costs of inefficient liquidation. Chemmanur and Fulghieri (1994) argue that firms with a low likelihood of distress (high credit quality) find renegotiation less valuable, thus preferring public debt, but firms with greater credit risk (low credit quality) value the benefits from renegotiation, therefore preferring private debt even if the costs are high. These theories also imply that firms with high profitability and low operating or credit risk tend to borrow from public sources.

As to empirical evidence, Johnson (1997) finds that public debt use negatively correlates with earnings volatility. Krishaswami et al. (1999) find a positive relation between unexpected earnings and the proportion of private debt. Denis and Mihov (2003) find that firms with high financial distress (Altman's Z-score <1.81) use less public debt. This finding supports the prediction by Chemmanur and Fulghieri (1994) that firms that are more likely to suffer financial distress need lenders who can make correct liquidation and renegotiation decisions, thus preferring bank debt. In addition, Denis and Mihov

(2003) and Rauh and Sufi (2010) find evidence that credit rating quality is a major determinant of debt mix. However, Rauh and Sufi (2010) challenge existing theories by discovering that firms do not reduce both public and private debt when their credit quality deteriorates. Instead, they find a complement effect among private and public debt, where the use of secured bank debt and subordinated bonds both increase.

Agency cost of asset substitution and underinvestment: Jensen and Meckling (1976) and Myers (1977) argue that firms with high leverage and growth opportunities face significant agency costs associated with asset substitution and underinvestment problems. This argument implies that these firms find bank monitoring useful, and therefore would prefer private to public debt. Hoshi et al. (1993) predicts that firms with high net worth (valuable assets-in-place and low leverage) prefer public debt financing. However, empirical evidence is mixed. Krishaswami et al. (1999) find a positive relation between market-to-book ratio and private long term debt, while Hoshi et al. (1993) find a negative relation. Houston and James (1996), Johnson (1997), and Denis and Mihov (2003) find an insignificant relationship between market-to-book ratio and bank loans. Hoshi et al. (1993) find a negative relation between leverage and bank debt.

1.2.2 Industry Factors

Firms in different industries may have different preferences for their debt sources, depending on industry-specific characteristics. Firms with specialized assets have lower collateral value due to less marketability of their assets at liquidation. This argument implies that these firms prefer bank to public debt. Extending this argument, firms in regulated industries prefer public to private debt because of their typically high collateral value. The literature documents evidence consistent with these predictions. Johnson

(1997) finds that the interaction between a dummy for specialized assets and the fixed asset ratio has significant impact on a firm's choice of debt sources. Krishnaswami et al. (1999) find that firms in regulated industries have a lower proportion of private debt in their capital structure.[4]

1.2.3 Macroeconomic Conditions

Previous studies show that macroeconomic factors are important determinants of firms' capital and debt structures. For example, Korajczyk and Levy (2003) examine the relation between firms' capital structure and macroeconomic conditions. They find that capital structure of financially constrained firms is more affected by the state of the economy than that of the unconstrained firms. According to Diamond (1991), economic conditions are a dominant factor that firms consider when issuing debt. His model implies that highly rated firms prefer public debt, but these firms switch to bank borrowing if the economy is poor, interest rates are high, or there is a high uncertainty of profitability. Julio et al. (2008) finds that economic states significantly affect firms' public debt structure, which is consistent with Diamond (1991).

1.3 Data Sources and Sample

1.3.1 Data Sources

We study the debt mix choice of non-financial firms (excluding SIC 6000-6999) in the period of 1993-2007. By comparison, the sample in Denis and Mihov (2003) and Arena (2010) is from 1995-96 and 1995-2003, respectively. We collect data on new debt issuances from two sources: Securities Data Corporation's (SDC) New Issues Database for public debt and non-bank private (144A) debt, and Loan Pricing Corporation's

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[4] See Mackay and Phillips (2005), Erhemjamts et al. (2010), and Leary and Roberts (2010) for more about the impacts of industry factors on firms' financial decisions.

Dealscan for bank loans. SDC's database provides information on many dimensions of public and 144A debt contracts, including principal amount, proceeds, yield to maturity, type of debt, credit rating, maturity, as well as purpose of new debt issuances. Dealscan provides detailed characteristics of bank loans at issuance, such as facility and deal amount, maturity, syndicated or sole bank lenders, loan purpose, as well as offer prices. A typical bank loan (deal) contains multiple tranches (facilities) with different characteristics. Because our analysis is based on deals rather than facilities, we aggregate facilities by deal contracts on a yearly basis. We aggregate multiple debt issues by type within a year as a single issue as in Denis and Mihov (2003) and Brockman, Martin, and Unlu (2010). The principal of the aggregated debt is computed as the sum of the principal of single debt issues, while the maturity is the weighted maturities with principal as the weight. Other related studies use different aggregation approaches. For example, Gomes and Philips (2005) aggregate debt issues by type on a monthly basis, Arena and Howe (2009) and Arena (2010) aggregate within a quarter. We argue that aggregating on an annual basis is appropriate for the length of our sample period and the different aggregation methods do not influence the empirical results. Denis and Mihov (2003), Arena and Howe (2009), and Arena (2010) report that their results remain the same if debt issues are collapsed on either a monthly or yearly basis. Finally, we obtain firms' financial data and issuer credit ratings from Compustat.[5] Macroeconomic data are collected from the Bureau of Labor Statistics.

[5] We use valid ratings reported in SDC and FISD databases to fill in any missing issuer ratings in Compustat.

1.3.2 Sample of New Debt Issues

For the period of 1993 to 2007 we collect all bank loans issued from Dealscan and match the loan sample with the set of public debt and 144A debt reported in SDC. This matching leads to 9,353 bank loans, 2,096 issuances of 144A debt, and 5,000 issuances of public debt issued by 1,370 unique firms. We next require valid Compustat data for the sample firms. This process results in 988 firms with valid financial and accounting data and a sample of 7,422 new bank loans, 1,576 new 144A debt issues, and 4,112 new public debt issues. Table A in the Appendix reports the descriptive statistics for new debt issues for the 988 firms in our sample.[6] Panel A reports characteristics for 7,422 new bank loan packages (10,342 facilities). The average amount for a facility and package is $459.9M and $645.4M, respectively. For comparison, bank loans have a larger principal amount, but a shorter maturity than both public and non-bank private debt. In terms of loan type, most bank loans are multi-year revolvers (54.4%) and 364-day facilities (24.5%). In contrast to public and non-bank private debt, bank loans are used for multiple purposes, including general purposes, debt payment, commercial paper backup/enhancement, and takeover/LBO.

Panel B provides characteristics for the non-bank private debt. 716 firms had 1,576 non-bank private debt issuances during the sample period. Number of issues and firms issuing non-bank private debt increase dramatically over time, which indicates the growing importance of non-bank private debt as an alternative form of debt financing. Unlike public debt, the majority of non-bank private debt is debentures (64%) and convertible bonds (31%). The average principal amount of 144A debt is higher than that

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[6] We report characteristics of new debt issues before collapsing individual debt issues by year. The reason is to provide their characteristics in more detail.

of public debt ($307.9M vs. $237.6M). Maturity is approximately 10 years, which is similar to that of public debt. Also, similar to public debt, the main purposes of non-bank private debt are general and refinancing. It is interesting to note that, non-bank private debt is mainly used for general purposes or takeover/LBO during 1993-1997, and becomes more diversified after that. Panel C shows that 596 firms had 4,112 new public debt issuances during the sample period. Fifty-nine percent and one third of these new public debt issuances are debentures and medium term notes (MTNs), respectively. On average, each new public debt has a principal amount of $237.6M, and approximate maturity of 10 years. Most of the public debt issues are used for general and financing purposes (64% and 26%, respectively).

1.4 Determinants of Corporate Debt Mix

1.4.1 Incremental Debt Issues and Outstanding Debt Mix Samples

To examine the determinants of corporate debt mix, we form two samples. The first sample is created based on the incremental approach and contains individual new debt issues. At the end of year for a given firm we aggregate the total principal amount of all debt by debt type. For example, we compute the sum of the principal amount of all 144A debt issues in 1993 for a given firm. The same procedure is repeated for each of the other two types of debt. Based on the sample of 1,576 144A debt issues, 4,112 public debt issues, and 7,422 new bank loans by 988 issuers, we arrive at a firm-year sample of 8,608 observations. It is important to note that there are cases in which a given firm issues more than one type of debt in a given year. To explore the factors that drive an issuer's decision on a certain type of debt, it is important to focus on the firm-year observations in which only one type of debt is issued by a given issuer in a given year.

Therefore, we exclude all observations in which a firm issues more than one types of debt. We arrive at the final sample of 5,079 firm-year observations associated with 967 unique firms, which we call the “incremental debt issues sample.”

The second sample is constructed by documenting the history of outstanding debt by debt type. In particular, we build the history of outstanding debt of the 988 sample firms from 1993 to 2007. For each firm in a given year, we examine all debt issues reported in Dealscan and SDC and determine at the end of each year the total debt outstanding based on the maturity structure of the issues. We record dollars outstanding of all debt, and that of each of the three debt types. Outstanding debt mix in a given year consists of the percentages of the three debt types calculated using dollars outstanding. The above process yields a sample of 11,329 firm-year observations associated with 988 firms, which we call the “outstanding debt mix sample.”

1.4.2 Univariate Analysis

To examine the determinants of corporate debt mix, we first show the characteristics of the issuers at the time of issuance by debt type using the incremental debt issues sample. In Table 1, we present the descriptive statistics for a set of firm variables that reflect an issuer’s reputation, size, investment policy, profitability, leverage, and credit risk. This set of variables is selected to test the theoretical explanations of corporate debt mix. First, we use firm age and size to test the information asymmetry explanation. Firm age is the difference between the issuance year of a new debt and the year in which the firm is founded. Total asset (to proxy for firm size) is the book value of assets shown in millions of dollars. Second, we use several variables to test the renegotiation and liquidation hypothesis. Fixed asset ratio is ratio of net property, plant, and equipment to total assets. R&D expenditure ratio is R&D expenditures scaled by sales. Capital expenditure growth is the average growth in capital expenditures during the three-year period prior to a new debt issue. Profitability is EBITDA divided by total assets. The dummy of Altman's Z-score equals one when Altman's Z-score is less than 1.81, and zero otherwise. The Z-score is calculated as (3.3 × EBIT + 1.0 × Sales + 1.4 × Retained earnings + 1.2 × Working capital)/Total assets + 0.6 × Market value equity/Total debt). Earnings volatility is the standard deviation of the first difference of EBITDA scaled by total assets during the 5-year period prior to the debt issuance. Third, credit risk is measured by the following three variables. Credit rating is the S&P senior debt rating from Compustat and is converted into a number between 1 and 24: 24 represents the highest rating and 1 the not-rated. Investment grade is an indicator variable that equals to 1 if the firm has credit rating of 14 (BBB-) or higher, and zero otherwise. Unrated firms are firms that are not rated. Finally, we use market-to-book ratio and leverage to test the agency cost explanation. Market-to-book ratio is calculated as the ratio of market value of assets to book value of assets. Market value of assets is the book value of total assets minus book value of common equity plus market value of common equity. Market leverage is total debt divided by the market value of assets. Total debt is the sum of long-term debt and debt in current liabilities.

TABLE 1: Univariate analysis of borrowers' characteristics

This table reports the mean values of key characteristics for 967 firms (out of 988 firms) with single aggregated new debt issues per year. The sample size is 5,079 observations. We call this sample "the incremental sample." Firm age (years) is the difference between the firm's founding year and the issuance year of a new debt. Total asset is the book value of total assets in Compustat. Fixed asset ratio is ratio of net property, plant, and equipment to total assets. R&D expenditure ratio is R&D expenditure scaled by sales. Market-to-book ratio is calculated as (book value of total asset minus book value of common equity plus market value of common equity) divided by book value of total asset. Capital expenditure growth is the average of capital expenditure over three years before a new debt issue. Profitability is the earnings before interest, taxes, depreciation, and amortization (EBITDA) scaled by book value of total assets. The dummy of Altman's Z-score<1.81 takes a value of 1 if Altman's Z-score<= 1.8, and zero otherwise. The Z-score is calculated as (3.3 x EBIT+ 1.0 × Sales + 1.4 × Retained earnings +1.2× Working capital)/Total assets + 0.6 × Market value equity/Total debt). Earnings volatility is the standard deviation of the first difference of EBITDA within 5 fiscal years and scaled by the average total assets of that period. Credit rating is the senior debt rating (S&P) from Compustat and is converted into equivalent number on a scale of 1-24 where the highest rating equals 24 and non-rated rating equals 1. Investment grade is an indicator variable equal to 1 if the firm has a credit rating of BBB or higher, and zero otherwise. Unrated firms are firms with no credit rating available. Leverage is total debt (long-term debt plus debt in current liabilities) scaled by the market value of assets (book value of total assets minus book value of common equity plus market value of common equity). All accounting variables are winsorized at the 1st and 99th percentiles. The mean and proportion differences are tested using the non-parametric Kruskal-Wallis and Wilcoxon rank sum test, respectively.

TABLE 1 (continued)

	Bank debt issuers		Non-bank debt issuers		Public debt issuers		P-value of the difference Non-bank private vs. Bank	P-value of the difference Public vs. Bank	P-value of the difference Public vs. Non-bank private	Bank debt issuers		Non-bank debt issuers		Public debt issuers		P-value of the difference Non-bank private vs. Bank	P-value of the difference Public vs. Bank	P-value of the difference Public vs. Non-bank private
	Obs.	Mean	Obs	Mean	Obs	Mean				Obs	Mean	Obs	Mean	Obs.	Mean			
	Panel A (Full sample)									Panel B (Sample of 1993-97)								
Firm age (years)	3605	52.99	433	33.79	737	71.16	0.00	0.00	0.00	918	47.90	34	39.65	308	71.42	0.32	0.00	0.00
Total asset ($millions)	3860	6219.95	452	2679.77	767	9758.64	0.00	0.00	0.00	1028	3907.28	35	1389.70	321	8710.85	0.02	0.00	0.00
Fixed asset ratio	3823	0.63	450	0.50	748	0.74	0.00	0.00	0.00	1014	0.64	34	0.41	312	0.80	0.00	0.00	0.00
R&D expenditure ratio	3860	0.02	452	0.06	767	0.02	0.00	0.82	0.00	1028	0.02	35	0.08	321	0.01	0.00	0.98	0.00
Market to book	3654	1.81	443	2.11	757	1.82	0.20	0.18	0.81	927	1.81	31	2.18	313	1.68	0.02	0.08	0.00
Capital expenditure growth	3681	0.28	434	0.38	744	0.25	0.38	0.06	0.89	941	0.36	29	0.77	305	0.29	0.15	0.23	0.08
Profitability	3847	0.14	448	0.12	762	0.15	0.00	0.00	0.00	1023	0.16	33	0.13	316	0.15	0.25	0.85	0.28
Proportion of firms with Altman's Z-score<1.81	3860	0.35	452	0.35	767	0.37	0.91	0.48	0.58	1028	0.35	35	0.29	321	0.36	0.46	0.77	0.41
Earnings volatility	3856	0.06	450	0.06	763	0.03	0.00	0.00	0.00	1028	0.09	35	0.16	317	0.03	0.11	0.00	0.00
Credit rating	3672	10.74	452	9.12	767	15.88	0.00	0.00	0.00	944	8.64	35	8.34	321	16.64	0.75	0.00	0.00
Proportion of firms with investment	3860	0.42	452	0.20	767	0.80	0.00	0.00	0.00	1028	0.33	35	0.29	321	0.84	0.61	0.00	0.00
Proportion of unrated firms	3860	0.31	452	0.27	767	0.02	0.06	0.00	0.00	1028	0.50	35	0.40	321	0.01	0.26	0.00	0.00
Leverage	3648	0.22	440	0.22	756	0.21	0.14	0.98	0.19	924	0.21	31	0.13	313	0.21	0.00	0.17	0.00

TABLE 1 (continued)

	Bank debt issuers		Non-bank debt issuers		Public debt issuers		P-value of the difference Non-bank private vs. Bank	P-value of the difference Public vs. Bank	P-value of the difference Public vs. Non-bank private	Bank debt issuers		Non-bank debt issuers		Public debt issuers		P-value of the difference Non-bank private vs. Bank	P-value of the difference Public vs. Bank	P-value of the difference Public vs. Non-bank private
	Obs.	Mean	Obs	Mean	Obs	Mean				Obs	Mean	Obs	Mean	Obs.	Mean			
	Panel C (Sample of 1998-02)									Panel D (Sample of 2003-07)								
Firm age (years)	1258	50.82	150	30.99	214	72.46	0.00	0.00	0.00	1429	58.16	249	34.68	215	69.49	0.00	0.00	0.00
Total asset ($ millions)	1350	5768.45	155	2870.79	222	8470.75	0.00	0.00	0.00	1482	8235.44	262	2739.10	224	12536.56	0.00	0.00	0.00
Fixed asset ratio	1332	0.61	154	0.49	217	0.73	0.00	0.00	0.00	1477	0.63	262	0.52	219	0.68	0.00	0.06	0.00
R&D expenditure ratio	1350	0.02	155	0.06	222	0.01	0.00	0.23	0.00	1482	0.02	262	0.06	224	0.03	0.00	0.15	0.03
Market to book	1270	1.92	151	2.58	221	1.83	0.00	0.61	0.01	1457	1.70	261	1.83	223	2.00	0.52	0.00	0.00
Capital expenditure growth	1277	0.34	147	0.56	217	0.22	0.08	0.96	0.11	1463	0.17	258	0.24	222	0.24	0.67	0.00	0.06
Profitability	1344	0.14	153	0.13	222	0.15	0.58	0.60	0.40	1480	0.13	262	0.10	224	0.15	0.00	0.00	0.00
Proportion of firms with Altman's Z-score<1.81	1350	0.36	155	0.28	222	0.41	0.06	0.11	0.00	1482	0.36	262	0.40	224	0.34	0.16	0.63	0.16
Earnings volatility	1347	0.06	154	0.05	222	0.02	0.20	0.00	0.00	1481	0.04	261	0.06	224	0.03	0.00	0.00	0.00
Credit rating	1287	10.95	155	11.23	222	16.16	0.20	0.00	0.00	1441	11.92	262	7.98	224	14.52	0.00	0.00	0.00
Proportion of firms with investment grade	1350	0.44	155	0.34	222	0.85	0.02	0.00	0.00	1482	0.48	262	0.11	224	0.68	0.00	0.00	0.00
Proportion of unrated firms	1350	0.30	155	0.14	222	0.01	0.00	0.00	0.00	1482	0.19	262	0.32	224	0.05	0.00	0.00	0.00
Leverage	1267	0.23	149	0.21	220	0.24	0.07	0.08	0.01	1457	0.22	260	0.23	223	0.19	0.93	0.00	0.04

TABLE 1 (continued)

	Bank debt issuers		Non-bank debt issuers		Public debt issuers		P-value of the difference Non-bank private vs. Bank	P-value of the difference Public vs. Bank	P-value of the difference Public vs. Non-bank private	Bank debt issuers		Non-bank debt issuers		Public debt issuers		P-value of the difference Non-bank private vs. Bank	P-value of the difference Public vs. Bank	P-value of the difference Public vs. Non-bank private
	Obs.	Mean	Obs.	Mean	Obs	Mean				Obs.	Mean	Obs	Mean	Obs	Mean			
	Panel E (Sample of low GDP growth)									Panel F (Sample of high GDP growth)								
Firm age (years)	1597	52.54	262	33.15	463	70.73	0.00	0.00	0.00	2008	53.34	171	34.78	274	71.88	0.00	0.00	0.00
Total asset ($ millions)	1727	5748.87	272	2809.08	488	10022.73	0.00	0.00	0.00	2133	6601.37	180	2484.36	279	9296.72	0.00	0.00	0.00
Fixed asset ratio	1710	0.63	271	0.49	476	0.74	0.00	0.00	0.00	2113	0.63	179	0.51	272	0.75	0.00	0.00	0.00
R&D expenditure ratio	1727	0.02	272	0.06	488	0.02	0.00	0.55	0.00	2133	0.02	180	0.06	279	0.02	0.00	0.54	0.00
Market to book	1620	1.77	266	1.94	479	1.82	0.73	0.00	0.12	2034	1.83	177	2.36	278	1.82	0.02	0.50	0.03
Capital expenditure growth	1624	0.29	262	0.35	471	0.27	0.45	0.00	0.45	2057	0.27	172	0.44	273	0.22	0.48	0.86	0.45
Profitability	1722	0.14	271	0.12	485	0.15	0.00	0.00	0.00	2125	0.14	177	0.11	277	0.14	0.00	0.56	0.00
Proportion of firms with Altman's Z-score<1.81	1727	0.37	272	0.34	488	0.36	0.40	0.64	0.69	2133	0.34	180	0.37	279	0.39	0.52	0.15	0.66
Earnings volatility	1725	0.07	271	0.06	486	0.03	0.02	0.00	0.00	2131	0.05	179	0.07	277	0.03	0.00	0.00	0.00
Credit rating	1639	10.28	272	9.36	488	15.86	0.00	0.00	0.00	2033	11.10	180	8.77	279	15.91	0.00	0.00	0.00
Proportion of firms with investment grade	1727	0.41	272	0.18	488	0.78	0.00	0.00	0.00	2133	0.44	180	0.23	279	0.82	0.00	0.00	0.00
Proportion of unrated firms	1727	0.35	272	0.24	488	0.02	0.00	0.00	0.00	2133	0.28	180	0.31	279	0.03	0.36	0.00	0.00
Leverage	1616	0.23	265	0.24	479	0.21	0.77	0.17	0.58	2032	0.21	175	0.20	277	0.22	0.01	0.23	0.00

Panel A presents the means of the firm variables by issuer group. Public debt issuers are the largest in firm size with an average total asset of $9.758 billion, and the most mature with an average firm age of 71.16 years. They also have the largest fixed asset ratio of an average of 74%, and the highest credit rating with an average rating of 15.88 (between BBB and BBB+). The non-bank private debt group has the smallest firm size, age, fixed asset ratio, and proportion of investment grade firms. In addition, these issuers have the largest amount of R&D expenditures. Interestingly, non-bank private debt and bank debt groups have an average credit rating of 9.12 (between B and B+) and 10.74 (between B+ and BB-) respectively, both in the speculative grade. However, market leverage and proportion of firms with an Altman's Z-score less than 1.81 for these two groups are similar to those for the public debt group.

To see the impact of macroeconomic environment on the issuers' decisions about debt type, we show the results by time period in Panels B through D and by GDP growth in Panels E through F. GDP growth is measured in the year prior to the debt issuance. By examining Panels B, C and D, we find that the above results for the full sample period remain mostly consistent across time periods. Interestingly, the average credit quality of non-bank private debt issuers is significantly lower than that of bank debt issuers in the 2003-2007 period, but not in the two earlier periods. Similarly, we see the same pattern in the period with high GDP growth. This finding suggests that non-bank private debt issuers are more likely to be lower quality firms during favorable economic conditions than during poor ones. This is consistent with the prediction of Diamond's model that borrowers may switch between types of debt sources when economic conditions change, given the same target capital structure.

In addition to examining the choice of debt type in the new issuances sample, we believe it is very important to examine the mix of corporate debt types by studying the issuers' outstanding debt at given points of time. To do so, in Table 2 we report the statistics of the percentages of bank, non-bank private debt, and public debt based on the outstanding debt mix sample described above. We show these percentages by each of the firm and macroeconomic factors that are potential determinants of corporate debt mix. We find several interesting results. First, large and mature firms have an average of 51% in bank debt, 38% in public debt, and the remainder in non-bank private debt. Small and young firms, on the other hand, use more private (bank and non-bank) debt and less public debt. Second, the investment grade issuers have a relatively even weight on public (47%) and bank (44%) debt, whereas speculative grade firms rely heavily on bank debt (65%). The finding is confirmed by the grouping results using Altman's Z-score. Third, it is interesting that the percentage of non-bank private debt is on an upward trend over time from 4% in 1993-1997 to 25% in 2003-2007, while that of public debt is on the downward slope from 37% in the earliest period to 21% in the latest. The percentage of bank debt remains relatively flat between 53% and 61%. Finally, we find that interest rate volatility may lead to a substitution between public and non-bank private debt. Specifically, high interest volatility prompts the issuers to shift from public to non-bank private debt.

TABLE 2: Univariate analysis of borrowers' outstanding debt mix

This table reports the univariate analysis of the 988 firms' outstanding debt by key firm-level and macroeconomic variables. Based on the original dataset of new debt issues from Dealscan and SDC, we build the outstanding debt mix history of these 988 firms during 1993-2007. After matching to Compustat, the outstanding debt mix sample includes 11,329 firm-year observations. The proportion of each type of debt is the outstanding amount of that debt divided by the total outstanding debt. For instance, the percentage of the outstanding bank debt is the outstanding bank debt divided by the sum of outstanding bank debt, outstanding non-bank private debt, and outstanding public debt. Previous public and private outstanding debt is a dummy variable indicating if a firm has or does not have public and private outstanding debt at the fiscal year t-1. Regulated firms are firms with SIC codes ranging from 4000 to 4999. Annual GDP growth is ranked low (high) if below (above) the median GDP. Similarly, interest rate volatility, which is defined as the standard deviation of the monthly 10 year constant maturity rate of the year before the debt issue date, is low (high) if below (above) the median interest rate volatility. Other variables are defined as in Table 1. All accounting variables are winsorized at the 1st and 99th percentiles. The mean and median differences are tested using the non-parametric Kruskal-Wallis and Wilcoxon rank sum test, respectively.

		% outstanding bank debt		% outstanding non-bank private debt		% outstanding public debt	
	N	Mean	Med.	Mean	Med.	Mean	Med.
By firm age							
Above the median	5,405	0.51	0.53	0.11	0.00	0.38	0.32
Below the median	5,290	0.62	0.70	0.20	0.00	0.17	0.00
p-value		0.00	0.00	0.00	0.00	0.00	0.00
By total asset							
Above the median	5,665	0.51	0.52	0.12	0.00	0.38	0.32
Below the median	5,664	0.64	0.73	0.19	0.00	0.17	0.00
p-value		0.00	0.00	0.00	0.00	0.00	0.00
By fixed asset ratio							
Above the median	5,607	0.56	0.59	0.11	0.00	0.33	0.23
Below the median	5,606	0.59	0.65	0.19	0.00	0.21	0.03
p-value		0.00	0.00	0.00	0.00	0.00	0.00

		% outstanding bank debt		% outstanding non-bank private debt		% outstanding public debt	
	N	Mean	Med.	Mean	Med.	Mean	Med.
By earnings volatility							
Above the median	5,653	0.60	0.65	0.18	0.00	0.22	0.00
Below the median	5,653	0.56	0.59	0.12	0.00	0.33	0.23
p-value		0.00	0.00	0.00	0.00	0.00	0.00
By leverage							
Above the median	5,469	0.57	0.61	0.14	0.00	0.29	0.16
Below the median	5,468	0.57	0.60	0.17	0.00	0.27	0.12
p-value		0.96	0.96	0.00	0.00	0.00	0.00
By previous outstanding debt							
With public and private outstanding debt at t-1	8,410	0.47	0.50	0.18	0.00	0.35	0.28
Without public or private outstanding debt at t-1	2,919	0.89	1.00	0.07	0.00	0.04	0.00
p-value		0.00	0.00	0.00	0.00	0.00	0.00

TABLE 2 (continued)

		% outstanding bank debt		% outstanding non-bank private debt		% outstanding public debt	
	N	Mean	Med.	Mean	Med.	Mean	Med.
By market to book ratio							
Above the median	5,481	0.57	0.62	0.17	0.00	0.26	0.11
Below the median	5,480	0.56	0.60	0.14	0.00	0.30	0.17
p-value		0.04	0.04	0.00	0.00	0.00	0.00
By credit rating							
Investment grade	4,842	0.47	0.48	0.08	0.00	0.44	0.42
Speculative grade	6,487	0.65	0.74	0.20	0.00	0.15	0.00
p-value		0.04	0.04	0.00	0.00	0.00	0.00
By unrated firms							
Unrated	3,011	0.72	1.00	0.16	0.00	0.12	0.00
Rated	8,318	0.52	0.56	0.15	0.00	0.33	0.24
p-value		0.00	0.00	0.00	0.00	0.00	0.00
By Altman's Z-score							
<=1.81	3,977	0.57	0.62	0.14	0.00	0.28	0.14
>1.81	7,352	0.58	0.62	0.16	0.00	0.27	0.12
p-value		0.58	0.58	0.36	0.36	0.00	0.00
By profitability							
Above the median	5,640	0.60	0.65	0.12	0.00	0.28	0.16
Below the median	5,640	0.55	0.59	0.18	0.00	0.27	0.10
p-value		0.00	0.00	0.00	0.00	0.00	0.00

		% outstanding bank debt		% outstanding non-bank private debt		% outstanding public debt	
	N	Mean	Med.	Mean	Med.	Mean	Med.
By regulated industry							
Regulated	2,061	0.53	0.56	0.10	0.00	0.36	0.28
Not regulated	9,268	0.59	0.63	0.16	0.00	0.25	0.10
p-value		0.00	0.00	0.00	0.00	0.00	0.00
By time period							
1993-1997	2,952	0.60	0.69	0.04	0.00	0.37	0.24
1998-2002	4,037	0.61	0.66	0.13	0.00	0.27	0.12
2003-2007	4,340	0.53	0.56	0.25	0.15	0.21	0.07
p-value		0.00	-	0.00	-	0.00	-
By GDP growth							
High GDP	6,136	0.59	0.64	0.15	0.00	0.26	0.12
Low GDP	5,193	0.56	0.59	0.15	0.00	0.28	0.14
p-value		0.00	0.00	0.89	0.88	0.00	0.00
By interest rate volatility							
High volatility	5,665	0.56	0.60	0.20	0.03	0.24	0.09
Low volatility	5,664	0.59	0.65	0.10	0.00	0.31	0.17
p-value		0.00	0.00	0.00	0.00	0.00	0.00

1.4.3 Multivariate Analyses: The Incremental Debt Issues Sample

In this section, we perform a multivariate analysis by using the multinomial logistic model to predict the likelihood of a given type of new debt issue. In practice, the logistic model fits the analysis of debt mix choice based on a sample of new debt issues. It helps determine, at a given time, the factors driving a firm's preference for a specific source of new debt issues. Our approach is similar to that of Denis and Mihov (2003), Dhaliwal et al. (2004), and Arena (2010), but different from those of Houston and James (1996) and Johnson (1997).[7] The specification of the general multinomial logistic model is described as follows.[8]

$$\Pr(Debt\ type = m|X) = \frac{exp\ (X\beta_{m|b})}{\sum_{j=1}^{J} exp\ (X\beta_{j|b})}\ for\ m = 1\ to\ J \qquad (1)$$

where *b* is the base group (comparison group). *J* indicates three types of debt financing (bank, non-bank private, and public debt) in our sample, where *m* takes a value of 1 if the firm issues a bank loan, 2 for non-bank private debt, and 3 for public debt. *X* is the vector of explanatory variables.

To test the determinants suggested by theoretical explanations and supported by empirical work (e.g., Houston and James (1996), Johnson (1997), Denis and Mihov (2003)), we include the following set of explanatory variables. Firm age and firm size (log of total assets) are used to test the information asymmetry explanation. For the renegotiation and liquidation hypothesis, we employ fixed asset ratio (a proxy for asset tangibility), profitability, a dummy for Altman's Z-score <1.81 (a proxy for financial distress), and earnings volatility (a proxy for operating risk). For credit risk, we use the

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7 Houston and James (1996) and Johnson (1997) use the balance sheet data, and the OLS and Tobit models, respectively.

8 See Long and Freese (2001) for the general specification of multinomial logistic models.

dummies for investment grade and unrated firm. To examine the agency cost explanation, we use market-to-book ratio and leverage. To control for the characteristics of the new debt issues and outstanding debt, we use the dollar principal amount of the new debt issue (a proxy for flotation costs), a dummy for outstanding public or private debt as in Denis and Mihov (2003), and the public debt mix ratio. For industry factors, we use a dummy for regulated industry as in Johnson (1997). To examine the impacts of macroeconomic variables, we follow Khang and King (2012) and use GDP growth, the slope of the yield curve and interest rate volatility. Slope is the difference between the 10-year and 1-year Treasury constant maturity rates. Interest rate volatility is the standard deviation the 10-year Treasury constant maturity rate in the year prior to the debt issuance. We also use the prime interest rate to test the Diamond's (1991) prediction about the impact of interest rates on firms' preferences for debt sources. Finally, we take into account the panel structure of our data by including dummy variables of industries to control for unobserved industry factors. We do not include the year dummies to control for unobserved time effects because our models include various macroeconomic variables already. In unreported results, we find almost the same results when controlling for both time and industry effects. The descriptive statistics of the above variables are presented in Table 3.

TABLE 3: Descriptive statistics of the incremental debt issues sample

This table reports summary statistics of key variables used to estimate the likelihood of debt source in Table 4. Firm age is the log of the difference between the founding year and the issuance year of a new debt issue. Firm size is the log of the book value of total asset. Fixed asset ratio is ratio of net property, plant, and equipment to total asset. Profitability is the earnings before interest, taxes, depreciation, and amortization (EBITDA) scaled by the book value of total asset. The dummy of Altman's Z-score<1.81 takes a value of 1 if Altman's Z-score<= 1.8, and zero otherwise. The Z-score is calculated as (3.3 x EBIT+ 1.0 × Sales + 1.4 × Retained earnings +1.2× Working capital)/Total assets + 0.6 × Market value equity/Total debt). Earnings volatility is defined as the standard deviation of the first difference of EBITDA within 5 fiscal years and scaled by the average total assets of that period. Unrated firm is a dummy variable taking a value of 1 if the firm has no available debt rating and zero otherwise. Investment grade is an indicator variable equal to 1 if the firm has a credit rating of BBB or higher, and zero otherwise. Market-to-book ratio is calculated as (book value of total assets minus book value of common equity plus market value of common equity) divided by book value of total assets. Leverage is total debt (long-term debt plus debt in current liabilities) scaled by the market value of assets (book value of total assets minus book value of common equity plus market value of common equity). Principal amount is the log of the principal amount of a new debt. No outstanding public or private debt is an indicator variable equal to 1 if the firm has neither outstanding public nor private debt at year t-1, zero otherwise. Public debt mix ratio is outstanding public debt scaled by total outstanding debt at year t-1. Regulated industry is a dummy variable equal to 1 if the firm has SIC codes ranging from 4000 to 4999, zero otherwise. Prime interest rate is the bank prime loan rate (%). Slope is the spread between constant maturity rates of the 10 year Treasury bond and the 1 year T-bill. GDP growth is annual growth rate (%). Interest rate volatility is the standard deviation of monthly 10 year constant maturity rate the year before the debt issue date. All accounting variables are winsorized at the 1st and 99th percentiles.

	Obs.	Mean	Std. Dev.	Min	Max	Median
Firm age (log)	4520	3.60	1.04	0.69	5.16	3.74
Firm size	4520	7.76	1.56	3.41	11.21	7.77
Fixed asset ratio	4520	0.64	0.39	0.03	1.75	0.58
Profitability	4520	0.14	0.08	-0.17	0.38	0.13
Altman's Z-score <1.81 (dummy)	4520	0.32	0.47	0.00	1.00	0.00
Earnings volatility	4520	0.04	0.10	0.00	1.13	0.02
Unrated firm	4520	0.24	0.43	0.00	1.00	0.00
Investment grade	4520	0.49	0.50	0.00	1.00	0.00
Market to book	4520	1.84	1.05	0.83	6.99	1.49
Leverage	4520	0.22	0.15	0.00	0.69	0.31
Principal amount (log)	4520	5.82	1.22	2.34	8.63	5.82
No outstanding public or private debt (t-1)	4520	0.26	0.44	0.00	1.00	0.00
Public debt mix ratio (t-1)	4520	0.28	0.33	0.00	1.00	0.14
Regulated industry	4520	0.19	0.40	0.00	1.00	0.00
Prime interest rate	4520	6.93	1.70	4.12	9.23	7.96
Slope	4520	1.15	1.02	-0.14	2.77	0.72
GDP growth	4520	5.38	1.06	3.17	6.62	5.92
Interest rate volatility	4520	0.38	0.33	0.00	1.35	0.34

We estimate the multinomial model specified in Equation (1) for the full sample and report the results for two models in Table 4. For each model, the first two columns represent the probability of issuing non-bank private and public debt relative to bank debt, respectively. The last column shows the probability of issuing public debt versus non-bank private debt.

Firm age, a proxy for reputation, is positively related to the probability of issuing public debt relative to bank debt, and this relation is significant in Model 1. In addition, firm age has a significantly positive effect on the likelihood of issuing public versus non-bank private debt, and a significantly negative effect on the choice between non-bank and bank debt. These relations imply that older firms prefer public to bank and to non-bank private debt, and prefer bank to non-bank debt if private debt is chosen. The finding lends support for Diamond's (1991) life cycle hypothesis, which implies that young firms use more bank debt, and then switch to public debt as they mature. The result for firm size suggests that larger firms are more likely to issue public debt relative to both bank and non-bank private debt. This finding is consistent with the empirical literature that large firms are more likely to issue public debt.

Our results show that asset tangibility is a significant determinant of corporate debt mix. We find that firms with a high fixed asset ratio are more likely to borrow from public sources. This evidence supports the findings of Hoshi et al. (1993), Houston and James (1996), Johnson (1997), Denis and Mihov (2003). They document that bank borrowers have fewer tangible assets than public issuers. In addition, we find that profitable firms are more likely to prefer bank debt to non-bank private or public debt. This finding is inconsistent with the theoretical prediction and empirical evidence that profitable firms use more public debt (e.g., Cantillo and Wright (2000)). Not surprisingly, we find that credit rating is an important determinant of the choice of debt mix. We also find that firms with a higher probability of financial distress (Altman's Z-score < 1.81) use more non-bank private debt relative to bank debt. However, we find no evidence supporting the relation between the proxy for financial distress and the likelihood of issuing public debt versus private debt. Our finding is inconsistent with the theoretical prediction by Chemmanur and Fulghieri (1994) that firms with a high probability of financial distress prefer private debt for the benefits of monitoring activities even at higher costs. In addition, we find a significant and negative relation between earnings volatility and the probability of issuing a public debt. This is consistent with the finding of Cantillo and Wright (2000), who document a positive relation with high or stable cash flows and the use of public debt.

TABLE 4: The likelihood of debt source: base results

This table reports the results of multinomial logistic regressions predicting the probability of debt source. The data source is the incremental sample (N=5,079). Columns 1 & 4 and columns 2 & 5 report the log-odds ratios of the probability of issuing non-bank debt (144A) and public debt versus bank debt, respectively. Columns 3 & 6 report the log-odds ratio of the probability of issuing public debt relative to non-bank private debt. Variables are defined as in Table 3. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Model 1			Model 2		
	Non-bank vs. Bank (1)	Public vs. Bank (2)	Public vs. Non-bank (3)	Non-bank vs. Bank (4)	Public vs. Bank (5)	Public vs. Non-bank (6)
Firm age (log)	-0.111	0.137	0.249	-0.114	0.091	0.205
	(0.065)*	(0.064)**	(0.087)***	(0.065)*	(0.064)	(0.088)**
Firm size	0.032	0.489	0.457	-0.012	0.450	0.462
	(0.068)	(0.058)***	(0.085)***	(0.068)	(0.058)***	(0.085)***
Fixed asset ratio	-0.176	0.571	0.748	-0.115	0.539	0.654
	(0.211)	(0.187)***	(0.269)***	(0.210)	(0.189)***	(0.269)**
Profitability	-2.681	-2.485	0.195	-2.735	-2.448	0.287
	(0.718)***	(0.953)***	(1.118)	(0.713)***	(0.958)**	(1.122)
Altman's Z-score <1.81	0.292	0.047	-0.246	0.295	0.079	-0.217
	(0.174)*	(0.162)	(0.226)	(0.172)*	(0.162)	(0.225)
Earnings volatility	-0.477	-6.152	-5.675	-0.351	-5.850	-5.500
	(0.616)	(2.028)***	(2.098)***	(0.616)	(1.974)***	(2.047)***
Unrated firm	-1.440	-2.751	-1.312	-1.172	-2.640	-1.468
	(0.173)***	(0.301)***	(0.337)***	(0.163)***	(0.295)***	(0.328)***
Investment grade	-0.974	0.564	1.538	-0.882	0.503	1.385
	(0.175)***	(0.156)***	(0.221)***	(0.177)***	(0.157)***	(0.224)***
Market to book	0.267	0.109	-0.157	0.245	0.114	-0.131
	(0.059)***	(0.073)	(0.088)*	(0.059)***	(0.073)	(0.088)
Leverage	-0.085	-0.963	-0.877	-0.495	-1.028	-0.533
	(0.495)	(0.550)*	(0.702)	(0.491)	(0.550)*	(0.700)
Principal amount (log)	-0.266	-0.930	-0.664	-0.235	-0.898	-0.663
	(0.071)***	(0.060)***	(0.087)***	(0.070)***	(0.060)***	(0.087)***
No outstanding public or private debt (t-1)	0.898	0.036	-0.861			
	(0.152)***	(0.150)	(0.202)***			
Public debt mix ratio (t-1)				-0.913	0.653	1.566
				(0.271)***	(0.157)***	(0.300)***
Regulated industry	-0.343	0.047	0.390	-0.225	0.005	0.230
	(0.900)	(0.824)	(1.166)	(0.920)	(0.816)	(1.177)
Prime interest rate	-0.682	0.482	1.163	-0.530	0.437	0.967
	(0.091)***	(0.070)***	(0.111)***	(0.090)***	(0.070)***	(0.110)***
Slope	-0.929	0.284	1.213	-0.678	0.194	0.872
	(0.155)***	(0.118)**	(0.187)***	(0.152)***	(0.119)	(0.186)***
GDP growth	-0.387	-0.247	0.140	-0.366	-0.264	0.102
	(0.061)***	(0.058)***	(0.080)*	(0.061)***	(0.058)***	(0.081)
Interest rate volatility	0.174	-0.857	-1.031	0.187	-0.869	-1.056
	(0.166)	(0.163)***	(0.221)***	(0.165)	(0.164)***	(0.221)***
Constant	6.499	-3.145	-9.644	5.759	-2.591	-8.351
	(1.555)***	(1.416)**	(2.027)***	(1.552)***	(1.421)*	(2.031)***
Observations	4520	4520	4520	4520	4520	4520
Pseudo R-squared	0.24	0.24	0.24	0.24	0.24	0.24

Similar to Denis and Mihov (2003), we find that relative to speculative grade firms, investment grade firms use more public than private debt. In addition, firms with investment grade ratings use less non-bank private debt than bank debt. One possible explanation is that these firms find bank monitoring efficient. Thus they prefer borrowing from banks rather than from non-bank private debt sources that are without the monitoring benefits. Using unrated firms as a proxy for access to capital markets, we find that unrated firms use less public debt than private debt and also borrow less non-bank private debt relative to bank debt. This finding is different from that of Denis and Mihov (2003). They report an insignificant relation between unrated firms and the choice between public debt and non-bank private debt. Finally, we find a significant and positive relation between the market to book ratio and the likelihood of issuing non-bank versus bank debt. For leverage, we find that firms with a high leverage ratio use less public relative to bank debt. The finding, although relatively weak, is consistent with the prediction and evidence provided by Hoshi et al. (1993) that low leverage firms use more public debt.

As in Denis and Mihov (2003) and Arena (2010), we control for the principal amount of new debt in our regression analysis.[9] We find that new issues with a larger principal amount reduce the likelihood of borrowing from a public source. This evidence is not consistent with the literature. For example, Kishnaswami et al. (1999) report that larger firms and firms with larger issue sizes have a lower proportion of private debt. However, we find evidence consistent with the literature that firms' choice of debt sources is closely related to their debt issuance history (e.g., Denis and Mihov (2003) and

[9] We also use the ratio of principal amount to total amount of outstanding debt as an alternative measure of principal amount. The results (not reported) are similar to those reported in Table 4.

Rauh and Sufi (2010)). The estimated coefficients of the dummy of no outstanding public or private debt indicate that firms with no outstanding debt prior to a new issue are more likely to issue non-bank private debt. We further use the public debt mix ratio as alternative measure of the issuer's history of debt issuances. We find that firms with a higher public debt ratio prefer public to private debt, and within private debt they choose bank to non-bank private debt.

Interestingly, we find no evidence to support that debt mix choices differ between regulated and non-regulated firms. This may be due to the fact that we have considered the fixed asset ratio, which is correlated with industry effects. In addition, the fixed asset ratio is a more direct and cleaner measure for the renegotiation and liquidity explanation than the regulated firm dummy variable. Consistent with the theoretical prediction of Diamond (1991), we find that economic conditions are major factors determining firms' choices of debt sources. All coefficients on the macroeconomic variables (prime interest rate, slope, and GDP growth) are statistically significant. For the choice within private sources, we find that high interest rates, a steep slope, or a high GDP growth reduces the likelihood that firms borrow from non-bank private debt versus bank debt. The results further show significant and positive relations between these macroeconomic variables and the likelihood of borrowing public versus private (non-bank private and bank) debt. More specifically, higher interest rates, slope, and GDP growth lead to a higher likelihood that firms borrow from public rather than private sources. This finding is generally consistent with Diamond's prediction (1991) that firms borrow more from public markets (banks) if economy is favorable (poor). High interest rates and a steep yield curve often reflect an economic boom. Along with GDP growth, these macroeconomic variables indicate that when economic conditions are favorable, public debt becomes a relatively more popular option for debt financing.

To examine if determinants of new debt sources are similar for investment grade and speculative grade firms, we estimate the Model 1 for each of the two subsamples. We add a dummy variable that equals one for issuers with a rating of A or above in the investment grade subsample, and a dummy that equals one for issuers with a rating of B or above in the speculative grade subsample. The results are reported in Table B in the Appendix. We find that the subsample results for firm size, fixed asset ratio, principal amount, and the dummy for no outstanding public or private debt are similar to the full sample results discussed above. However, interesting results emerge for some of the other variables when we compare between the two subsamples. First, we find that firm age remains a significant determinant of the debt mix for investment grade issuers, but becomes insignificant for the speculative grade firms. Second, investment grade firms with a higher rating use more public than private debt, but are indifferent to bank loans and non-bank private if private debt is considered. Speculative grade firms, however, are more likely to choose non-bank private or public debt instead of bank loans when they have a better rating. Interestingly, profitability and prior issuance history matter for speculative grade firms, but not for the investment grade forms. Third, regulated firms in the investment grade subsample use more bank debt than public or non-bank private debt than non-regulated firms. Finally, macroeconomic factors are not significant factors to consider when investment grade issuers choose between bank and non-bank private debt.

We perform two additional robustness checks by dividing the sample by time period and interest rate volatility respectively. Table C in the Appendix reports the results by time period. The results are generally similar across time; however, there are some interesting differences. First, credit rating has very limited effects on the likelihood of debt sources during the 1993-1997 period, whereas it is an important factor in the other two periods. The coefficient on the investment grade dummy is generally insignificant in the earliest period. In addition, previous outstanding debt and macroeconomic factor play a significantly lesser role in determining the likelihood of debt source in the earliest period versus the later periods. Comparing the three time periods, economic conditions in the mid-1990s are the most favorable with the highest average GDP growth and interest rates. It is likely that during the good economic states in which the capital markets are more heavily utilized to support growth, the issuers' credit standing and debt issuance history matter minimally to firms' motivations to borrow using a certain type of debt source. Similarly, macroeconomic factors play a much less important role in determining which debt source to use when economy is a relatively good shape. Finally, Table D in the Appendix shows the regressions by interest rate volatility. We find that firm age and profitability are major drivers of likely debt sources when interest rate volatility is high, but not when it is low. Interestingly, we find that the GDP growth leads to a higher (lower) probability of bank debt during periods of high (low) interest rate volatility. Similarly, during the high volatility periods an increase in volatility leads to more bank debt, while the reverse holds true during the low volatility periods. To sum up, we find that the set of determinants differs across time periods and by interest rate volatility.

The above analysis shows that credit rating is one of the major determinants of debt financing types. In particular, we find that firms with investment grade ratings use more public than bank debt and unrated firms use less public debt. We further examine the impacts of credit ratings on firms' choice of new debt sources. To do this, we re-estimate Equation (1) with the dummies of credit rating categories as unique explanatory variables. The results are reported in Table 5. The omitted rating is AA or better. We report two models: Model 1 includes only the rating dummy variables and Model 2 includes additional explanatory variables used in the regressions reported in Table 4.

We find strong results on the importance of credit rating in determining corporate debt mix. Signs of the coefficients are as expected, and all coefficients are statistically significant at the 1% level. The results indicate that firms with a lower credit rating use more non-bank private or bank debt than public debt, and prefer non-bank private debt to bank debt. This finding is consistent with Denis and Mihov (2003). The results remain the same if we control for firm-level factors, industry and macroeconomic variables. Thus, the results indicate that Denis and Mihov's (2003) results are robust to economic environment and time period, and not confined to the 1995-1996 period.

TABLE 5: The likelihood of debt source: credit rating regression

This table reports the robust results taking into account the role of credit ratings as the main factor driving the choice of debt source. The data source is the incremental sample (N=5,079). Note that firms with no rating are excluded from this analysis. Columns 1 & 4 and columns 2 & 5 report the log-odds ratios of the probability of issuing non-bank debt (144A) and public debt versus bank debt, respectively. Columns 3 & 6 report the log-odds ratio of the probability of issuing public debt relative to non-bank private debt. In model 1, all explanatory variables are indicator variables of credit rating. For instance, A is a dummy variable equal to 1 if the firm has an A rating, and zero otherwise. The omitted rating is AA or better. Model 2 includes rating dummies, as well as firm-level and macroeconomic variables. Other variables are defined as in Table 3. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Model 1			Model 2		
	Non-bank vs. Bank (1)	Public vs. Bank (2)	Public vs. Non-bank (3)	Non-bank vs. Bank (4)	Public vs. Bank (5)	Public vs. Non-bank (6)
A rating dummy	1.059	0.223	-0.836	1.221	-0.026	-1.247
	(0.467)**	(0.145)	(0.478)*	(0.520)**	(0.177)	(0.536)**
BBB rating dummy	1.525	-0.313	-1.838	1.642	-0.326	-1.968
	(0.449)***	(0.147)**	(0.463)***	(0.511)***	(0.193)*	(0.534)***
BB rating dummy	2.475	-0.921	-3.396	2.499	-0.621	-3.120
	(0.439)***	(0.171)***	(0.460)***	(0.516)***	(0.240)***	(0.552)***
B rating dummy	2.827	-1.080	-3.907	2.711	-0.500	-3.211
	(0.444)***	(0.211)***	(0.477)***	(0.543)***	(0.311)	(0.604)***
CCC and below rating dummy	3.029	-1.550	-4.579	2.706	-1.429	-4.135
	(0.606)***	(0.752)**	(0.917)***	(0.723)***	(0.840)*	(1.026)***
Firm age (log)				-0.087	0.132	0.219
				(0.077)	(0.066)**	(0.096)**
Firm size				0.196	0.536	0.341
				(0.085)**	(0.062)***	(0.099)***
Fixed asset ratio				-0.131	0.403	0.534
				(0.251)	(0.196)**	(0.300)*
Profitability				-1.808	-1.299	0.509
				(1.023)*	(1.063)	(1.363)
Altman's Z-score <1.81				0.315	0.063	-0.252
				(0.207)	(0.168)	(0.251)
Earnings volatility				-0.297	-7.618	-7.321
				(0.950)	(2.241)***	(2.388)***
Market to book				0.309	0.069	-0.240
				(0.082)***	(0.080)	(0.105)**
Leverage				0.163	-0.946	-1.108
				(0.591)	(0.575)	(0.771)
Principal amount (log)				-0.503	-1.000	-0.497
				(0.086)***	(0.063)***	(0.099)***

TABLE 5 (continued)

No outstanding public or private debt (t-1)				1.092 (0.179)***	0.064 (0.156)	-1.028 (0.222)***
Regulated industry				-0.229 (0.919)	0.018 (0.834)	0.247 (1.179)
Prime interest rate				-0.454 (0.112)***	0.526 (0.073)***	0.980 (0.128)***
Slope				-0.557 (0.189)***	0.350 (0.123)***	0.908 (0.215)***
GDP growth				-0.378 (0.072)***	-0.261 (0.059)***	0.117 (0.088)
Interest rate volatility				0.148 (0.191)	-0.892 (0.167)***	-1.040 (0.238)***
Constant	-4.849 (1.141)***	-2.170 (1.056)**	2.679 (1.521)*	1.713 (1.934)	-2.543 (1.529)*	-4.256 (2.366)*
Observations	3910	3910	3910	3518	3518	3518
Pseudo R-squared	0.09	0.09	0.09	0.23	0.23	0.23

1.4.4 Multivariate Analyses: The Outstanding Debt Mix Sample

In this section, we use the fractional multinomial logit model (FMLM) to examine the determinants of outstanding debt mix. FMLM regression, proposed by Papke and Wooldridge (1996), is an approach for modeling fractional dependent variables that range between 0 and 1. This method models the conditional expected value of the dependent variable as a logistic function. The model is fitted by maximum quasi-likelihood. Our goal is to analyze how factors such as firm characteristics drive the proportions of bank debt, non-bank private debt, and public debt. Thus, the fractional multinomial logit regression fits our analysis well. We estimate the model using *fmlogit module* by Maarten Buis (2008). The functional form of FMLM is similar to that of the multinomial logit model (MLM). One difference is that the dependent variable of FMLM takes values continuously from 0 to 1, while that of MLM takes either 0 or 1. This approach is similar to that of Houston and James (1996), and Johnson (1997), and Rauh and Sufi (2010), in which balance sheet data are used. We employ the same set of explanatory variables used in regressions in Table 4. The panel data sample consists of percentages of bank, non-bank private, and public debt outstanding at year-ends for all firms and the corresponding firm, industry, and macroeconomic variables. The descriptive statistics of the debt mix percentages and explanatory variables are reported in Table 6.

TABLE 6: Descriptive statistics of the outstanding debt sample

This table provides summary statistics of variables used in the regression models in Table 7. The data source comes from the debt mix sample (N=11,329). The proportion of outstanding bank debt (non-bank debt) is calculated as outstanding bank debt (non-bank debt) divided by total outstanding debt, where total outstanding debt is outstanding bank debt plus outstanding non-bank private debt plus outstanding public debt. Similarly, the proportion of outstanding public debt is outstanding public scaled by total outstanding debt. The definitions of the other variables are the same in Table 3. All accounting variables are winsorized at the 1st and 99th percentiles.

Variable	Obs.	Mean	Std. Dev.	Min	Max	Median
Percentage of outstanding bank debt	10252	0.56	0.34	0.00	1.00	0.60
Percentage of outstanding non-bank private debt	10252	0.16	0.26	0.00	1.00	0.00
Percentage of outstanding public debt	10252	0.28	0.33	0.00	1.00	0.14
Firm age (log)	10252	3.57	1.03	0.69	5.16	3.68
Firm size	10252	7.67	1.53	3.59	11.14	7.63
Fixed asset ratio	10252	0.63	0.39	0.03	1.74	0.57
Profitability	10252	0.14	0.08	-0.20	0.37	0.13
Altman's Z-score <1.81	10252	0.32	0.47	0.00	1.00	0.00
Earnings volatility	10252	0.04	0.07	0.00	0.62	0.02
Unrated firm	10252	0.25	0.44	0.00	1.00	0.00
Investment grade	10252	0.45	0.50	0.00	1.00	0.00
Market to book	10252	1.81	1.01	0.82	6.79	1.48
Leverage	10252	0.22	0.16	0.00	0.69	0.20
No outstanding public or private debt (t-1)	10252	0.23	0.42	0.00	1.00	0.00
Regulated industry	10252	0.18	0.39	0.00	1.00	0.00
Prime interest rate	10252	7.01	1.67	4.12	9.23	7.96
Slope	10252	1.11	1.02	-0.14	2.77	0.72
GDP growth	10252	5.32	1.06	3.17	6.62	5.67
Interest rate volatility	10252	0.38	0.33	0.00	1.35	0.34

Table 7 reports the base case FMLM regressions of percentages of debt mix on explanatory variables.[10] The results confirm what we find in the MLM regressions using the incremental debt issues sample. Most importantly, we find that macroeconomic conditions are major determinants of corporate debt mix. Table E in the Appendix reports the results by investment and speculative grade firms. There are several interesting comparisons. First, for both investment and speculative firms, better ratings always result in public rather than private debt. However, a higher rating leads to more non-bank private than bank debt for speculative grade issuers but does not matter for investment grade issuers. Second, the risk of financial distress has a strong impact on the debt mix for speculative grade firms, but has a much weaker effect for the investment grade firms. This result confirms that financial distress is a major determinant of corporate debt mix and its impact is most prominent for borrowers with a high probability of distress. Finally, earnings volatility is significantly related to the outstanding debt mix for speculative grade firms, but not for the investment grade issuers.

[10] We do not report the goodness-of-fit measure such as R-squared because it is not appropriate for fractional multinomial logistic model. This model is one with multiple dependent variables, thus ruling out the R-squared. Theoretically, the R-squared is the proportion variance in the dependent variable explained by the independent variables. So, it becomes a problem for models with multiple related dependent variables. We thank Maarten Buis for providing this explanation.

TABLE 7: Estimating the proportions of debt mix: base results

This table reports the results of the fractional multinomial logistic model (FMLM) estimating the proportions in the debt mix. The data source comes from the debt mix sample (N=11,329). The dependent variables are the proportions of outstanding bank debt, non-bank private debt, and public debt. Their definitions are as in Table 6. Control variables are defined as in Table 3. Columns 1 and 2 provide the log-odds ratios of the proportions of outstanding non-bank private debt and public debt relative to the proportion of outstanding bank debt, respectively. For comparison, the last column reports the log-odds ratios of the proportion of outstanding public debt versus non-bank private debt. The regression includes industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Non-bank vs. Bank (1)	Public vs. Bank (2)	Public vs. Non-bank (3)
Firm age (log)	-0.101	0.135	0.235
	(0.022)***	(0.022)***	(0.029)***
Firm size	-0.206	0.094	0.300
	(0.020)***	(0.016)***	(0.024)***
Fixed asset ratio	-0.211	0.414	0.625
	(0.068)***	(0.066)***	(0.090)***
Profitability	-3.897	-2.046	1.851
	(0.300)***	(0.317)***	(0.388)***
Altman's Z-score <1.81	0.059	0.023	-0.037
	(0.059)	(0.052)	(0.073)
Earnings volatility	0.912	0.892	-0.019
	(0.341)***	(0.390)**	(0.485)
Unrated firm	-0.374	0.062	0.436
	(0.063)***	(0.069)	(0.087)***
Investment grade	-0.378	0.703	1.081
	(0.055)***	(0.049)***	(0.067)***
Market to book	0.241	0.026	-0.215
	(0.026)***	(0.028)	(0.035)***
Leverage	-0.637	-0.969	-0.332
	(0.178)***	(0.183)***	(0.240)
No outstanding public or private debt (t-1)	-1.692	-2.698	-1.006
	(0.079)***	(0.096)***	(0.123)***
Regulated industry	-0.568	-0.916	-0.348
	(0.223)**	(0.318)***	(0.424)
Prime interest rate	-0.729	0.520	1.249
	(0.031)***	(0.023)***	(0.037)***
Slope	-0.981	0.902	1.884
	(0.051)***	(0.040)***	(0.061)***
GDP growth	-0.183	0.060	0.243
	(0.022)***	(0.017)***	(0.026)***
Interest rate volatility	0.082	-0.188	-0.270
	(0.066)	(0.050)***	(0.077)***
Constant	7.039	-6.194	-13.233
	(0.513)***	(0.359)***	(0.561)***
Observations	10252	10252	10252

Table F in the Appendix reports the regressions by interest rate volatility.[11] The subsample results are generally similar to those in Table 7, with a few distinct differences. We note that interest rate level and slope remain significant factors with a higher level and slope leading to more public debt (than private debt) and more bank debt if private debt is used. Interestingly, GDP growth and interest rate volatility have significant impacts on corporate debt mix only when interest volatility is high. In other words, issuers are most sensitive to economic conditions when making corporate debt mix decisions during times of high uncertainty.

1.5 Substitute or Complement Effect

1.5.1 Full Sample Analysis

One of the major contributions of this paper is the examination of complement and substitute effects between public and private debt over time. Using Lee and Tang's (2011) model, we test whether public and private debt are substitutes or complements. Lee and Tang (2011) develop a model to test the substitute/ complement effect between managerial compensation components. We revise their model as follows. At a given point in time, a firm's outstanding debt is funded by private and public sources. As in Denis and Mihov (2003) and Johnson (1997), we define private debt as bank and non-bank private (144A debt). Let TD, PUBL, PRIV be total debt, public debt, and private debt, respectively. Thus, total debt at a given time is defined as:

$$TD = PUBL + PRIV \tag{2}$$

By taking the log of both sides of Equation (2) and assuming that X is the vector of the determinants of total debt, we have:

[11] We also perform the regressions by time period, and the results are qualitatively similar to those reported in Table C in the Appendix.

$$Ln(TD) = Ln(PUBL + PRIV) = \beta_i + \beta_1 X \tag{3}$$

Equation (3) becomes:

$$Ln(PUBL + PRIV) = Ln\left[PUBL\left(1 + \frac{PRIV}{PUBL}\right)\right] = LnPUBL + Ln\left(1 + \frac{PRIV}{PUBL}\right) = \beta_i + \beta_1 X \tag{4}$$

Finally, the testable model is:

$$LnPUBL = \beta_i + \beta_1 X - Ln\left(1 + \frac{PRIV}{PUBL}\right) = \beta_i + \beta_1 X + \beta_2 Ln\left(1 + \frac{PRIV}{PUBL}\right) \tag{5}$$

where, β_2 predicts the relation between public debt and private debt. If β_2 is negative, public debt and private debt are substitutes. Otherwise, this relation implies a complementary effect between the two. The explanatory variables in vector X are the same as those in the regressions reported in Sections 1.4.3 and 1.4.4.

We estimate the model in Equation (5) by using the OLS regression framework with fixed and random effects. The regression results are presented in Table 8. We find that, in both two models, the estimate of β_2 is negative and significant at the 1% level. This implies the existence of a substitute effect between public debt and private debt. In general, this evidence is consistent with the theoretical assumption in the literature that public debt and private debt are alternative sources. However, our finding is not supported by previous evidence in Rauh and Sufi (2010). They document evidence of a complement effect between the two.

TABLE 8: The substitute/complement effect

This table reports the result of OLS regression testing whether public debt and private debt are substitute or complement. Data source comes from the debt mix sample (N=11,329). Note that firms with no outstanding public debt are excluded from this analysis. The dependent variable is the log of outstanding public debt. The main interested explanatory variable is the log (1+ ratio of outstanding private debt to public debt). Outstanding private debt is the sum of outstanding bank debt and non-bank private debt. Other variables are defined as in Table 3. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Dependent variable: Log of outstanding public debt	
	Model 1 (Fixed effect)	Model 2 (Random effect)
Log of (1+ private debt/public debt)	-0.402 (0.014)***	-0.433 (0.013)***
Firm age (log)	0.156 (0.058)***	0.071 (0.027)***
Firm size	0.449 (0.023)***	0.568 (0.016)***
Fixed asset ratio	-0.287 (0.063)***	-0.095 (0.045)**
Profitability	0.149 (0.151)	0.139 (0.148)
Altman's Z-score<1.81	-0.010 (0.027)	-0.006 (0.026)
Earnings volatility	1.090 (0.146)***	1.209 (0.145)***
Unrated firm	-0.088 (0.041)**	-0.097 (0.039)**
Investment grade	0.125 (0.028)***	0.086 (0.027)***
Market to book	0.050 (0.015)***	0.059 (0.015)***
Leverage	0.875 (0.097)***	0.804 (0.091)***
Regulated industry		0.072 (0.064)
Prime interest rate	-0.224 (0.012)***	-0.210 (0.010)***
Slope	-0.368 (0.020)***	-0.348 (0.018)***
GDP growth	-0.050 (0.006)***	-0.047 (0.006)***
Interest rate volatility	0.052 (0.017)***	0.048 (0.018)***
Constant	4.245 (0.348)***	3.338 (0.212)***
Observations	6076	6076
R-squared	0.41	0.40

For brevity, we omit the detailed discussions of the results on the other explanatory variables because the main coefficient of interest is β_2 which indicates a substitute or complement effect between public and private debt sources. The explanatory variables are included as control variables to better discern the effect of interest. In addition, the above model requires that the ratio of outstanding private debt to public debt is valid, implying removal of firm-year observations with zero outstanding public debt. In other words, the above results are based on firms with nonzero outstanding public debt.

1.5.2 Rating Downgrades and Upgrades

In this section we analyze the substitute/complement effect among public debt, bank debt, and non-bank private debt when there is a change of credit rating.[12] As shown in Section 1.4, credit quality is one of major determinants of corporate debt mix. Therefore, a credit rating downgrade or upgrade of credit rating may trigger a shift among the debt sources. We find that 513 out of 988 firms in our sample have at least one credit rating downgrade and 446 firms have at least one credit rating upgrade during the sample period. We examine if a substitute or complement effect exists among public debt, bank debt, and non-bank private debt during the five-year period before a ratings change event and the five-year period afterwards.

We follow Rauh and Sufi's (2010) approach and test the econometric model below:

$$\frac{Debt\ type_{i,t}}{Total\ outstanding\ debt_{i,t}} = \propto_i + \beta_1 I_{i,t}^{t-5} + \beta_2 I_{i,t}^{t-4} + \beta_3 I_{i,t}^{t-3} + \beta_4 I_{i,t}^{t-2} + \beta_5 I_{i,t}^{t} + \beta_6 I_{i,t}^{t+1} + \beta_7 I_{i,t}^{t+2} + \beta_8 I_{i,t}^{t+3} + \beta_9 I_{i,t}^{t+4} + \beta_{10} I_{i,t}^{t+5} + \varepsilon_{i,t} \qquad (6)$$

[12] We do not make assumptions about the reasons triggering an upgrade or downgrade of credit ratings.

where the dependent variable is the proportion of public debt, bank debt, and non-bank private debt to total debt outstanding. The *I* variables are indicator variables for the years before and after the downgrade or upgrade year. For instance, I^{t-5} and I^{t+5} are five years before and five years after the downgrade or upgrade year *t*, respectively. As in Rauh and Sufi (2010), we use the year right before the downgrade or upgrade year as the comparison group (I^{t-1} is omitted). The objective is to test if the pattern changes significantly around the year of the rating change. The signs of the coefficients indicate whether there is a substitute or complement effect among alternative financing sources. More specifically, a positive sign on the coefficient of an indicator variable shows an increase (complement effect) in the proportion of a specific debt type relative to the omitted year, while a negative sign indicates a decrease (substitute effect).

The model estimates of Equation (6) for the subsample of credit rating changes are presented in Table 9. Panel A presents the results for rating downgrades. For rating downgrades, we see a clear pattern of substitution between the public and private debt. In particular, from years -5 through -3, firms borrow significantly more from public debt, but less from non-bank private debt; but the difference declines as the ratings downgrade approaches, indicating a shift from public toward non-bank private debt. The pattern in bank debt is generally negative but not significant. This finding implies that a substitute effect is significant between public and non-bank private debt before a downgrade.

TABLE 9: The substitute/complement effect around ratings changes

There are 513 (446) of 988 firms having at least one ratings downgrade (upgrade) in two consecutive fiscal years during the period of 1993-2007. From the debt mix sample, we create these firms' debt mix history within 5 years before and 5 years after the event of a ratings downgrade (upgrade). This table reports the results of OLS regressions testing whether bank debt, non-bank private debt, and public debt are substitutes or complements when the firms' rating is downgraded (Panel A) and upgraded (Panel B). The dependent variables are the proportions of outstanding bank debt, non-bank private debt, and public debt. The explanatory variables are indicator variables of time before or after the downgrade/upgrade year. The omitted indicator variable is the year right before the downgrade/upgrade year. The positive (negative) sign of a coefficient indicates the complement (substitute) effect. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Panel A: Sample of firms with rating downgrade

	% outstanding bank debt	% outstanding non-bank debt	% outstanding public debt
Five years before the downgrade	-0.023	-0.049	0.072
	(0.015)	(0.009)***	(0.016)***
Four years before the downgrade	-0.021	-0.033	0.054
	(0.015)	(0.009)***	(0.015)***
Three years before the downgrade	-0.008	-0.024	0.032
	(0.014)	(0.009)***	(0.014)**
Two years before the downgrade	-0.011	-0.012	0.023
	(0.013)	(0.009)	(0.014)*
The year of the downgrade	0.003	0.019	-0.022
	(0.013)	(0.009)**	(0.013)*
One year after the downgrade	-0.028	0.036	-0.008
	(0.013)**	(0.010)***	(0.013)
Two years after the downgrade	-0.049	0.047	0.002
	(0.013)***	(0.010)***	(0.013)
Three years after the downgrade	-0.043	0.050	-0.007
	(0.013)***	(0.010)***	(0.014)
Four years after the downgrade	-0.040	0.052	-0.012
	(0.013)***	(0.011)***	(0.014)
Five years after the downgrade	-0.031	0.044	-0.012
	(0.014)**	(0.011)***	(0.015)
Constant	0.455	0.005	0.540
	(0.043)***	(0.009)	(0.040)***
Observations	9367	9367	9367
R-squared	0.07	0.16	0.13

TABLE 9 (continued)

Panel B: Sample of firms with rating upgrade

	% outstanding bank debt	% outstanding non-bank debt	% outstanding public debt
Five years before the upgrade	0.020	-0.061	0.041
	(0.018)	(0.012)***	(0.019)**
Four years before the upgrade	0.005	-0.040	0.035
	(0.017)	(0.012)***	(0.017)**
Three years before the upgrade	0.000	-0.024	0.024
	(0.017)	(0.012)*	(0.017)
Two years before the upgrade	-0.007	-0.012	0.019
	(0.016)	(0.012)	(0.016)
The year of the upgrade	-0.005	0.017	-0.012
	(0.015)	(0.012)	(0.015)
One year after the upgrade	0.004	0.006	-0.011
	(0.015)	(0.012)	(0.015)
Two years after the upgrade	0.008	0.008	-0.015
	(0.015)	(0.012)	(0.015)
Three years after the upgrade	-0.003	0.012	-0.009
	(0.016)	(0.013)	(0.015)
Four years after the upgrade	-0.021	0.016	0.005
	(0.016)	(0.013)	(0.016)
Five years after the upgrade	-0.045	0.029	0.017
	(0.017)***	(0.014)**	(0.017)
Constant	0.802	0.105	0.093
	(0.036)***	(0.020)***	(0.036)**
Observations	6430	6430	6430
R-squared	0.11	0.11	0.13

During the year of a downgrade, the coefficients reverse, indicating a continued shift toward non-bank private debt and away from public debt[13]. During the five years after the downgrade, we observe that firms borrow relatively less from banks; while borrowing significantly more from non-bank private lenders. This finding suggests a substitute effect between toward non-bank private debt and away from bank debt after a downgrade. Overall, this pattern is consistent with a deterioration in the credit quality of firms that experience downgrades, both before and after a ratings downgrade. Prior to the downgrade, these firms have higher levels of outstanding public debt and lower levels of non-bank private debt relative to the year before the downgrade. Further, the pattern over time indicates a shift toward non-bank private debt and away from public debt.

After the downgrade, they have higher levels of non-bank private debt and lower levels of bank debt relative to the year before the downgrade. Thus, public lenders appear to react to a deterioration in a firm's credit quality and reduce its ability to access public debt even before a downgrade. Bank lenders appear to restrict access to bank financing only after a downgrade, perhaps because this event affects the firm's ability to operate. This is consistent with bank lenders monitoring borrowers and giving them more time through renegotiation if they experience credit quality issues. Note that it does not indicate that banks are slow to react to a firm's deteriorating condition, because the downgrade sample is conditional on firms having been downgraded. In other words, there is a sample selection issue. It may be that a majority of the firms that banks give more

[13] Note that the coefficient reverses, but this indicates a continuation of the pattern because it is now after the omitted year rather than before. For example, suppose the firm is 50% public debt/50% private debt in the omitted year. Suppose the year before the omitted year we have 60%public/40% private debt. This would yield a positive coefficient on public debt and a negative coefficient on private debt. Suppose the year after the omitted year we have 40% public/60% private debt. This would yield a negative coefficient on the public debt and a positive coefficient on the private debt. However, both indicate a trend toward less public debt and more private debt, though the coefficient switches sign.

time by renegotiating their debt contracts ultimately avoid being downgraded, so these cases would be excluded from this sample.

We repeat the analysis for the firms with credit ratings upgrades and the results are presented in Panel B. Surprisingly, we do not find evidence in support of a substitute or complement effect among the three debt sources when a firm's credit rating is upgraded. In fact, our results show that firms are likely to use more public debt and less non-bank private debt during the pre-upgrade period, but use less public but more non-bank private debt in the post-upgrade period. However, most of the estimates of coefficients on the substitute and complement variables are not statistically significant.

1.5.3 New Issuance Events

In this section, we examine the substitute/complement effect among public, bank and non-bank private debt in the five years before and five years after the event of a new debt issue. Based on the model shown in Equation (6), we define the *I* variables as indicator variables for the years before and after the year of a new debt issue with the year before issuance being the omitted year. We estimate the model for 5,079 debt issuances by 967 firms and the results are reported in Table 10.

Columns 1 and 2 show the results for the bank debt issues. We find that before a bank debt issuance, the proportion in non-bank private debt is lower in years -5 through -2 than in the omitted year (-1). After a bank debt issuance, the proportion in non-bank private debt stays below the level in the omitted year (-1) for years 0 and +1, but then rises above in years +3 through +5. Conversely, before a bank debt issuance, the proportion in public debt is higher in years -5 through -2 than in the omitted year (-1), though the amount by which it is higher declines over those years. After a bank debt issuance, the proportion in public debt then drops below the proportion in the omitted year (-1) and stays below that level, indicating less public debt in years 0 through +5. This is consistent with an eventual substitution effect (years +3 onward) toward non-bank private debt and away from public debt both before and after the bank debt issuance.[14] Further, after a bank debt issuance, the magnitude of the coefficients in years +3 through +5 indicates a shift toward private debt (both bank debt and non-bank private debt) and away from public debt since the negative coefficients for the public debt are larger than the positive coefficients on the non-bank private debt.

Columns 3 and 4 report the estimates for the proportions of bank and public debt around the omitted year (-1) when there is an issuance of non-bank private debt. Interestingly, there is very little effect on the bank or public debt mix in the pre-issue period. From the issuance year and onward, we find that both the proportion of bank and public debt drop significantly. All coefficients on the indicator variables from years 0 through +4 are negative and statistically significant. The finding supports a substitute effect between the non-bank private and bank/public debt in the post-issue period. We present the results for the public debt issues sample in the last two columns. The pattern is very similar to that in the non-bank debt issues sample. In particular, prior to the issuance of public debt there is no discernible effect in the percentages of the other two debt types. After the issuance, the percentages of bank and non-bank private decrease, indicating the substitutability between public and private debt.

[14] Note that in years 0 through +1, both non-bank private debt and public debt are lower, which is consistent with bank debt having just been issued, increasing its proportion versus the other two.

TABLE 10: The substitute/complement effect at the event of a new issuance

From the incremental sample of 5,079 unique debt issues, we pull out the samples of 3,860 bank debt, 452 non-bank private debt, and 767 public debt issuances. Next, we create the debt mix history for the firms around 5 years before and 5 years after the event of a new issuance. For each issuance sample, we test the substitute/complement effect among bank debt, non-bank private debt, and public debt. This table reports the OLS regression results: Columns 1&2 for the bank debt sample, columns 3&4 for the non-bank private debt sample, and columns 4&5 for public debt sample. The dependent variables are the proportions of outstanding bank debt, non-bank private debt, and public debt. The explanatory variables are indicator variables of time before and after the issuance. The omitted indicator variable is the year right before the issuance. The positive (negative) sign of a coefficient indicates the complement (substitute) effect. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Bank issuance sample		Non-bank issuance sample		Public issuance sample	
	% outstanding NB debt (1)	% outstanding public debt (2)	% outstanding bank debt (3)	% outstanding public debt (4)	% outstanding bank debt (5)	% outstanding NB debt (6)
Five years before the issuance	-0.054 (0.005)***	0.052 (0.009)***	0.070 (0.025)***	0.050 (0.019)***	-0.013 (0.021)	0.006 (0.012)
Four years before the issuance	-0.040 (0.005)***	0.037 (0.008)***	0.026 (0.025)	0.048 (0.019)**	-0.029 (0.020)	0.014 (0.011)
Three years before the issuance	-0.024 (0.005)***	0.028 (0.008)***	0.019 (0.024)	0.031 (0.018)*	-0.029 (0.019)	0.015 (0.011)
Two years before the issuance	-0.013 (0.005)***	0.009 (0.008)	-0.004 (0.024)	0.011 (0.017)	-0.016 (0.018)	0.002 (0.010)
Year of the issuance	-0.037 (0.004)***	-0.078 (0.006)***	-0.299 (0.021)***	-0.044 (0.014)***	-0.154 (0.016)***	-0.031 (0.008)***
One year after the issuance	-0.012 (0.005)**	-0.062 (0.007)***	-0.283 (0.022)***	-0.042 (0.015)***	-0.122 (0.016)***	-0.034 (0.008)***
Two years after the issuance	-0.000 (0.005)	-0.059 (0.007)***	-0.282 (0.022)***	-0.047 (0.014)***	-0.103 (0.017)***	-0.038 (0.008)***
Three years after the issuance	0.014 (0.005)***	-0.054 (0.007)***	-0.258 (0.023)***	-0.037 (0.015)**	-0.078 (0.017)***	-0.029 (0.008)***
Four years after the issuance	0.028 (0.006)***	-0.064 (0.007)***	-0.261 (0.024)***	-0.029 (0.016)*	-0.083 (0.017)***	-0.020 (0.008)**
Five years after the issuance	0.048 (0.006)***	-0.052 (0.007)***	-0.241 (0.027)***	-0.008 (0.020)	-0.064 (0.017)***	-0.009 (0.009)
Constant	0.050 (0.008)***	0.315 (0.024)***	1.040 (0.026)***	0.018 (0.014)	0.241 (0.053)***	0.063 (0.009)***
Observations	32260	32260	3677	3677	6295	6295
R-squared	0.08	0.13	0.29	0.17	0.17	0.14

It is worth noting that the different results for bank issuance versus public and non-bank private issues may be explained by the result in Denis and Mihov (2003). They find that those with the worst credit use non-bank private debt, those in the middle use bank debt, and those with the best credit use public debt. This means that non-bank private debt and public debt are used by firms at the two ends of the credit spectrum, with banks in the middle. Thus, firms that that have public debt and bank debt that issue non-bank private debt are moving down in the credit spectrum. They are substituting non-bank private debt to replace public and bank debt, which are higher in the credit spectrum. Conversely, firms that have non-bank private and bank debt that issue public debt are moving up in the credit spectrum. They are substituting public debt to replace non-bank private and bank debt. Hence, there is a straightforward substitution in each case.

However, the issuance of bank debt is different because it is in the middle of the credit spectrum. Firms with public and non-bank private debt that issue bank debt could be moving up or down on the credit spectrum. Our results indicate that the eventual move is predominantly downward, though. This is likely due to our sample being predominantly populated with firms that also have public debt, so they have issued public debt in the past, putting them at the higher end of the spectrum. So there is more movement downward than upward, given the sample selection. If a firm is moving down in the credit spectrum, then it can issue bank debt and non-bank private debt to replace public debt (or non-bank private to replace bank and public). If a firm is moving up in the credit spectrum, then it can issue bank and public debt to replace non-bank private (or public to replace bank and non-bank private). Our results indicate that firms who issue bank debt eventually increase their non-bank private debt. Thus, they are using bank and eventually non-bank private debt to replace public debt. This is consistent a greater proportion of the firms issuing bank debt in our sample being firms moving down in the credit spectrum (firms with no public debt are not in the sample). This is consistent with Rauh and Sufi (2010) who show that higher rated companies that move down in credit rating often lose access to the commercial paper market and use bank loans instead.

In summary, this section examines the substitute/complement effect among debt financing sources around the event of an issuance of a specific type of debt. We first observe that, when firms obtain a new bank loan, their non-bank private and public debt percentages change before and after the issuance. In particular, before the bank debt issue, firms have higher levels of public debt but lower levels of non-bank private debt. After the issue, firms have lower levels of public debt and eventual higher levels of non-bank private debt and bank debt. This is consistent with a substitution effect of private debt (both bank and non-bank) and for public debt both before and after the bank debt issuance. Second, we find empirical evidence supporting the substitutability of non-bank private debt and for other two types of debt after the issuance of non-bank private debt. Similarly, we find evidence consistent with the substitutability of public debt for bank and non-bank private debt after a new issuance of public debt. This evidence is consistent with Detragiache's (1994) argument on the substitutability between these debt types.

1.6 Conclusion

Based on a sample of 988 firms with new debt issuances in the period of 1993-2007, we examine the factors that drive firms' choice among public debt, non-bank private debt, and bank debt over time. Our study is related to Denis and Mihov (2003), Arena (2010), and Rauh and Sufi (2010). However, unlike these studies, we examine if the determinants of new debt sources vary over time and under different macroeconomic conditions. In particular, we develop an incremental new issues sample and an outstanding debt mix sample to perform the analyses. In addition to our examination of the determinants of corporate debt mix using the two different samples and most importantly, we test whether there is a substitute/complement effect among different debt financing sources. Using the balance sheet data, Rauh and Sufi (2010) provide evidence on a complement effect among debt types for fallen angels. We examine the substitute/complement effect for a large sample of firms in general, at ratings upgrades and downgrades, and at new issue events.

We have the following main findings. First, firm age and firm size are significant drivers of the probability of debt type in new issuances and the percentage of debt mix. Larger and older firms prefer public debt to private debt, and choose bank over non-bank private if private debt is used. This finding is consistent with the information asymmetry explanations of corporate debt mix. Asset tangibility, probability of distress, and earnings volatility lead to significant impacts on corporate debt mix. In particular, a higher fixed asset ratio or a lower earnings volatility is associated with more public than private debt. Interestingly, more profitable firms prefer bank debt to the other two debt types. Firms with a higher probability of distress prefer non-bank private to bank debt. Not surprisingly, credit quality is an important determinant of corporate debt mix. Consistent with Denis and Mihov (2003), we find that investment grade firms are more likely to borrow from public sources, while they prefer bank to non-bank private when private sources are considered. An in-depth analysis using individual rating categories confirms the above conclusion. Using the prior issuance history and outstanding debt mix, we show that firms who are newer to the debt markets are more likely to start with non-bank private debt. In addition, experienced borrowers with a high percentage of public debt typically choose public over private debt, and prefer bank to non-bank private. Most importantly, we find that macroeconomic factors such as prime interest rate, slope, interest rate volatility, and GDP growth significantly impact the probabilities of issuing new debt of a particular type and the percentages in the outstanding debt mix.

Second, we find that the set of determinants of corporate debt mix change over time. In particular, firm age matters in the 1998-2002 period, but not in the other two time periods. Interestingly, asset tangibility is a significant factor in the early and later periods, but not in the 1998-2002 period. The early period of 1993-1997 is unique in terms of having the least number of significant determinants among the three periods. Credit quality, earnings volatility, prior issuance behavior, and macroeconomic factors have little or no impacts on corporate debt mix in the 1993-1997 period, while they are important drivers in the other two more recent periods of 1998-2002 and 2003-2007. We also find that the set of drivers differs by interest rate volatility. When market uncertainty is high, firm age and earnings volatility matter much more to borrowers when making the decision on corporate debt mix.

Third, this study documents that in general public debt and private debt are substitutes for each other. Using the panel data of outstanding debt mix for our sample firms, we find evidence in strong support of the substitute effect. Using the subsample of 513 firms with credit rating downgrades, we find that firms substitute non-bank private debt for public debt before a downgrade event. After a downgrade, we find that firms substitute non-bank private debt for bank debt. These results are consistent with a deterioration of firm credit both before and after a downgrade. Surprisingly, our analysis of the 446 firms with rating upgrades provides little evidence of a substitute/complement effect.

Finally, we extend the substitute/complement effect among the three types of debt to new debt issuance events and find evidence in support of a general finding of a substitute effect among the three types of debt sources. In particular, when there is a new issue of non-bank private or public debt, the percentage outstanding of the other two debt types decreases after the issuance event. For the sample of bank loan issuance, we find evidence consistent with a substitution effect between private (both bank and non-bank private) and public debt.

This study makes significant contributions to the literature on corporate debt mix decisions by provide a comprehensive examination of the choice of debt type and percentage of outstanding debt mix based on an extensive sample. We highlight the important role played by macroeconomic factors in determining corporate debt mix and how the set of determinants change over time. We provide strong evidence on the substitute effect between public and private debt in general, at credit rating downgrades, and at new issuances. Our study sheds light on one of the major corporate decisions regarding debt financing.

CHAPTER 2: PRODUCT MARKET COMPETITION, CORPORATE GOVERNANCE, AND DEBT MATURITY STRUCTURE

2.1 Introduction

Related literatures have emphasized the roles of product market competition, corporate governance, and debt maturity in mitigating the agency costs associated with the conflicts of interests between shareholders and managers. Specifically, intensification of competition in the product market can reduce managerial slacks (Hart, 1983). Guadalupe and Perez-Gonzalez (2010) empirically document that competition leads to less private benefits of control available to managers, which induces them to less entrench. Corporate governance is also an important mechanism to control mangers to work in alignment with shareholders. For instance, Gompers, Ishii and Metrick (2003) find that firms with stronger shareholder rights (good governance) had higher firm value and better operating performance and made fewer acquisitions in the 1990s. In addition, there is a strong argument that debt maturity can reduce the agency costs (e.g., Jensen (1986); Hart and Moore (1995)). In general, using short-term debt makes mangers to be more frequently monitored by creditors through refinancing activities, thus making them to be more aligned with shareholders. Short-term debt can also reduce the agency costs related to underinvestment problems and free cash flows (Myers (1977); Jensen (1986)).

Given the roles of these three disciplinary mechanisms as discussed above, an interesting question is how firms choose debt maturity structure in the presence of competition among firms in the output markets and the presence of their existing corporate governance? For example, we might want to know if firms in more competitive industries use less short-term maturity when their corporate governance is strong. We might also want to know if the relations between product market competition, corporate governance and debt maturity depend on types of competition. This study will answer such questions.

Competition intensification in the output markets might affect firms' choices of leverage as well as the choices of debt maturity structure. Seminal studies by Brander and Lewis (1986), Fudenberg and Tirole (1986), Maksimovic (1988), and Bolton and Scharfstein (1990) argue that firms use debt as a strategic variable to compete in the output markets, suggesting that firms would consider the competition among rivals when making capital structure decisions. Previous studies find evidence consistent with this argument. For example, Leary and Roberts (2010) find a high interdependence of a firm's financing decisions to its peers' financing decisions. Although majority of previous studies have focused on the general relation between competition and firm leverage, several studies have paid attention on the relation between competition and debt maturity. Glazer (1994) argues that, under imperfect market conditions, firms only get the strategic benefits of debt when issuing long-term debt, implying that maturity structure might be important for firms to respond to the rivals' actions. More specifically, Kanatas and Qi (2001) predict a negative relation between industry concentration and short-term maturity. A recent study by Erhemjamts, Raman and Shahrur (2010) first finds evidence that short-term maturity increases at the low level of industry concentration, but decreases at the higher concentration level, which is not consistent with the prediction by Kanatas and Qi (2001).

The governance literature provides theoretical predictions and evidence about the relation between corporate governance and debt maturity. The entrenchment argument suggests that entrenched managers, especially in weak corporate governance mechanism, tend to make suboptimal decisions such as using less short-term maturity. The results of empirical studies by Benmelech (2006), Jiraporn and Kitsabunnarat (2007) and Harford, Li and Zhao (2008) imply that firms with weak corporate governance tend to use less short-term maturity and vice versa.

In this study, we examine the impacts of product market competition and corporate governance on the choices of debt maturity in manufacturing firms (SIC 2000-3999) in the period 1990-2008. Following the literature (e.g., Campello (2005), Gaspar and Massa (2006), Grullon and Michaely (2007), Haushalter, Klasa and Maxwell (2007)), we use the Herfindahl-Hirschman Index (HHI) as a proxy for product market competition. Alternatively, in a robustness analysis, we follow Fresard (2010) to use the U.S import tariff change as a quasi-natural experiment of product market competition. For corporate governance, we use governance index (G-index) as a proxy as in Gompers, Ishii and Metrick (2003). Our study is closely related to previous studies by Benmelech (2006), Jiraporn and Kitsabunnarat (2007), and Erhemjamts, Raman and Shahrur (2010). These studies examine either corporate governance or competition on debt maturity separately. Different from them, we examine the effects of these two disciplinary mechanisms within an analysis framework. Our study is also in line with recent studies that consider the effects of both product market competition and corporate governance. For example, Giroud and Mueller (2010, 2011) examine the effects of these two mechanisms on firm performance and equity prices. Meanwhile, Paligorova and Yang (2012) examine their effects on the cost of debt.

We come up with main findings as follows. Overall, we find empirical evidence that product market competition and corporate governance have significant effects on debt maturity, after controlling for well-documented determinants of debt maturity. More specifically, we find a positive relation between industry concentration and short-term maturity, indicating that firms in less competitive industry (high industry concentration) use more short-term maturity than firms operating in more competitive industries. This result is consistent evidence in Erhemjamts, Raman and Shahrur (2010). A further analysis, which takes into account the effect of being dominant firms, shows that the positive relation between HHI and short-term maturity is mainly driven by the agency effect rather than the predation effect. Therefore, our result is consistent with the agency effect hypothesis that, other things equal, firms might use short-term maturity to address the agency problems associated with the lack of competition pressures in the product markets. Additionally, using change in the import tariff rates as an alternative proxy for product market competition, we come up with consistent results. We find that firms in industries with experience of reductions in the import tariff rates (more competition) use less short-term debt than those in industries without experience of the import tariff cuts (less competition).

Consistent with our hypothesis, we find that short-term maturity decreases in corporate governance index (G-index), suggesting that firms with weak corporate governance tend to use less short-term maturity than the counterparts with good corporate governance. This result supports the entrenchment argument that entrenched managers are more likely to use less short-term debt under poor quality of corporate governance. Consistently, our additional analysis shows that, compared with firms in low G-index tercile, firms in the upper G-index terciles tend to use less short-term maturity. Our result is consistent with previous studies by Benmelech (2006) and Jiraporn and Kitsabunnarat (2007). These studies document that good corporate governance firms use more long-term debt and vice versa.

Given the above results, we test a hypothesis that, in less competitive industries (high industry concentration), firms with weak corporate governance tend to use less short-term maturity. We do this by including the interaction term between HHI and G-index, and between HHI and dummies of G-index terciles in our regression specifications. Our results show mixed evidence, which is not consistent with the hypothesis. The estimated results of Model 3 in Table 14 show that the coefficient on the interaction term between HHI and G-index is negative in both ST3 and ST5 maturity regressions, but is significant for ST5 only. Overall, this result is consistent with our hypothesis. However, additional analyses use dummies of G-index terciles show the opposite results. The estimated results of Model 4 (Table 14) and Model 2 (columns 5 and 6 in Table 16) show that the interaction between HHI and high G-index dummies has positive and significant coefficient, which is not consistent with our expectation. Similarly, the analysis using change in the import tariff rates as a proxy for product market competition provides evidence not consistent with the hypothesis. As shown in Table 17, firms in the upper G-index terciles who operate in the industries with experience of import tariff cuts (high competition) significantly use more short-term maturity, compared with firms in low G-index tercile. Instead, our hypothesis implies that these firms should use less short-term maturity.

Interestingly, we find that types of competition have a significant impact on the relations between product market competition, corporate governance, and debt maturity. Following Lyandres (2006), we use competitive strategy measure (CSM) as a proxy for types of competition and find the existence of the positive relation between HHI and short-term maturity for both two subsamples of negative and positive CSM. This result complements evidence in Erhemjamts, Raman and Shahrur (2010). They find that the relation exists only in their positive CSM sample. Therefore, there is evidence that, regardless of ways of competition (strategic substitutes or complements), firms operating in less competitive industries tend to use more short-term debt, compared with those in more competitive industries. In addition, we find new evidence that that the negative relation between governance index and short-term maturity is significant when firms compete in strategic substitutes only. Thus, types of competition matter the effect of corporate governance on debt maturity.

This study contributes to the literature in several ways. First, we find empirical evidence consistent with the literature that both product market competition and corporate governance are important determinants of debt maturity choices. Previous studies often focus on the effect of each mechanism on debt maturity separately. Erhemjamts, Raman and Shahrur (2010) ignore the effect of corporate governance when examining the influence of industry concentration on debt maturity. Meanwhile, Benmelech (2006) and Jiraporn and Kitsabunnarat (2007) examine how corporate governance affects debt maturity without consideration of the effect of product market competition. Different from them, we consider the impacts of these two substitute disciplinary mechanisms on debt maturity all together.

Second, this study documents empirical evidence that the effect of product market competition on debt maturity was mainly driven by the agency effect rather than the predation effect. This interesting result means that although predatory attacks prevail in the output markets, especially in highly concentrated industries, they do not significantly affect the general relation between product market competition and debt maturity. Similarly, in a related paper, Grullon and Michaely (2007) find that the positive relation between level of competition intensification in the product market, measured by HHI, and payout ratios is driven by the outcomes of competition among firms, not by the predatory attacks.

Finally, we provide new evidence that the impact of product market competition on debt maturity does not depend on types of competition. Regardless of competing in strategic substitutes or complements, firms in less competitive industries use more short-term maturity than firms in more competitive industries. Lyandres (2006) also find that types of competition do not affect the relation between competition in the product market and firm leverage. Therefore, we might conclude that the effects of competition on either leverage or maturity structure are not dependent on ways of competition. In addition, we first show the ways firms compete have a significant impact on the relation between corporate governance and debt maturity. Our result shows that the effect of corporate governance on debt maturity holds only when firms compete in strategic substitutes.

The chapter is structured as follows. In the next section, we discuss the related literatures and develop our hypotheses. Section 2.3 provides information about data sources and reports descriptive summary on firms' characteristics. Section 2.4 discusses empirical results. Section 2.5 concludes.

2.2 Related Literatures and Hypotheses

In this section, we discuss a review of previous studies about the relation between product market competition, corporate governance, and debt maturity and develop our hypotheses.

Optimal capital structure models (e.g., Modigliani and Miller (1958) and Stiglitz (1974)) are based on a single-firm framework, which ignore the interactions among firms in product markets. For example, Stiglitz (1974) argues that corporate financial policies such as leverage, maturity, and payout ratio are irrelevant under the perfect market assumptions. As an extension, seminal studies by Brander and Lewis (1986), Fudenberg and Tirole (1986), Maksimovic (1988), and Bolton and Scharfstein (1990) take into account competition among firms. According to them, firms use debt as a strategic variable to compete and market structures play an important role in determining firms' financial policies[1]. However, Glazer (1994) shows that, under imperfect market conditions, the strategic benefits of debt only exist when firms issue long-term debt rather than short-term debt or no debt. This suggests that structure of debt maturity is important for firms to respond their rivals' competitive moves in the output markets.

The literature suggests that competition in the product markets affects firms' structure of debt maturity through two channels: agency and predation effects. On the one hand, there is a common notion that market competition works as an external disciplinary

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[1] See Zingales (1998), Kovenock and Phillips (1997), Chevalier (1995), Showalter (1999), Schargrodsky (2002), Campello (2003), Mackay and Phillips (2005), Xu (2007), Leary and Roberts (2010) for further empirical evidence about the relation between competition in the product markets and capital structure.

mechanism (e.g., Hart (1983) and Allen and Gale (1999)), which can reduce managerial slack. Consistent with this prediction, Guadalupe and Perez- Gonzalez (2010) find that market competition leads to less private benefits of control available to managers. Furthermore, under competition pressure, the allocation of resources among firms is more efficient, which provides a benchmark for shareholders, especially creditors to compare a firm's performance with others. The above arguments imply that strong market competition would make the agency problems less severe and also reduce the information asymmetry among managers, shareholders and creditors. Therefore, ceteris paribus, the monitoring benefits of short-term maturity would be higher in less competitive industries (high industry concentration) to address the severity of agency problems and asymmetric information related to the lack of competition pressure. Following Grullon and Michaely (2007), we call the impact of competition through the agency channel as agency effect. For empirical evidence, Erhemjamts, Raman and Shahrur (2010) use HHI as a proxy for industry concentration and find that short-term maturity is positively associated with HHI, but negatively associated with HHI squared. They conclude that the use of short-term maturity increases at low industry concentration, but decreases at higher industry concentration.

On the other hand, predation theories by Fudenberg and Tirole (1986) and Bolton and Scharfstein (1990) predict that the use of debt induces predatory threats from the rivals through reducing price and increasing outputs to drive firms with financial constraints out of the markets. To optimally respond to predation threats, Bolton and Scharfstein (1990) suggest that the sensitivity of refinancing decision to firm performance should be lowered. This conclusion may be applicable to debt maturity structure. In a related paper, Hoberg, Phillips and Prabhala (2012) find that firms facing with predation threats pay lower dividends and keep higher cash, implying that firms would have more conservative financial policies such as lower leverage and long-term maturity to reduce the disadvantages of potential predation threats. Theoretically, using short-term maturity would make firms more vulnerable to predatory attacks because of higher liquidity risk. Kanatas and Qi (2001) examine if firms choose long-term or short-term capital market debt or bank credit, given an incentive conflict between managers and creditors and imperfect market conditions. Their model predicts that the use of short-term debt is decreasing in industry concentration. Thus, product market competition might affect firm's choice of debt maturity through the potential predation. We name this impact predation effect as in Grullon and Michaely (2007).

The governance literature documents that corporate governance has significant impact on firms' debt maturity. Theoretically, entrenched managers tend to make suboptimal decisions that benefit themselves rather than shareholders. For example, they would prefer using less short-term debt to avoid the monitoring by external creditors. Therefore, corporate governance mechanisms are designed to discipline such discretionary behaviors. In fact, the literature provides well-documented evidence that good corporate governance makes managers to better align with shareholders (e.g., Gompers, Ishii and Metrick (2003)). We argue that, other things equal, good corporate governance ensures that managers choose optimal maturity that benefits shareholders and vice versa. More specifically, we expect that firms with good (weak) corporate governance use more (less) short-term maturity. Empirical studies by Benmelech (2006) and Jiraporn and Kitsabunnarat (2007) find that long-term debt maturity is positively associated with G-index, indicating that weak corporate governance firms tend to use more long-term debt or equivalently less short-term debt. In addition, Harford, Li and Zhao (2008) examine the effect of corporate governance on financial policies and find that firms with stronger boards use higher leverage and more short-term debt as well.

Based on the review above, we come up with main hypotheses as follows. First, following the literature, we use HHI as a proxy for product market competition. Consistent with Erhemjamts, Raman and Shahrur (2010), we expect a positive relation between HHI and short-term maturity. Although predation theories (Fudenberg and Tirole (1986), Bolton and Scharfstein (1990), Kanatas and Qi (2001)) imply that short-term maturity decreases in industry concentration, we posit that predatory attacks often occur at very highly concentrated industries such as duopolistic markets. Therefore, we predict that the general positive relation between HHI and short term maturity might be driven by the agency effect rather than predation effect. We test this prediction by examining the effect of being dominant firms.

About the relation between corporate governance and debt maturity, we predict that firms with weak corporate governance use less short-term maturity than firms with good corporate governance. This hypothesis is based on the entrenchment argument and is consistent with evidence in Benmelech (2006) and Jiraporn and Kitsabunnarat (2007). Following Gompers, Ishii and Metrick (2003), we use G-index as a proxy for corporate governance. We expect a positive relation between G-index and short-term maturity.

Competition in the product markets can reduce managerial slacks (see for example Hart (1983), Allen and Gale (1999), and Guadalupe and Perez- Gonzalez (2010)). This implies that, under less competition pressure, managers are more likely to entrench themselves by making suboptimal decisions such as using less short-term debt. This argument leads to our hypothesis that weak corporate governance firms in less competitive industries (high industry concentration) tend to use less short-term maturity. We test this prediction by including the interaction term between HHI and G-index in our regression specifications. We expect a negative coefficient on this interaction term.

2.3 Data

In this section, we discuss formation of the sample and provide descriptive statistics of firm characteristics.

2.3.1 Sample

We examine the impact of product market competition and corporate governance on maturity structure in manufacturing firms (SIC 2000-3999) in the period 1990-2008. We choose this period because of the availability of governance data beginning from 1990. Previous studies such as Campello (2005), Gaspar and Massa (2006), Grullon and Michaely (2007), and Haushalter, Klasa and Maxwell (2007), among others, also examine different aspects of competition in the manufacturing industries.

In both economics and finance literatures, the Herfindahl-Hirschman Index (HHI) is widely used as a proxy for product market competition. Researchers can directly calculate HHI from Compustat database or use the HHI provided by the U.S Economic Census of Manufacturers. One advantage of the Census HHI is that it covers both public and private firms, thus would reflect the market structure better than the Compustat-based HHI. Furthermore, the Census HHI is used by the U.S Department of Justice as a measure of market power in antitrust policies. By definition, the Census HHI is calculated by summing of the squares of market shares of the biggest 50 firms in an industry. If there are less than 50 firms in a specific industry, HHI is the sum of the squares of market shares of all firms in that industry. In this study, we follow Campello (2005), Gaspar and Massa (2006), Grullon and Michaely (2007), and Haushalter, Klasa and Maxwell (2007), among others, to use the Census HHI a main proxy for product market competition. Because HHIs are reported every 5-year period, we follow the literature to use the recent HHI to fill in the years with missing observations. For instance, we use HHI in year 1987 to fill in the years 1990 and 1991. We use HHI based on 4-digit SIC codes.

In a robustness analysis, following Fresard (2010), we use the U.S import tariff change as a quasi-natural experiment of product market competition. Fresard (2010) argues that the import tariff cut leads to harder competition among domestic manufacturing firms. Therefore, using the import tariff change as a proxy for product market competition helps us to deal with the endogeneity concerns between competition, corporate governance and maturity structures. Due to the limitation of data, we have the import tariff from 1990 through 2005 only.

As in the literature, we use governance index (G-index) as a proxy for corporate governance. G-index is constructed by Gompers, Ishii and Metrick (2003), which consists of 24 antitakeover and shareholder rights provisions from IRRC governance database. Under the shareholders' points of view, a firm with low G-index has good governance and vice versa. Because G-index is available for the years 1990, 1993, 1995, 1998, 2000, 2002, 2004, and 2006 only, we use the recent G-indexes to fill in the intermediate years as in the literature. For example, we use G-index in year 2006 to fill in the years 2007 and 2008.

We obtain firm data from Compustat annual database and stock prices from CRSP. To form the sample, we create an initial sample of manufacturing firms in Compustat database from 1990 through 2008. To get information on product market competition and corporate governance, we match the initial sample to the Census HHI and G-index datasets. In addition, we require non-missing data on all variables used in multivariate analysis. This process leads to the final sample consisting of 6,228 firm-year observations. For the robustness analysis, we match the final sample to the U.S import tariff cut dataset and obtain a subsample including 3,973 firm-year observations in the period 1990-2005.

2.3.2 Descriptive Statistics

Table 11 reports descriptive statistics of firm characteristics. The first two panels provide a snapshot about the intensification of product market competition and corporate governance of the sample firms. Our proxy for product market competition, HHI, has the average of 729 and its median value is approximately 542. And, G-index, a measure of corporate governance quality, has the average and medium of 9.

TABLE 11: Summary statistics of market competition, corporate governance, and firm characteristics

This table reports the summary statistics for the sample firms. The sample consists of 6,228 firm-year observations in the period 1990-2008. To be included in the sample, firms must operate in the manufacturing sector (SIC 2000-3999), have financial data on Compustat Annual Industrial file and have available information on corporate governance. The Herfindahl-Hirschman Index (HHI) is based on the 4-digit SIC from the Census of Manufacturers. G-index is a proxy for corporate governance, which is constructed by Gompers, Ishii and Metrick (2003). Both HHI and G-index are available for specific years; the missing observations are filled in using the recent indexes. Firm size is the market value of the firm (estimated as the book value of assets minus the book value of equity plus the market value of equity). Fixed asset ratio is the net plant, property, and equipment divided by total assets. Profitability is earnings before interest, taxes, depreciation, and amortization (EBITDA) scaled by the book value of total asset. Leverage is total debt (debt in current liability plus long-term debt) divided by the market value of the firm. Market to book ratio is the firm market value scaled by the book value of total assets. Abnormal earnings is measured as (earnings in year t+1 - earnings in year t)/share price x outstanding shares in year t. Asset maturity is the book value weighted average of the maturities of the plant, property, and equipment (PPE) and current assets, measured as (PPE/Total asset) x (PPE/Depreciation expense))+ (Current asset /Total asset) x (Current asset/COGS). Asset return volatility is calculated as monthly stock return standard deviation during the fiscal year multiplied by the ratio of the market value of equity to the firm market value. Percentage of debt maturing in 3 years (5 years) or less is defined as debt that matures in 3 years (5 years) or less scaled by total debt. All accounting data are winsorized at the 1st and 99th percentiles.

	Obs.	Mean	Standard Deviation	25th percentile	Median	75th percentile
Market competition						
Herfindahl-Hirschman Index	6228	728.92	552	340.6	541.7	1015.8
Corporate governance						
G-index	6228	9.12	2.7	7	9	11
Firm characteristics						
Firm size ($M)	6228	8946.8	22877.6	774.23	2002.21	6293.98
Fixed assets ratio	6228	0.26	0.16	0.14	0.23	0.34
Profitability	6228	0.13	0.11	0.09	0.14	0.19
Market to book	6228	2.13	1.45	1.26	1.66	2.42
Leverage	6228	0.14	0.14	0.02	0.11	0.22
Abnormal earnings	6228	0.02	0.18	-0.01	0.01	0.03
Asset maturity	6228	8.37	6.6	3.86	6.4	10.77
Asset return volatility	6228	0.08	0.05	0.04	0.06	0.1
Percentage of debt maturing in 3 years or less (ST3)	6228	0.48	0.37	0.14	0.41	0.9
Percentage of debt maturing in 5 years or less (ST5)	6228	0.64	0.35	0.36	0.68	1
Proportion of observations with credit ratings	0.49					

The last panel reports various characteristics of the sample firms. The average firm holds assets with market value of $9 billion, approximately. While, the market value of assets held by the median firm is about $2 billion. The average and median firm has fixed asset ratio of 0.26 and 0.23, respectively. The median firm has profitability of 14%, which is a bit higher than that of the average firm (13%). As in the literature, we use market to book as a proxy of growth opportunities. Our sample firm has market to book ratio with the mean of 2.13 and median of 1.66. About leverage policy, the average firm holds 14 % debt, while the median firm uses lower debt at 11%. The mean (median) values of abnormal earnings, asset maturity, and asset return volatility are 0.02, 8.37, and 0.08 (0.01, 6.40, and 0.06), respectively.

As in the literature, we use the proportion of debt that matures in 3 years (5 years) or less to measure short-term maturity structure (hereafter ST3 and ST5). On average, the sample firm uses 48% of ST3 and 64% of ST5. Meanwhile, the median firm uses 41% of ST3 and 68% of ST5. Interestingly, the median firm uses less ST3, but more ST5 than the average firm. The last row of Table 11 shows that about a half of the sample firms have credit ratings available.

2.4 Empirical Analysis

2.4.1 Univariate Results

The Pearson correlation coefficients in Table 12 show a simple relation between short-term debt maturity, product market competition, and corporate governance. The positive coefficient between HHI and two measures of short-term maturity imply that short-term maturity is positively correlated with product market competition, which is consistent with our expectation. In contrast, the coefficient between G-index and short-term maturity measures is significantly negative, which suggests that firms with weak corporate governance (high G-index) tend to use more short-term debt and vice versa. This evidence supports the findings by Benmelech (2006) and Jiraporn and Kitsabunnarat (2007). Additionally, the correlation coefficient between HHI and G-index is significantly negative as expected, indicating that these two disciplinary mechanisms are substitutes.

TABLE 12: Pearson correlation matrix between short-term debt maturity, product market competition, and corporate governance

This table reports a matrix of Pearson correlation coefficients between short-term debt maturity, product market competition, and corporate governance. Variables are defined as in Table 11. * denotes significance at 5 percent level.

	Percentage of debt maturing in 3 years or less (ST3)	Percentage of debt maturing in 5 years or less (ST5)	HHI	G-index
Percentage of debt maturing in 3 years or less (ST3)	1			
Percentage of debt maturing in 5 years or less (ST5)	0.7779*	1		
HHI	0.0358*	0.0288*	1	
G-index	-0.1340*	-0.0999*	-0.0538*	1

Following Gompers, Ishii and Metrick (2003), we classify firms with G-index of 5 or below into low tercile, firms with G-index in between 6 and 13 into medium tercile, and those with G-index of 14 or higher into high tercile. Similar to them, we label firms in the low G-index tercile as democracy firms and those in the high G-index tercile as dictatorship firms. Next, we compare the average short-term maturity across HHI quintiles and G-index terciles. The results are reported in Table 13.

A closer look at each row of the two panels in Table 13 reveals that although there is no pattern that the average short-term maturity (ST3 and ST5) increases across HHI quintiles, the average ST3 and ST5 is statistically different between two extreme HHI quintiles. Regardless of corporate governance quality, firms in the highest HHI quintile use more ST3 and ST5 than those in the lowest HHI quintile, implying that firms in less competitive industries tend to use more short-term debt than those in more competitive industries. For instance, on average, democracy firms in the highest HHI quintile have 68% (78%) debt that matures in three years (five years) or less, compared with the corresponding 55% (68%) debt held by the counterparts in the lowest HHI quintile.

The analysis by column of Panel A in Table 13 shows that, within each HHI quintile, firms with low G-index (good corporate governance) use relatively more short-term maturity (ST3) than others with medium and high G-index (weak corporate governance). For instance, within the lowest HHI quintile, democracy firms use 56% debt maturing in three years or less; meanwhile, medium G-index and dictatorship firms use only 48% and 31%, respectively. Thus, consistent with the result from the correlation analysis above, there is empirical evidence that firms with good corporate governance (low G-index) use more short-term debt than those with poor corporate governance (high G-index), regardless of the competition intensification in the product markets. This general result still holds, but is relatively weaker for the alternative measure of short-term maturity, ST5 as shown in Panel B of Table 13.

TABLE 13: Short-term maturity across HHI quintiles and G-index terciles

This table reports a comparison of average short-term maturity (ST3 and ST5) across HHI quintiles and G-index terciles. Results for ST3 and ST5 are in Panel A and Panel B, respectively. The average HHI across HHI quintiles is also reported in the bottom of each panel. The last column of each panel provides a test of the difference in average ST3, ST5, and HHI between the highest and lowest HHI quintiles. * denotes significance at 1 percent level.

Panel A: Percentage of debt that matures in 3 years or less (ST3) across HHI quintiles and G-index terciles

	HHI quintiles					
	Lowest	2	3	4	Highest	Highest-lowest difference
Low G-index (Democracy) (G-index<=5)	0.56	0.56	0.62	0.57	0.68	0.12*
Medium G-index (6<=G-index<=13)	0.48	0.49	0.44	0.46	0.50	0.02*
High G-index (Dictatorship) (G-index >=14)	0.31	0.43	0.39	0.41	0.69	0.38*
Average HHI	173.4	392.8	569.1	903.0	1626.6	1453.2*

Panel B: Percentage of debt that matures in 5 years or less (ST5) across HHI quintiles and G-index terciles

	HHI quintiles					
	Lowest	2	3	4	Highest	Highest-lowest difference
Low G-index (Democracy) (G-index<=5)	0.68	0.66	0.71	0.75	0.78	0.10*
Medium G-index (6<=G-index<=13)	0.66	0.63	0.59	0.61	0.66	0.00
High G-index (Dictatorship) (G-index >=14)	0.48	0.66	0.65	0.63	0.75	0.27*
Average HHI	173.4	392.8	569.1	903.0	1626.6	1453.2*

2.4.2 Multivariate Results

2.4.2.1 Model Specification and Variable Selections

In our regression models, the dependent variable is short-term maturity measured by ST3 and ST5. Our interest variables are HHI, G-index, and their interaction terms. To analyze the effect of corporate governance in further details, we group G-index into low, medium and high tercile as in Gompers, Ishii and Metrick (2003) and use their dummies and the interaction terms with HHI in the regression models. We also include year dummies and 2-digit SIC dummies to control for the time and industry fixed effects.

We select other control variables based on previous studies (Barclay and Smith, 1995; Johnson, 2003; Barclay, Max and Smith, 2003; Datta, Iskandar-Datta and Raman, 2005; Billett, King and Mauer, 2007). Firm quality is an important determinant of debt maturity. For example, Diamond (1991) argues a non-linear relation between firm quality and maturity: firms with the lowest and highest credit ratings prefer short-term debt, while firms in the middle range use long-term debt. We use firm size as proxy for credit quality and expect a negative coefficient on it. In addition, we include firm sized squared and expect that its coefficient is positive. The use of short-term maturity can address the underinvestment problem, especially in high growth firms (Myers, 1977). Thus, we use market to book as a proxy for investment opportunities and predict a positive coefficient on this variable. As in Johnson (2003), Billett, King and Mauer (2007) and Brockman, Martin and Unlu (2010), we control for firm leverage and expect a negative sign on it. Signaling models (Flannery, 1986; Diamond, 1991) argue that firms use maturity structure to signal their credit quality to financial markets. This implies that high quality firms prefer short-term maturity because they might benefit from the efficiency of monitoring by lenders.

Following Barclay and Smith (1995), we include abnormal earnings and expect that it has positive coefficient. Firms often match the maturity of asset to that of liabilities in an attempt to reduce the agency costs associated with the shareholders-bondholders conflicts (Myers, 1977). Thus, we include asset maturity and expect that it has a negative coefficient. Following Johnson (2003), we control for asset return volatility as an alternative proxy for credit risk and expect a negative sign on this variable. Brockman, Martin and Unlu (2010) argue that firms with high volatility of cash flows might prefer long term debt to short-term debt. We also control for credit ratings and predict that firms with ratings are likely to have access to financial markets, thus can borrow more long-term debt. Finally, we include term structure as a proxy for the effect of tax on debt maturity and expect that its coefficient is negative.

2.4.2.2 Base Results

In this section, we discuss our base regression results. The dependent variables are two measures of short-term maturity (ST3 and ST5). Recall that our interest variables are HHI, G-index and their interaction terms. In Model 1, we regress ST3 and ST5 on HHI and control variables only. Model 2's explanatory variables consist of HHI, G-index and other control variables. In Model 3, we add an interaction term between HHI and G-index as an additional independent variable. The explanatory variables of Model 4 include HHI, dummies of medium and high G-index tercile, interaction terms between HHI and G-index tercile dummies, and other control variables. The dummy of low G-index tercile is omitted in Model 4. We tabulate the estimated results in Table 14.

TABLE 14: Regressions of short-term debt maturity on product market competition and corporate governance

This table reports the OLS regression results of short-term maturity on product market competition and corporate governance. The variables medium G-index and high G-index take a value of one if G-index is from 6 to 13 and G-index is 14 or higher respectively, and zero otherwise. The low G-index (i.e., G-index <=5) is the reference group. In Model 4, the interaction between HHI and low G-index is omitted to avoid multicollinearity issues. Rating dummy takes the value one for rated firms and zero for nonrated firms. Term structure is the spread between the yield on 10-year government bonds and the yield on one-year government bonds at the fiscal year end. Yield data comes from the FRED at the Federal Reserve Bank of St. Louis. Other variables are defined as in Table 11. All regressions include 2-digit SIC dummies and year dummies. t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2		Model 3		Model 4	
	ST3	ST5	ST3	ST5	ST3	ST5	ST3	ST5
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HHI	0.5182	0.3742	0.5294	0.3707	0.6186	1.0030	0.5893	0.6712
	(6.26)***	(4.52)***	(6.39)***	(4.47)***	(2.09)**	(3.38)***	(2.17)**	(2.46)**
G-index			-0.0033	-0.0011	-0.0024	0.0037		
			(2.01)**	(0.65)	(0.87)	(1.38)		
HHI x G-index					-0.0124	-0.0708		
					(0.39)	(2.22)**		
Medium G-index							-0.0408	-0.0029
							(1.63)	(0.11)
High G-index							-0.1481	-0.0743
							(3.86)***	(1.93)*
HHI x Medium G-index							-0.1400	-0.3667
							(0.50)	(1.31)
HHI x High G-index							1.8838	1.3672
							(3.92)***	(2.84)***
Firm size	-0.2208	-0.1316	-0.1634	-0.1304	-0.2171	-0.1301	-0.2219	-0.1335
	(10.92)***	(6.50)***	(10.23)***	(6.41)***	(10.69)***	(6.40)***	(10.98)***	(6.60)***
Firm size squared	0.0128	0.0072	0.0092	0.0071	0.0126	0.0071	0.0129	0.0073
	(10.35)***	(5.80)***	(9.49)***	(5.74)***	(10.17)***	(5.71)***	(10.46)***	(5.92)***
Market to book	-0.0056	-0.0107	-0.0074	-0.0109	-0.0060	-0.0107	-0.0063	-0.0110
	(1.50)	(2.88)***	(1.97)**	(2.91)***	(1.60)	(2.86)***	(1.69)*	(2.96)***
Leverage	-0.8416	-0.4774	-0.8576	-0.4786	-0.8455	-0.4800	-0.8484	-0.4836
	(21.35)***	(12.10)***	(21.83)***	(12.11)***	(21.43)***	(12.15)***	(21.57)***	(12.27)***

TABLE 14 (continued)

Abnormal earnings	0.1241	0.1072	0.0251	0.1075	0.1247	0.1065	0.1262	0.1084
	(5.24)***	(4.52)***	(5.74)***	(4.53)***	(5.26)***	(4.48)***	(5.34)***	(4.57)***
Asset maturity	-0.0015	-0.0019	-0.0016	-0.0019	-0.0014	-0.0019	-0.0012	-0.0017
	(2.03)**	(2.63)***	(2.24)**	(2.60)***	(1.92)*	(2.56)**	(1.66)*	(2.31)**
Asset return volatility	0.0386	0.1223	0.0335	0.1134	0.0107	0.1060	0.0103	0.1047
	(0.34)	(1.09)	(0.30)	(1.00)	(0.09)	(0.94)	(0.09)	(0.93)
Rating dummy	-0.1516	-0.1370	-0.1483	-0.1365	-0.1497	-0.1355	-0.1503	-0.1367
	(13.19)***	(11.91)***	(12.99)***	(11.83)***	(12.99)***	(11.74)***	(13.10)***	(11.89)***
Term structure	0.0048	0.0111	0.0042	0.0112	0.0049	0.0113	0.0055	0.0116
	(0.37)	(0.85)	(0.32)	(0.85)	(0.38)	(0.87)	(0.42)	(0.89)
Constant	1.6369	1.3464	1.4490	1.3511	1.6436	1.3083	1.6825	1.3593
	(18.65)***	(15.32)***	(19.51)***	(15.32)***	(18.24)***	(14.50)***	(18.57)***	(14.97)***
Observations	6228	6228	6228	6228	6228	6228	6228	6228
R-squared	0.25	0.15	0.25	0.15	0.25	0.15	0.25	0.16

As expected, HHI has positive and statistically significant coefficient in both ST3 and ST5 maturity regressions across all four models, implying that short-term maturity is statistically increasing in industry concentration. Consistently, Erhemjamts, Raman and Shahrur (2010) document a positive coefficient on HHI in short-term maturity regressions. Recall that the univariate analysis above also finds that firms in the highest HHI quintile (highly concentrated industry) use more short-term maturity than their counterparts in the lowest HHI quintile (less concentrated industry). Collectively, we find that firms in less competitive industries (high industry concentration) use more short-term maturity than those in more competitive industries (low industry concentration). This result is consistent with the agency effect hypothesis. We will explain the interaction between HHI and G-index below.

The effect of corporate governance on debt maturity is examined in Models 2-4. The result of Model 2 shows that the estimated coefficient on G-index is negative for both ST3 and ST5 regressions, but it is statistically significant at 5% level for ST3 only. However, the result of Model 3 shows conflicting signs and insignificance on G-index' coefficient. While not significant at 5% level, the coefficient on G-index is negative in ST3 regression, but is positive in ST5 regression. Therefore, we find weak evidence to support our hypothesis on a negative association between G-index and short-term maturity. As expected, the interaction term between HHI and G-index in Model 3 has negative coefficient for both ST3 and ST5, but is statistically significant for ST5 only. Thus, there is evidence that weak corporate governance firms operating in less competitive industry (high industry concentration) use less short-term maturity as our expectation. To further analyze the effect of corporate governance on debt maturity, we break out the raw G-index into three terciles as in Gompers, Ishii and Metrick (2003) and use their dummies and interaction terms with HHI as explanatory variables.

The last two columns of Table 14 show that the estimated coefficient on high G-index dummy is significantly negative, while the dummy of medium G-index has negative and insignificant coefficient. By and large, these results provide empirical evidence that firms in upper G-index terciles (poor corporate governance) tend to use less short-term maturity, compared with those in low G-index tercile. Interestingly, signs of the coefficients on the interaction between HHI and G-index tercile dummies are mixed. In particular, the coefficient on the interaction between HHI and medium G-index dummy is insignificantly negative, while that on the interaction between HHI and high G-index dummy is statistically positive. This result means that, in less competitive industries, firms in high G-index tercile (weak corporate governance) use more short-term maturity than those in low G-index tercile. This result does not support our hypothesis.

Overall, the sign and significance of the estimated coefficients on other control variables in both ST3 and ST5 regressions are consistent with previous literature. Consistent with previous studies by Johnson (2003) and Brockman, Martin and Unlu (2010), among others, the coefficient on firm size is statistically negative, while that of firm size squared is statistically positive in Models 1-4. Collectively, our results support Diamond's (1991) prediction on the non-linear relation between firm quality and debt maturity. Except for ST3 regressions in Models 1&3, variable market to book has negative and significant coefficient across all models, which does not support Myers' (1977) prediction. Our finding is consistent with empirical evidence documented in

Johnson (2003) and Billett, King and Mauer (2007), meanwhile not consistent with others. For instance, Barclay and Smith (1995), Barclay, Max and Smith (2003), and Datta, Iskandar-Datta and Raman (2005) find that long-term debt decreases in market to book, which is consistent with Myers (1977). We find a negative association between leverage and two proxies for short-term maturity across Models 1-4, which is consistent with well-documented evidence in capital structure literature. Furthermore, our result supports signaling theories on debt maturity.

Like Johnson (2003) and Billett, King and Mauer (2007), we find that the coefficient on variable abnormal earnings is statistically positive in all models, indicating that good firms can signal their high quality to financial markets through refinancing their debt more frequently. Consistent with Myers' (1977) argument and empirical evidence in Johnson (2003) and Brockman, Martin and Unlu (2010), we find that two measures of short-term maturity are negatively associated with asset maturity. Not as expected, the coefficient on asset return volatility is positive, but not significant at 5% level in all models. Johnson (2003), for example, finds that short-term maturity is increasing in asset return volatility. Consistent with the literature, we find that the coefficient on ratings dummy is statistically negative, implying that rated firms are likely to borrow less short-term debt or equivalently more long-term debt than unrated firms. Finally, variable term structure has positive, but not significant coefficient at 5% level, which does not support theoretical prediction on the negative association between term structure and short-term maturity.

2.4.2.3 The Effect of Being Dominant Firms

The above analysis finds strong evidence in support of the agency effect hypothesis about a positive relation between industry concentration and short-term maturity, which not consistent with Kanatas and Qi's prediction (2001). However, predatory attacks often occur in highly concentrated industries such as oligopoly markets, implying that the predation effect might exist at higher level of industry concentration. In this section, we test if predation effect exists by analyzing if the positive relation between HHI and short-term maturity is different between dominant and non-dominant firms. Our approach is similar to Grullon and Michaely (2007). Following them, we define the dominant firm as the one with the largest market equity value in year *t* within a specific 4-digit SIC industry. In our regression, dominant is a dummy variable which takes one if a firm is the dominant firm and zero otherwise.

We argue that dominant firms have sufficient resources to avoid predatory attacks and they might trigger a predation. Therefore, the positive relation between HHI and short-term maturity should be stronger among dominant firms, and equivalently weaker among non-dominant firms. We test this prediction by including an interaction term between HHI and the dominant dummy. A significant coefficient on this interaction term indicates that the predation effect exists and vice versa. We also examine whether the effect of corporate governance on debt maturity is different between dominant and non-dominant firms. We do this analysis by including an interaction term between G-index and the dominant dummy. Furthermore, an interaction term between HHI, G-index and dominant dummy is included in our regressions. The results are provided in Table 15.

TABLE 15: The effect of being dominant firms on the relation between product market competition, corporate governance and short-term maturity

This table presents the testing results of the hypothesis about whether the agency effect or the predatory effect significantly explains the relation between product market competition, corporate governance and short term maturity. As in Grullon and Michaely (2007), a dominant firm is defined as the firm with the largest market value of equity (calculated as the stock price multiplied by the number of outstanding common stock) at year t in a specific 4-digit SIC industry. Dominant is a dummy variable taking 1 if a firm is dominant, otherwise zero. Rating dummy takes the value one for rated firms and zero for nonrated firms. Term structure is the spread between the yield on 10-year government bonds and the yield on one-year government bonds at the fiscal year end. Yield data comes from the FRED at the Federal Reserve Bank of St. Louis. Other variables are defined as in Table 11. All regressions include 2-digit SIC dummies and year dummies. t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	Model 1		Model 2		Model 3	
	ST3	ST5	ST3	ST5	ST3	ST5
	(1)	(2)	(3)	(4)	(5)	(6)
HHI	0.5468	0.3650	0.5460	0.3642	0.5456	0.3629
	(5.73)***	(3.82)***	(5.72)***	(3.81)***	(5.71)***	(3.80)***
G-index	-0.0033	-0.0012	-0.0036	-0.0015	-0.0036	-0.0015
	(2.00)**	(0.72)	(2.02)**	(0.86)	(2.00)**	(0.81)
HHI x Dominant	-0.1386	0.0292	-0.1323	0.0358	0.2051	1.0956
	(0.81)	(0.17)	(0.78)	(0.21)	(0.29)	(1.53)
G-index x Dominant			0.0020	0.0021	0.0040	0.0085
			(0.48)	(0.49)	(0.68)	(1.43)
HHI x G-index x Dominant					-0.0364	-0.1143
					(0.49)	(1.52)
Dominant	0.0153	0.0238	-0.0045	0.0032	-0.0238	-0.0574
	(0.90)	(1.39)	(0.10)	(0.07)	(0.40)	(0.96)
Firm size	-0.2180	-0.1293	-0.2174	-0.1286	-0.2174	-0.1286
	(10.72)***	(6.35)***	(10.66)***	(6.30)***	(10.66)***	(6.30)***
Firm size squared	0.0126	0.0069	0.0126	0.0069	0.0126	0.0069
	(10.15)***	(5.53)***	(10.10)***	(5.49)***	(10.10)***	(5.49)***
Market to book	-0.0059	-0.0103	-0.0059	-0.0103	-0.0059	-0.0103
	(1.59)	(2.75)***	(1.59)	(2.75)***	(1.59)	(2.76)***

TABLE 15 (continued)

Leverage	-0.8433	-0.4719	-0.8432	-0.4718	-0.8440	-0.4742
	(21.31)***	(11.91)***	(21.31)***	(11.91)***	(21.31)***	(11.96)***
Abnormal earnings	0.1247	0.1080	0.1249	0.1082	0.1248	0.1080
	(5.26)***	(4.55)***	(5.27)***	(4.56)***	(5.26)***	(4.55)***
Asset maturity	-0.0014	-0.0018	-0.0014	-0.0018	-0.0014	-0.0018
	(1.92)*	(2.52)**	(1.90)*	(2.51)**	(1.89)*	(2.46)**
Asset return volatility	0.0101	0.1190	0.0091	0.1179	0.0070	0.1114
	(0.09)	(1.05)	(0.08)	(1.04)	(0.06)	(0.99)
Rating dummy	-0.1499	-0.1358	-0.1500	-0.1360	-0.1502	-0.1366
	(13.00)***	(11.77)***	(13.01)***	(11.78)***	(13.02)***	(11.83)***
Term structure	0.0048	0.0112	0.0049	0.0112	0.0049	0.0112
	(0.37)	(0.86)	(0.37)	(0.86)	(0.37)	(0.86)
Constant	1.6512	1.3446	1.6513	1.3447	1.6513	1.3447
	(18.74)***	(15.24)***	(18.74)***	(15.24)***	(18.74)***	(15.24)***
Observations	6228	6228	6228	6228	6228	6228
R-squared	0.25	0.15	0.25	0.15	0.25	0.15

Overall, the sign and significance of other control variables' coefficient are with the same as in Table 14. It is not worth discussing their estimated results here. Instead, we focus on interpreting the results of the variables in our interests. Table 15 shows that short-term maturity significantly increases in industry concentration but decreases in G-index, which is consistent with the base results. More specifically, the coefficient on HHI is significantly positive across three models for both ST3 and ST5 regressions. G-index has negative and statistically significant coefficient in the ST3 regression. However, the result in ST5 regression is weaker.

The coefficient on the interaction between HHI and the dominant dummy has mixed signs and is not statistically significant, indicating that there is no existence of the predation effect. Thus, the positive relation between industry concentration and short-term maturity is mainly driven by the agency effect, even in high level of industry concentration. In addition, the estimated results of Models 2-3 show that the interaction between G-index and dominant dummy has positive coefficient, but not statistically significant. Thus, being dominant firms has no impact on the relation between corporate governance and short-term maturity. Furthermore, the coefficient on the interaction between HHI, G-index and dummy variable dominant is negative, but not significant. Not as expected, the coefficient on the dummy for dominant has mixed signs and is not statistically significant at 5% level for all three models. This means there is no evidence that dominant firms use more short-term maturity than the non-dominant firms.

2.4.2.4 The Effect of Types of Competition

This section examines if types of competition have any effects on the relation between product market competition, corporate governance, and short-term maturity.

Following Lyandres (2006), we use competitive strategy measure (CSM) as a proxy for types of competition. CSM is simply the correlation between the ratio of the implied change in the firm's profit ($\Delta\tilde{\pi}_i$)to the implied change in its sales ($\Delta\tilde{S}_i$) over two consecutive years and the change in the rival's combined sales (ΔS_R) between two years, as defined in the following formula:

$$CSM = corr\left[\frac{\Delta\tilde{\pi}_i}{\Delta\tilde{S}_i}, \Delta S_R\right]$$

The implied changes in sales and profits of each firm are estimated using Lyandres' approach (2006). For the sake of brevity, we do not discuss her approach here. We use earnings before interest and tax (EBIT) as a proxy for profit and require at least 10 observations available to estimate CSM. Given the estimates of implied changes in sales and profit for each firm, for each year-industry, we calculate the correlation defined in the above formula for each firm, then calculate the average CSM for each 4-digit industry and assign this CSM to all firms in that industry. By definition, a negative and positive CSM indicates that firms compete in strategic substitutes and complements, respectively. According to Bulow, Geanakoplos and Klemperer (1985), firms compete in strategic substitutes (complements) if a more aggressive strategy by a firm lowers (raises) its rivals' profits.

We classify the main sample with valid CSM data into two subsamples of negative and positive CSM. As mentioned above, we discard any firms with less than 10 observations available when estimating CSM. As a result, the sample size reduces from 6,228 to 6,089 observations. For each subsample, we re-estimate Models 2 and 4 in the base analysis section (Table 14), using the same dependent and explanatory variables. As previously, we also control for time and fixed industry effects. The results are tabulated in Table 16. Again, we will focus on the estimated results of the interest variables rather than other control variables. In general, the sign and significance of their coefficients on other control variables are consistent with Table 14.

The estimated results for Model 1 are reported in columns 1-4. As expected, the coefficient on HHI is significantly positive in ST3 and ST5 maturity regressions for both negative and positive CSM samples, which implies that firms in less competitive industries (high concentration) use more short-term maturity, regardless of whether firms are competing in strategic substitutes or complements. This result confirms the general result in the base analysis and provides more insights that types of competition do not matter the relation between competition in the output markets and debt maturity. Our result extends the finding by Erhemjamts, Raman and Shahrur (2010) stating that the positive association between industry concentration and short-term debt maturity only exists if firms compete in strategic complements.

As shown in columns 1-4 of Table 16, the variable G-index has negative coefficient for both ST3 and ST5 regressions, however its coefficient is statistically significant for the subsample of negative CSM only. While consistent with the base result on the negative relation between G-index and short-term maturity, this result provides new evidence that this relation depends on types of competition. More specifically, we find new evidence that weak corporate governance firms tend to use less short-term debt when they are competing in a way of strategic substitutes in the product markets.

TABLE 16: The effect of types of competition on the relation between product market competition, corporate governance and short-term maturity

This table reports the regression results of short-term maturity on product market competition and corporate governance by the subsamples of the types of competition. Following Lylandres (2006), we use the competitive strategy measure (CSM) as a proxy for competition type. CSM is calculated on the basis of 4-digit SIC industry. A negative (positive) CSM indicates the competitions among firms are strategic substitutes (complements). The variables medium G-index and high G-index take a value of one if G-index is from 6 to 13 and G-index is 14 or higher respectively, and zero otherwise. The low G-index (i.e., G-index <=5) is the reference group. In Model 2, the interaction between HHI and low G-index is omitted to avoid multicollinearity issues. Rating dummy takes the value one for rated firms and zero for nonrated firms. Term structure is the spread between the yield on 10-year government bonds and the yield on one-year government bonds at the fiscal year end. Yield data comes from the FRED at the Federal Reserve Bank of St. Louis. All regressions include 2-digit SIC dummies and year dummies. t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

	Model 1				Model 2			
	ST3		ST5		ST3		ST5	
	Neg. CSM (1)	Pos. CSM (2)	Neg. CSM (3)	Pos. CSM (4)	Neg. CSM (5)	Pos. CSM (6)	Neg. CSM (7)	Pos. CSM (8)
HHI	0.5606	0.3814	0.3438	0.3374	0.4952	0.4568	0.5079	0.6496
	(4.65)***	(3.07)***	(2.84)***	(2.69)***	(1.46)	(0.98)	(1.49)	(1.38)
G-index	-0.0053	-0.0010	-0.0040	0.0010				
	(2.28)**	(0.42)	(1.72)*	(0.42)				
Medium G-index					-0.0803	-0.0207	-0.0126	-0.0104
					(2.44)**	(0.52)	(0.38)	(0.26)
High G-index					-0.2312	-0.0453	-0.1700	-0.0381
					(3.97)***	(0.75)	(2.90)***	(0.62)
HHI x Medium G-index					-0.0564	-0.0745	-0.2809	-0.3214
					(0.16)	(0.16)	(0.81)	(0.67)
HHI x High G-index					2.5929	0.5738	1.9541	1.1354
					(4.46)***	(0.60)	(3.34)***	(1.18)
Firm size	-0.2531	-0.1796	-0.1363	-0.1009	-0.2669	-0.1810	-0.1463	-0.1041
	(8.03)***	(6.08)***	(4.31)***	(3.39)***	(8.54)***	(6.12)***	(4.65)***	(3.49)***
Firm size squared	0.0151	0.0101	0.0079	0.0053	0.0159	0.0103	0.0084	0.0055
	(7.90)***	(5.66)***	(4.10)***	(2.91)***	(8.37)***	(5.72)***	(4.41)***	(3.07)***

TABLE 16 (continued)

Market to book	0.0067	-0.0123	-0.0031	-0.0133	0.0075	-0.0127	-0.0026	-0.0141
	(1.05)	(2.37)**	(0.49)	(2.54)**	(1.19)	(2.45)**	(0.42)	(2.69)***
Leverage	-0.7897	-0.9283	-0.4934	-0.4607	-0.7860	-0.9284	-0.4909	-0.4662
	(13.73)***	(16.03)***	(8.55)***	(7.88)***	(13.77)***	(16.02)***	(8.54)***	(7.98)***
Abnormal earnings	0.1471	0.1211	0.1128	0.1046	0.1456	0.1222	0.1112	0.1063
	(4.27)***	(3.49)***	(3.26)***	(2.99)***	(4.25)***	(3.52)***	(3.22)***	(3.04)***
Asset maturity	-0.0008	-0.0015	-0.0014	-0.0026	-0.0004	-0.0014	-0.0011	-0.0022
	(0.82)	(1.30)	(1.43)	(2.15)**	(0.39)	(1.21)	(1.14)	(1.88)*
Asset return volatility	0.1176	-0.1332	0.0188	0.0576	0.1164	-0.1380	0.0338	0.0301
	(0.63)	(0.86)	(0.10)	(0.37)	(0.63)	(0.90)	(0.18)	(0.19)
Rating dummy	-0.1542	-0.1397	-0.1545	-0.1217	-0.1574	-0.1403	-0.1576	-0.1224
	(9.25)***	(8.33)***	(9.24)***	(7.19)***	(9.51)***	(8.36)***	(9.46)***	(7.24)***
Term structure	0.0220	-0.0072	0.0296	-0.0001	0.0230	-0.0071	0.0302	-0.0001
	(1.21)	(0.39)	(1.62)	(0.00)	(1.27)	(0.38)	(1.66)*	(0.01)
Constant	1.7985	1.4386	1.4109	1.1682	1.8897	1.4519	1.4377	1.1907
	(13.45)***	(11.16)***	(10.52)***	(8.98)***	(13.80)***	(10.94)***	(10.43)***	(8.89)***
Observations	2922	3167	2922	3167	2922	3167	2922	3167
R-squared	0.30	0.23	0.20	0.13	0.31	0.23	0.21	0.13

For Model 2, we estimate the regressions of two measures of short-term maturity on HHI, dummies of G-index terciles and interactions between HHI and the dummies as in Model 4 of Table 14. Similarly, the reference group is low G-index tercile. Columns 5-8 report the estimated results. The coefficient on HHI still has positive sign, but not statistically significant at 5% level, for both two subsamples. Thus, this result is statistically weaker than the above result and the base result. In general, the estimated results for G-index tercile dummies and their interactions with HHI are similar to those of Model 4 in Table 14. The dummies of medium and high G-index terciles all have negative coefficients, but their coefficients are statistically significant for the negative CSM sample only. Consistent with our finding in Table 14, this result suggests that firms with upper G-index terciles use less short-term maturity, compared with those in low G-index tercile. However, this relation holds for firms who compete in strategic substitutes. Consistent with Table 14, the coefficient on the interaction between HHI and medium G-index dummy is insignificantly negative for both two subsamples. In contrast, the interaction between HHI and high G-index dummy has positive and significant coefficient for the sample of negative CSM, indicating that, in less competitive industries, firms in high G-index tercile use more short-term maturity than firms in low G-index tercile. Again, this result does not support our hypothesis.

2.4.2.5 Robustness Check: Alternative Proxy for Competition

There is a concern about the possibilities of endogeneity between product market competition, corporate governance, and debt maturity. To address this concern, following Fresard (2010), we use the U.S import tariff changes as an alternative proxy for product market competition. Theoretically, changes in the import tariffs are exogenous shocks to product market competition, thus making the competition harder or softer. Other thing equals, when the import tariff rates are cut or import quotas are lift, the supply of foreign products tends to increase in the domestic economy. As consequences, the demand-supply law suggests that competitions among domestic firms will be harder.

We define that, for a given year, a specific industry experiences a reduction in the import tariff when a negative change in the import tariff rate is 2, 2.5, or 3 times larger than the average change of the import tariff in that industry. The first and last cut-off provides the least strict and the strictest measure of the import tariff cut, respectively. We use the dummy variables tariff cut 2, 2.5 and 3 x mean (ΔT) to indicate a year-industry with a reduction in the import tariff rates. Due to the limitation of data on the import tariff rates, the sample used in this analysis includes 3,973 firm-year observations in the period 1990-2005

We re-estimate Models 3 and 4 in Table 13 using the dummies of the tariff cut instead of HHI. The estimated results are provided in Table 17. Panel A of Table 17 reports the regression results of ST3 and ST5 on the tariff cut dummies, G-index, and their interaction terms. As expected, all three measures of the import tariff cut (tariff cut 2, 2.5, and 3) have negative and significant coefficients, suggesting that firms in the industries with experience of reductions in the import tariff rate use less short-term maturity. In other words, there is evidence that firms facing with higher competition resulted from reductions in the import tariff rate prefer short-term debt. Equivalently, this result is consistent with the above finding that firms in highly concentrated industries (less competition) use more short-term maturity. In addition, the coefficient on G-index is significantly negative across Panel A, which is consistent with the above finding on the negative relation between G-index and short-term maturity. Interestingly, the interaction terms between tariff cut dummies and G-index have positive and significant coefficient, which implies that weak governance firms in the industries with the import tariff reductions tend to use more short-term maturity. Unfortunately, this finding is not consistent with that of the analysis using HHI as a proxy for product market competition. Overall, the sign and significance of other control variables are consistent with Table 14.

The results of ST3 and ST5 regressions on the dummies of the tariff cuts, G-index terciles and their interactions are presented in Panel B of Table 17. Except for one case, the estimated coefficients on the import tariff cut dummies are significantly negative, which is consistent with the result in Panel A. In regard of the G-index terciles, we find that the dummy variable medium G-index has negative and significant coefficient. Meanwhile, the coefficient on variable high G-index is also negative, but its significance is weak. In general, these results imply that, compared with firms in low G-index tercile (democracy firms), there is evidence that firms in the upper G-index terciles (dictatorship firms) use less short-term maturity. This is consistent with the above result about the negative relation between G-index and short-term maturity. Across Panel B, all interaction terms between three measures of import tariff cut and medium and high G-index terciles have positive and significant coefficients. This implies that, within industries with experience of reductions in the import tariff rates, firms in the upper G-index terciles (weak governance) use less short-term maturity than firms in low G-index tercile (good governance).

TABLE 17: Robustness check using import tariff change as a quasi-natural experiment of product market competition

This table provides a robustness check on the relation between product market competition, corporate governance and short-term maturity. Panels A and B re-estimate Model 3 and Model 4 in Table 11, respectively. Following Fresard (2010), we use import tariff change as a quasi-natural experiment of product market competition. Fresard (2010) argues that tariff reductions indicate higher competition levels in domestic industries. Tariff cut 2, 2.5 and 3 x mean (ΔT) are indicator variables equal one if a negative change in the import tariff rate is 2, 2.5 or 3 times larger than its mean change respectively, and zero otherwise. The variables medium G-index and high G-index take a value of one if G-index is from 6 to 13 and G-index is 14 or higher respectively, and zero otherwise. The low G-index (i.e., G-index <=5) is the reference group. In Panel B, the interaction between tariff cut and low G-index is omitted to avoid multicollinearity issues. Other variables are defined as in Table 11. All regressions include 2-digit SIC dummies and year dummies. t-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Panel A: Regressions of short-term maturity on import tariff cut, G-index, and their interactions

	ST3			ST5		
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff cut 2 x mean (ΔT)	-0.1650			-0.1761		
	(3.67)***			(3.94)***		
Tariff cut 2.5 x mean (ΔT)		-0.1377			-0.1637	
		(2.84)***			(3.40)***	
Tariff cut 3 x mean (ΔT)			-0.1408			-0.1387
			(2.66)***			(2.63)***
G-index	-0.0071	-0.0061	-0.0056	-0.0054	-0.0047	-0.0038
	(3.16)***	(2.81)***	(2.59)***	(2.44)**	(2.16)**	(1.79)*
Tariff cut 2 x mean (ΔT) x G-index	0.0184			0.0180		
	(4.05)***			(3.97)***		
Tariff cut 2.5 x mean (ΔT) x G-index		0.0170			0.0176	
		(3.47)***			(3.60)***	
Tariff cut 3 x mean (ΔT) x G-index			0.0170			0.0154
			(3.19)***			(2.92)***
Firm size	-0.2190	-0.2186	-0.2188	-0.1235	-0.1234	-0.1232
	(9.00)***	(8.98)***	(8.99)***	(5.11)***	(5.10)***	(5.09)***
Firm size squared	0.0135	0.0134	0.0135	0.0075	0.0075	0.0075
	(9.00)***	(8.98)***	(8.99)***	(5.05)***	(5.04)***	(5.03)***

TABLE 17 (continued)

Market to book	-0.0053	-0.0053	-0.0052	-0.0103	-0.0103	-0.0102
	(1.22)	(1.22)	(1.19)	(2.37)**	(2.39)**	(2.36)**
Leverage	-0.7633	-0.7649	-0.7635	-0.4041	-0.4059	-0.4046
	(14.86)***	(14.89)***	(14.86)***	(7.92)***	(7.95)***	(7.92)***
Abnormal earnings	0.1310	0.1331	0.1338	0.1084	0.1104	0.1113
	(4.14)***	(4.21)***	(4.23)***	(3.45)***	(3.51)***	(3.54)***
Asset maturity	-0.0017	-0.0017	-0.0017	-0.0032	-0.0032	-0.0032
	(1.67)*	(1.70)*	(1.69)*	(3.24)***	(3.26)***	(3.24)***
Asset return volatility	0.0181	0.0236	0.0237	0.0887	0.0958	0.0979
	(0.14)	(0.18)	(0.18)	(0.68)	(0.74)	(0.75)
Rating dummy	-0.1630	-0.1635	-0.1638	-0.1576	-0.1581	-0.1584
	(11.59)***	(11.62)***	(11.64)***	(11.28)***	(11.30)***	(11.32)***
Term structure	0.0054	0.0054	0.0053	0.0066	0.0067	0.0064
	(0.35)	(0.34)	(0.34)	(0.42)	(0.43)	(0.41)
Constant	1.6023	1.5898	1.5857	1.2570	1.2475	1.2365
	(14.98)***	(14.88)***	(14.86)***	(11.83)***	(11.75)***	(11.65)***
Observations	3973	3973	3973	3973	3973	3973
R-squared	0.23	0.23	0.23	0.15	0.15	0.15

Panel B: Regressions of short-term maturity on import tariff cut, G-index terciles, and their interactions

	ST3			ST5		
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff cut 2 x mean (ΔT)	-0.1062			-0.1274		
	(2.69)***			(3.25)***		
Tariff cut 2.5 x mean (ΔT)		-0.0660			-0.1047	
		(1.53)			(2.44)**	
Tariff cut 3 x mean (ΔT)			-0.0797			-0.0971
			(1.66)*			(2.04)**
Medium G-index	-0.0685	-0.0585	-0.0567	-0.0538	-0.0459	-0.0417
	(3.64)***	(3.19)***	(3.15)***	(2.88)***	(2.51)**	(2.33)**
High G-index	-0.0621	-0.0556	-0.0507	-0.0345	-0.0248	-0.0171
	(1.91)*	(1.76)*	(1.63)	(1.07)	(0.79)	(0.55)

TABLE 17 (continued)

Tariff cut 2 x mean (ΔT) x Medium G-index	0.1170			0.1253		
	(2.83)***			(3.05)***		
Tariff cut 2 x mean (ΔT) x High G-index	0.2199			0.2116		
	(3.48)***			(3.37)***		
Tariff cut 2.5 x mean (ΔT) x Medium G-index		0.0855			0.1093	
		(1.88)*			(2.42)**	
Tariff cut 2.5 x mean (ΔT) x High G-index		0.2255			0.2052	
		(3.33)***			(3.05)***	
Tariff cut 3 x mean (ΔT) x Medium G-index			0.0960			0.1067
			(1.91)*			(2.13)**
Tariff cut 3 x mean (ΔT) x High G-index			0.2407			0.1981
			(3.31)***			(2.74)***
Firm size	-0.2246	-0.2240	-0.2246	-0.1283	-0.1276	-0.1283
	(9.23)***	(9.21)***	(9.23)***	(5.30)***	(5.27)***	(5.30)***
Firm size squared	0.0138	0.0137	0.0138	0.0078	0.0077	0.0078
	(9.20)***	(9.18)***	(9.20)***	(5.23)***	(5.20)***	(5.22)***
Market to book	-0.0053	-0.0053	-0.0053	-0.0103	-0.0104	-0.0103
	(1.23)	(1.22)	(1.23)	(2.39)**	(2.40)**	(2.39)**
Leverage	-0.7614	-0.7671	-0.7672	-0.4033	-0.4079	-0.4084
	(14.83)***	(14.94)***	(14.95)***	(7.90)***	(7.99)***	(8.00)***
Abnormal earnings	0.1335	0.1355	0.1351	0.1104	0.1123	0.1119
	(4.22)***	(4.29)***	(4.27)***	(3.52)***	(3.57)***	(3.56)***
Asset maturity	-0.0016	-0.0017	-0.0017	-0.0032	-0.0032	-0.0032
	(1.67)*	(1.69)*	(1.70)*	(3.23)***	(3.24)***	(3.23)***
Asset return volatility	0.0341	0.0321	0.0277	0.1007	0.1037	0.1004
	(0.26)	(0.25)	(0.21)	(0.78)	(0.80)	(0.78)
Rating dummy	-0.1635	-0.1641	-0.1639	-0.1583	-0.1588	-0.1587
	(11.66)***	(11.69)***	(11.68)***	(11.35)***	(11.38)***	(11.37)***
Term structure	0.0069	0.0068	0.0066	0.0078	0.0076	0.0072
	(0.44)	(0.43)	(0.42)	(0.50)	(0.48)	(0.46)
Constant	1.6169	1.6072	1.6100	1.2685	1.2588	1.2575
	(15.04)***	(14.96)***	(14.98)***	(11.87)***	(11.79)***	(11.77)***
Observations	3973	3973	3973	3973	3973	3973
R-squared	0.23	0.23	0.23	0.15	0.15	0.15

2.5 Conclusion

This empirical study examines the effects of product market competition and corporate governance on firms' debt maturity structure. As in the literature, we use the Herfindahl-Hirschman Index as a proxy for product market competition and governance index (G-index) as a proxy for corporate governance. Previous studies often look at the effect of either product market competition or corporate governance on debt maturity separately. Differently, we examine the effect of these two disciplinary mechanisms on debt maturity within one analysis framework, based on the idea that these two mechanisms are substitutes (see, for example Allen and Gale (1999)).

Consistent with the literature, we find that firms in less competitive industries (high industry concentration) are more likely to use more short-term maturity than firms in more competitive industries (low industry concentration). Additionally, we provide evidence that this relation is mainly driven by the agency effect rather than the predation effect. About the relation between corporate governance and debt maturity, we find that firms with weak corporate governance (high G-index) use less short-term maturity, compared with firms with high corporate governance (low G-index). This result supports the entrenchment argument stating that entrenched managers tend to use less short-term maturity (Benmelech (2006)) and is consistent with empirical evidence in Benmelech (2006) and Jiraporn and Kitsabunnarat (2007). However, we find mixed evidence about the combined effect of product market competition and corporate governance on debt maturity, indicating that their effect on debt maturity is complicated. Furthermore, we find new empirical evidence that types of competition does not matter the relation between product market competition and debt maturity, but matter the relation between corporate governance and debt maturity.

Finally, we realize that endogeneity issue is common in corporate finance. Following Fresard (2010), we use change in the U.S import tariff rates as a quasi-natural experiment of competitive environment in the output markets in an attempt to deal with the possibilities of endogeneity issues among product market competition, corporate governance, and debt maturity. Using this alternative proxy for competition could deal with the endogeneity between product market competition and debt maturity, and between product market competition and corporate governance. However, we could not control for the potential endogeneity between corporate governance and debt maturity. This is a limitation of this study.

CHAPTER 3: INSIDE DEBT COMPENSATION AND CORPORATE POLICIES

3.1 Introduction

Inside debt or debt-like compensation is defined as pensions and deferred compensation. These terms are used interchangeably in the literature. Different from other forms of traditional compensation, the payoff of inside debt is positive in bankruptcy and proportional to the firm's liquidation value (Edmans and Liu, 2011). Therefore, inside debt is unsecured debt and has payoff similar to that of debt. Because of this debt-like characteristic, executives with inside debt holdings have the same claims against their firms as debtholders when the firms go bankcrupt. This implies that inside debt induces executives to behave like debtholders.

Jensen and Meckling (1976) argue about the important role of debt-like compensation in addressing the asset substitution (risk shifting) problem. However, this research area has been ignored due to the unavailability of data and the lack of theoretical foundations as well. Sundaram and Yermack (2007) trigger this line of research and find that pensions can reduce overall firm risks. Edmans and Liu (2011) first theoretically show that inside debt is an effective alternative compensation mechanism to mitigate the agency costs associated with the shareholder-bondholder conflict. The availability of data on pensions and deferred compensation as a result of a new disclosure regulation by SEC (effective in spring 2007) also facilitates further research in this area.

In line with recent studies on the effect of inside debt on the firm's policy choices (Cassell, Huang, Sanchez and Stuart, 2012; Liu, Mauer and Zhang, 2012; Peng, 2012;

and White, 2012), we examine how inside debt affects the firm's financial and investment policies. In particular, using ExecuComp data on pensions and deferred compensation from 2006 to 2011, we examine the effect of inside debt on three important policy decisions: firm leverage, debt maturity structure, and investment policies (R&D and capital expenditure). To address the concern of the common issue of endogeneity in corporate finance, we use simultaneous equations systems, which model inside debt and a specific policy as endogenous variables. We estimate the systems by two-stage least squares (2SLS) approach. We also provide 3SLS estimated results as robustness checks.

In general, we find that inside debt and firm leverage have a positive relationship. The result also holds for its components (i.e., pensions and deferred compensation). This result supports the prediction of Edmans and Liu (2011), but is not consistent with evidence provided in Cassell, Huang, Sanchez and Stuart (2012). Their OLS regression result shows that firm leverage is significantly decreasing in inside debt. These conflicting findings indicate the complicated relation between inside debt and debt policy as argued by Cen (2007). In a study examining determinants of inside debt, Cen (2007) finds that inside debt is first increasing in firm leverage, then decreasing later on, which implies a non-linear relationship between inside debt and firm leverage.

Interestingly, we find the first empirical evidence that, in one direction, inside debt and its components positively affect short-term maturity, which would imply that CEOs with high inside debt holdings are likely to borrow more short-term debt. This result is not consistent with the theoretical prediction that the risk-decreasing incentive induced by inside debt makes CEOs prefer less short-term maturity to avoid the risks of rolling over debt more frequently. However, the result can be explained in the sense that the CEOs, like debtholders, would find monitoring role of short-term debt more efficient in preserving the firm value. In other direction, we find that higher short-term maturity leads to lower inside debt compensation. Collectively, our results show no evidence on the two-way positive relationship between inside debt and short-term debt maturity, as expected.

Consistent with the prediction of Edmans and Liu (2011) and empirical evidence provided in the literature (for example, Sundaram and Yermack, 2007; and Cassell, Huang, Sanchez and Stuart, 2012), we find that CEOs with inside debt holdings have conservative investment policies. More specifically, we find a negative relationship between inside debt and high risk investment (R&D), which indicates that CEOs with inside debt holdings tend to invest less in R&D activities. This finding is consistent with empirical evidence in Cassell, Huang, Sanchez and Stuart (2012). However, we find weak evidence about the negative relationship between inside debt and capital expenditures, implying that there is a little evidence that CEOs with inside debt would spend less for low-risk investments. Our further analysis shows that the negative relationship between inside debt and R&D is mainly driven by pensions, while the relationship between inside debt and capital expenditures are driven by both pensions and deferred compensation.

We also confirm the existing evidence documented in the literature that variables such as firm age and size, leverage, market to book, tenure, and CEO age are important determinants of inside debt. Additionally, we find that equity-based incentives and other form of compensation such as cash and bonus compensation are also important factors determining inside debt. To be specific, we find that inside debt is significantly increasing in vega and cash compensation, whereas is decreasing in short-term maturity and delta. This evidence is new in the literature.

This study contributes to the literature on inside debt by providing further evidence of how inside debt significantly affects the firm's policy choices. Our result on the positive relationship between inside debt and firm leverage is in favor of the theoretical prediction of Edmans and Liu (2011), but is inconsistent with empirical evidence in the literature (Cassell, Huang, Sanchez and Stuart , 2012). This inconsistence indicates a puzzle of the impact of inside debt on the firm's debt policy. We also extend the literature by showing the complicated relationship between inside debt and debt maturity. In particular, we first document that, in one direction, short-term maturity increases in inside debt. However, in other direction, inside debt decreases in short-term maturity. As a further contribution, we find that inside debt might negatively affect not only high risk investment (R&D), but also low risk investment (CAPEX). This would suggest that, differing from equity-based incentives, inside debt might not lead to a reallocation of capital between R&D activities and capital expenditures. In addition, we provide new evidence that cash and bonus compensation, as well as incentives from stock and options compensation play an important role in determining inside debt compensation.

It is important to note that Cassell, Huang, Sanchez and Stuart (2012) also look at the effect of inside debt on firm leverage and investment policy (only R&D). However, they do not control for the possibility of endogeneity between inside debt and firm leverage. They also use the relative debt-to-equity ratio, defined as CEO debt-to- equity ratio over the firm debt-to-equity ratio as the proxy of inside debt in their leverage regression. This would be problematic because firm debt appears on both sides of the regression model. Thus, their OLS results on the leverage regression would be biased. Differently, we use the CEO personal leverage as the proxy for inside debt and carefully control for the endogeneity issue by employing simultaneous equation systems in which inside debt and a policy measure are endogenous. Our study also differs from theirs in a way that we do analysis for not only inside debt but also its components. The result of Liu, Mauer and Zhang (2012) suggests that the effects of the components of inside debt on firm policies are not the same. Finally, we extend their analysis on investment policy by considering both high and low risk investment (R&D and capital expenditure).

The chapter proceeds as follows. In Section 3.2, we discuss the related literature and hypothesis development. Section 3.3 describes the construction of the data sample and provides descriptive statistics of firm and CEO characteristics. Section 3.4 reports empirical results and Section 3.5 concludes.

3.2 Literature Review and Hypotheses

Jensen and Meckling (1976) first mentioned that debt-like compensation (i.e, pensions and deferred compensation) might address the agency costs associated with the asset-substitution (risk-shifting) problem. They argue that executives should be compensated in a way that their personal debt-equity ratio is the same as the firm debt-equity ratio. Sundaram and Yermack (2007) find that pensions reduce the firm risk of default and also find a positive relation between pensions and firm leverage. Edmans and Liu (2011) first theriorically prove that, because inside debt compensation makes managers better align with creditors, it is efficient to mitigate the agency costs of debt associated with the shareholder-debtholder conflicts.

One line of research in the literature considers inside debt as the dependent variable to examine factors determining inside debt compensation. Previous studies such as Gerakos (2007), Sundaram and Yermack (2007), and Cen (2007) document that firm-variables (e.g., firm size, firm age, and leverage) and CEO characteristics (tenure and age) are important determinants of inside debt. Furthermore, a recent paper by Liu, Mauer and Zhang (2012) documents that governance structure significantly determines inside debt. They find that the coefficients for two proxies of governance structure (G-index and CEO-chair duality) are significantly positive in the inside debt regression, which suggests that the executives of firms with low quality governance should be paid relatively more inside debt. However, the literature has not yet documented any evidence if equity-based incentives and debt maturity structure can determine inside debt.

The other line of research uses inside debt as the independent variable to analyze its effect on the firms' behaviors. Wei and Yermack (2009) find that there is a wealth transfer from equity holders toward debt holders: bond prices rise while equity prices fall, and the prices of both securities are less volatile when information on CEO inside debt is first disclosed. This result implies that compensating the executives by inside debt may signal the financial markets about the less severity of the conflicts between shareholders and bondholders in the firms. Chen, Dou and Wang (2010) find that firms with higher CEO inside debt are offered lower interest rate for public debt and less strict covenants. In addition, White (2012) examines how pensions affect firm dividend policy and find that dividend yield, payout ratio and stock purchases are significantly lower when managers are paid higher pensions. Recently, there are two papers examining the effect of inside debt on cash holdings and mergers and acquisitions (M&A) activities. Liu, Mauer and Zhang (2012) find that CEOs with higher inside debt holdings have more cash holdings. This result is interesting because it shows how inside debt affects CEOs behaviors when they allocate limited capital between R&D and capital expenditure, for instance. Peng (2012) looks at the relation between mergers and acquisitions and inside debt and finds that CEOs with higher relative debt-like compensation tend to acquire less risky targets and are more likely to use debt financing to fund M&A activities.

In summary, the existing literature documents empirical evidence of the significant effects of inside debt on various corporate policies. However, there is still a gap of understandings on how inside debt compensation affects other corporate policies such as debt maturity. Sundaram and Yermack (2007) argue that inside debt can alter managerial incentives then, in turn, affects different policy decisions such as project selections, capital structure, maturity, dividend policy, and choice of new security issuance. In this study, we focus on examining how inside debt affects three important policies, namely debt policy, debt maturity structure and investment policies. To deal with the possibility of endogeneity between inside debt and a corporate policy, we use simultaneous equations systems in which inside debt and a particular corporate policy are endogenous. Model specifications and estimating approach are described in Section 3.4.

We develop the following hypotheses on the relation between inside debt and each of the three corporate policies: firm leverage, debt maturity structure, and investment policies (R&D and CAPEX).

3.2.1 Relation Between Inside Debt and Leverage

In one direction, we expect that inside debt compensation has a positive effect on firm leverage. This hypothesis is based on the results of several prior studies. Peng (2012) find that CEOs with higher inside debt are more likely to use debt financing to fund M&A activities. In addition, in an event study, Wei and Yermack (2009) document a wealth transfer from stockholders to bondholders when the information of inside debt compensation was revealed, which implies that inside debt provides signal the firms' quality to the debt markets. Chen, Dou and Wang (2010) find that firms who pay inside debt have lower cost of debt and less restrict covenants. Therefore, we can predict that firms would have more access to the debt markets as the markets observe the use of inside debt in firm compensation scheme. In the other direction, Edmans and Liu (2011) show that managers with inside debt are better aligned with creditors, which can mitigate the agency costs of debt. They predict that high leverage should lead to high inside debt compensation. The literature provides evidence consistent with this prediction (see Sundaram and Yermack, 2007; Cen, 2007; Liu et al., 2012). Thus, a positive effect of leverage on inside debt compensation is also expected.

3.2.2 Relation Between Inside Debt and Short-term Debt Maturity

As shown in Edmans and Liu (2011), inside debt compensation makes managers work like debtholders. Thus, we expect that managers with inside debt holdings will use more short-term debt to make them align more with debtholders. We name this incentive the alignment incentive. However, the risk-averse incentive caused by inside debt compensation could induce managers to use less short-term maturity to reduce the risks of refinancing more frequently. We posit that the alignment incentive outweighs the risk-averse incentive, suggesting a positive effect of inside debt on short-term maturity structure. In the other direction, firms with optimal short-term maturity structure would find it efficient to offer more inside debt compensation. Therefore, we expect a positive effect of short-term maturity on inside debt compensation.

3.2.3 Relation Between Inside Debt and Investment Policies

Edmans and Liu (2011) predict that managers with inside debt compensation are more risk-averse, thus have more conservative investment policies. To protect their wealth in the incident of bankrupt, managers with inside debt holdings might have incentives to take less risk when they make investment decisions. Coles, Daniel and Naveen (2006) argue that, in limited capital, risk-averse managers would reallocate investment dollars away from intangible assets such as R&D activities to tangible assets such as capital expenditures (CAPEX). Thus, we hypothesize that high inside debt leads to less investment in high risk R&D activities, but more investment in low risk capital expenditures (CAPEX). In other words, we expect a negative (positive) effect of inside debt on R&D (CAPEX). On the other direction, it is likely that firms with the optimal investment policies (low R&D, high capital expenditure) find it efficient to provide more inside debt compensation. Therefore, we expect that inside debt should decrease with R&D, but increase with CAPEX.

3.3 Data and Descriptive Statistics

3.3.1 Data

We obtain CEO compensation from the Standard and Poor's ExecuComp database from 2006 to 2011. We start from year 2006 because data on pensions and deferred compensation is only available from 2006, as a result of SEC's new disclosure regulations (FAS 123R). ExecuComp database covers firms in the S&P 500, S&P Midcap 400, S&P Smallcap 600 and other companies that were once part of the S&P

indexes, but are currently removed. The database provides comprehensive data on salary, bonus, pensions, deferred compensation, total compensation, equity-based compensations (stock awards and outstanding stock options), and personal data for the top-five executives of these firms. As in Chava and Purnanadam (2010), we identify CEOs based on the annual CEO title flag.

After identifying CEOs, we compile data on their wealth portfolios held at the fiscal year end. By definition, an executive's wealth portfolio consists of non-stock portfolio (cash salary and bonus, pensions, deferred compensation, and other compensations) and stock-based wealth portfolio (common stock, restricted stock awards, and stock options holdings). We follow Guay (1999) and Core and Guay (2001) to calculate the Black- Scholes values of outstanding stock options and equity-based incentives (vega and delta) for each CEO. In addition, we get rid of any CEOs with no inside debt compensation (i.e., no information on both pensions and deferred compensation available) and also require sufficient information to calculate vega and delta for each CEO. We also collect CEO personal characteristics such as age and tenure provided in ExecuComp.

Following the literature, we exclude financial and utilities firms (SIC6000-6999 and SIC4000-4999). Accounting data and stock prices are obtained from Compustat industrial annual files and CRSP, respectively. After merging CEO wealth portfolio dataset to Compustat data, we have a sample of 1,932 CEOs for 1,419 firms in the period of 2006-2011. The final sample consists of 6,748 firm-year observations.

3.3.2 Descriptive Statistics

Panel A of Table 18 reports descriptive statistics of the main characteristics of the sample firms. The average (median) firm is 27 (25) years old. The average net sales of the sample firms is close to $6.1 billion and the median sales is about $1.5 billion. The average fixed assets ratio, which is used as a proxy for asset tangibility, is 0.25 and the median is 0.18. The average profitability, measured as the ratio of EBITDA and total asset, is 0.14 and the median is 0.13. For debt policy, the sample firms have the average market leverage of 14% and median of 11%. Following the literature, we use market to book ratio as a proxy for growth opportunities. The average market to book ratio is substantially high at 1.86, and the market to book median is also high at 1.55. For investment policies, the sample firms spend, on average, 3% of total assets for research and development activities (R&D). The median firm spends 1% of total asset for R&D. However, the firms spend slightly higher proportion of total assets for net capital expenditure (CAPEX) with the mean and median of 5% and 3%, respectively. For debt maturity, the average firm holds 37% (58%) of debt that matures in three (five) years or less and the median firm holds 27% (57%) of debt maturing in three (five) years or less.

TABLE 18: Descriptive statistics of firm and CEO characteristics

Panel A reports descriptive statistics of firm characteristics. Firm age is the difference between the first year which a firm's stock first appears in CRSP database and the fiscal year. Firm size is net sales in millions of dollars. Fixed asset ratio is the net plant, property, and equipment divided by total asset. Profitability is the earnings before interest, taxes, depreciation, and amortization (EBITDA) scaled by the book value of total asset. Leverage is total debt (debt in current liability plus long-term debt) divided by the market value of the firm (estimated as the book value of assets minus the book value of equity plus the market value of equity). Market to book ratio is the market value of the firm scaled by the book value of total assets. Abnormal earnings is measured as (earnings in year t+1 - earnings in year t)/share price x outstanding shares in year t. Asset maturity is the book value weighted average of the maturities of the plant, property, and equipment (PPE) and current assets, measured as (PPE/Total asset) x (PPE/Depreciation expense))+ (Current asset /Total asset) x (Current asset/COGS). R&D is the ratio of research and development expenditure and total asset. CAPEX is net capital expenditure (calculated as capital expenditure minus sale of property, plant and equipment) scaled by total asset. Proportion of debt maturing in 3 years (5 years) or less is defined as debt that matures in 3 years (5 years) or less scaled by total debt.

Panel B reports summary statistics of CEO characteristics. Total compensation is the variable TDC1 in Execucomp. Cash compensation is the sum of current salary and cash bonus. Equity value is the sum of the value of CEO outstanding common stock holdings plus the Black- Scholes value of outstanding options held by CEOs at the fiscal year end. Vega is the dollar change of CEO option portfolios for 1% change in stock return volatility. Delta is the dollar change of CEO stock and option portfolios for 1% change in stock price. We follow Guay (1999) and Core & Guay (2002) to calculate the dividend-adjusted Black- Scholes values of executive options, vega, and delta. Pensions are the present value of accumulated pension benefits from all pension plans. Deferred compensation is total aggregate balance in deferred compensation plans at fiscal year end. CEO personal leverage is defined as the sum of pensions and deferred compensation divided by the sum of pensions and deferred compensation plus equity value. Pension (deferred compensation) ratio is calculated as pension (deferred compensation) divided by the sum of pensions and deferred compensation plus equity value. Personal debt-equity ratio is the sum of pensions and deferred compensation scaled by equity value. Relative debt-equity ratio is defined as personal debt-equity ratio divided by firm debt-equity ratio, where firm debt-equity ratio is total debt scaled by the market value of equity. Tenure is the number of years as the CEO of the firm. Age is the present age of CEOs at the fiscal year. To mitigate the influence of large outliers, the relative debt-equity ratio is winsorized at the 5^{th} and 95^{th} percentiles. All other accounting variables are winsorized at the 1^{st} and 99^{th} percentiles.

TABLE 18 (continued)

Panel A: Descriptive statistics of firm characteristics

	Obs.	Mean	Standard deviation	25th percentile	Median	75th percentile
Firm age (years)	6748	26.95	15.23	13	25	43
Firm size ($M)	6748	6058.28	14015.98	531.56	1506.97	4740.9
Fixed assets ratio	6748	0.25	0.21	0.09	0.18	0.35
Profitability	6748	0.14	0.1	0.09	0.13	0.18
Leverage	6748	0.14	0.14	0.02	0.11	0.22
Market to book	6748	1.86	1.02	1.19	1.55	2.16
R&D	6748	0.03	0.06	0	0.01	0.05
CAPEX	6748	0.05	0.05	0.02	0.03	0.06
Proportion of debt maturing in 3 years or less (ST3)	5338	0.37	0.34	0.07	0.27	0.58
Proportion of debt maturing in 5 years or less (ST5)	5338	0.58	0.35	0.3	0.57	0.98

Panel B: Descriptive statistics of CEO characteristics

	Obs.	Mean	Standard deviation	25th percentile	Median	75th percentile
Wealth portfolios						
Total compensation ($000s)	6748	5395.39	5410.91	1780.02	3630.32	6922.64
Cash compensation ($000s)	6748	956.54	698.06	566.89	805	1070
Equity value ($000s)	6748	49888.17	102464	7740.5	18579.04	45472.77
Pensions ($000s)	6748	2514.72	5965.14	0	0	1501.03
Deferred comp.($000s)	6748	2014.38	5818.39	0	45.12	1315.02
Equity-based incentives						
Vega ($000s)	6748	146.95	220.33	19.98	61.65	170.96
Delta ($000s)	6748	560.64	1094.9	83.21	209.28	539.35
Inside debt						
Personal leverage	6748	0.11	0.16	0	0.02	0.17
Pension ratio	6748	0.06	0.12	0	0	0.06
Deferred comp. ratio	6748	0.04	0.08	0	0	0.05
Personal debt-equity ratio	6748	0.19	0.4	0	0.02	0.2
Relative debt-equity ratio	5702	1.13	2.13	0	0.18	1.07
Other characteristics						
Tenure (years)	6748	7.11	6.82	0.08	5	9
Age (years)	6748	55.14	6.92	29	55	60

Panel B of Table 18 provides descriptive statistics of CEO wealth portfolios, inside debt compensation, and other personal characteristics. The top of panel B provides a snapshot of CEO wealth portfolios. The mean (median) of CEO total compensation, measured as TDC1 variable in ExecuComp database, is approximately $5.4 (3.6) million. The average and median cash compensation (cash plus bonus) is about $0.96 million and $0.86 million, respectively. Obviously, the largest component of CEO wealth portfolio is stock and option holdings (equity holdings), which illustrates the common use of stock-based compensation in reality. The average CEO holds stock and options with approximately estimated value of $50 million and the median CEO holds about $18.6 million of stock and options in their wealth portfolios. Note that the value of stocks held by a CEO is calculated as his number of common outstanding stocks multiplied by the stock price at the fiscal year end. We follow the dividend-adjusted Black-Scholes model used by Guay (1999) and Core & Guay (2002) to estimate the values of outstanding options held by a CEO.

The figures also show that inside debt accounts for a substantial proportion in CEO wealth portfolios. The average CEO receives slightly higher pensions than deferred compensation ($2,515 thousand vs. $2,014 thousand). In contrast, the median CEO has substantially higher deferred compensation than pensions ($45,000 vs. $0). To compare with cash compensation, it is clear that the mean of both pensions and deferred compensation is much higher than that of cash compensation. However, the median of cash compensation is significantly higher than that of pensions and deferred compensation. Note that, by definition, pensions are the present value of accumulated pension benefits from all pension plans. Deferred compensation is total aggregate balance in deferred compensation plans at fiscal year end.

The summary statistics of equity-based incentives (vega and delta) are also reported in the second part of Panel B in Table 18. Vega is defined as the dollar change of the executive's option portfolio for 1% change in stock return volatility. Delta is measured as the dollar change of the executive's stock and option portfolios for 1% change in stock price. Vega and delta are estimated based on the approach by Guay (1999) and Core & Guay (2002). The mean (median) vega is close to $147,000 ($62,000). Delta is higher than vega with the mean at $561,000 and median at $209,000, approximately.

Following the literature, we calculate five proxies for inside debt compensation. Their descriptive statistics are provided in Panel B. The mean (median) CEO personal leverage, which is defined as the sum of pensions plus deferred compensation scaled by the sum of pensions and deferred compensation plus equity value, is 11% (2%). The average (median) ratios of pensions and deferred compensation are 6% (0%) and 4 % (0%), respectively. Note that pension (deferred compensation) ratio is pension (deferred compensation) scaled by the sum of pensions and deferred compensation plus equity value. Two alternative proxies for inside debt are personal debt-equity ratio (defined as the sum of pensions and deferred compensation scaled by equity value), and relative debt-equity ratio (defined as personal debt-equity ratio divided by firm debt-equity ratio, where firm debt-equity ratio is total debt scaled by the market value of equity). The mean (median) personal debt-equity ratio is 19% (2%). The average relative debt-equity ratio is 1.13 and its median is 0.18. As in Liu, Mauer and Zhang (2012), we use the first three proxies: personal leverage, pension and deferred compensation ratios for the main analysis. Doing analysis for pension and deferred compensation ratios provides additional information about which inside debt component drives the effect of inside debt on corporate policies. In addition, we use personal debt-equity and relative debt-equity ratios in a robustness analysis.

The bottom of panel B in Table 18 also provides additional information about CEO tenure and age. The average and median CEO serves his firm for about 7 years and 5 years, respectively. The mean and median CEO age is about 55 years.

TABLE 19: Pearson correlation coefficients among inside debt, leverage, debt maturity, R&D, and CAPEX

This table presents a matrix of Pearson correlation coefficients among various measures of inside debt compensation, leverage, debt maturity, R&D and CAPEX. All variables are defined as in Table 18. * denotes significance at 5 percent level.

	Leverage	Proportion of debt maturing in 3 years or less	Proportion of debt maturing in 5 years or less	R&D	CAPEX	Personal leverage	Pension ratio	Deferred comp. ratio	Personal debt-equity ratio
Proportion of debt maturing in 3 years or less	-0.4354*	1							
Proportion of debt maturing in 5 years or less	-0.2967*	0.7443*	1						
R&D	-0.2798*	0.2127*	0.1337*	1					
CAPEX	0.0061	-0.0793*	-0.0600*	-0.1786*	1				
Personal leverage	0.1994*	-0.1634*	-0.1527*	-0.1832*	-0.0501*	1			
Pension ratio	0.1940*	-0.1541*	-0.1394*	-0.1512*	-0.0583*	0.8284*	1		
Deferred comp. ratio	0.0888*	-0.0888*	-0.0883*	-0.1196*	-0.0088	0.6234*	0.0893*	1	
Personal debt-equity ratio	0.1749*	-0.1029*	-0.0972*	-0.1377*	-0.0450*	0.9243*	0.7837*	0.5176*	1
Relative debt-equity ratio	-0.3112*	0.1130*	0.0368*	-0.0199	-0.0390*	0.5417*	0.4022*	0.4056*	0.4811*

Table 19 reports Pearson correlation coefficients among inside debt, leverage, debt maturity, and R&D and CAPEX expenditures. This correlation matrix simply reveals basic relations among these variables. Firm leverage is significantly positively correlated with personal leverage, pension ratio, deferred compensation ratio, and personal debt-equity. This correlation is consistent with the prediction of Edmans and Liu (2011) on a positive relationship between inside debt and firm leverage and is consistent with previous empirical evidence (Sundaram and Yermack (2007); Chen, Dou and Wang (2010); Cen (2007); Liu, Mauer and Zhang (2012). Nevertheless, firm leverage is negatively correlated with relative debt-equity ratio, which is consistent with the finding in Cassell, Huang, Sanchez and Stuart (2012) that inside debt negatively affects firm leverage. Two measures of short-term debt maturity (ST3 and ST5) are negatively correlated with personal leverage, pension ratio, deferred compensation ratio, and personal debt-equity ratio, whereas is positively correlated with relative debt-equity ratio. Finally, consistent with Edmans and Liu (2011) and Cassell, Huang, Sanchez and Stuart (2012), Table 19 shows that R&D expenditure is negatively correlated with all proxies of inside debt, which implies that a CEO with inside debt have conservative investment policies. Net capital expenditure (CAPEX) is also negatively correlated with all proxies of inside debt, which is not consistent with the hypothesis that inside debt positively affect CAPEX due to the reallocation of capital between R&D and CAPEX. Note that the correlation analysis does not consider the impacts of other control variables as the multivariate analysis. The next section provides empirical analysis in a multivariate regression framework.

3.4 Empirical Analysis

Empirical studies such as Coles et al. (2006) and Brockman et al. (2010) document evidence on the joint determinants between corporate policies and managerial compensation incentives. We also posit that corporate policies and inside debt compensation are jointly determined. To explore this causal relation between them, we set up a simultaneous two-equation system as follows:

$$policy\ measure_{i,t} = f\left(inside\ debt_{i,t}, equity\ \ incentives_{i,t}, other\ control\ variables_{i,t}\right)$$

$$inside\ debt_{i,t} = f\left(policy\ measures_{i,t}, equity\ incentives_{i,t}, other\ control\ variables_{i,t}\right)$$

In this system, *policy measure* represents leverage, debt maturity, R&D and CAPEX expenditures. *Inside debt* represents proxies for inside debt compensation. More specifically, in the first equation of the system, the dependent variable is a specific policy decision (e.g., firm leverage) and the interested explanatory variable is a proxy for inside debt (e.g., CEO personal leverage). In the second equation, the proxy for inside debt (e.g., CEO personal leverage) is the dependent variable, and the policy decision (e.g., firm leverage) is an explanatory variable. Recall that we use three proxies: CEO personal leverage, pension ratio, and deferred compensation ratio in the main analysis and two alternative proxies: personal debt-equity ratio and relative debt-equity ratio to provide robustness checks. *Equity incentives* are vega and delta, which control for the effect of managerial incentives induced by equity-based compensation packages such as stocks and options. The set of other control variables includes firm-level variables, which are selected from the related literatures. The model also controls for time and industry fixed effects by adding year dummies and 2-digit SIC dummies into the system.

Following Johnson (2003) and Datta, Iskandar-Datta and Raman (2005), we use two- stage least squares (2SLS) approach to estimate the above simultaneous equations system and report the second-stage 2SLS regression results in the main analysis. Wooldridge (2002) proves that the system 2SLS estimator is not efficient. Therefore, to provide robustness checks, we re-estimate the system by three-stage least squares (3SLS) approach and report the main results only.

3.4.1 Inside Debt and Firm Leverage

3.4.1.1 Variable Selections

Based on the general model setting above, we set up a simultaneous system of two equations in which firm leverage and inside debt are endogenous. The leverage equation includes inside debt and other explanatory variables selected from the vast literature on capital structure. While, the inside debt equation contains leverage and other independent variables borrowed from the existing studies on inside debt compensation.

For the leverage equation, we include vega and delta as two proxies for equity-based incentives. Previous studies such as Coles, Daniel and Naveen (2006) and Brockman, Martin and Unlu (2010) provide empirical evidence on the positive (negative) relation between firm leverage and vega (delta). Cash compensation is the sum of salary and bonus. Guay (1999) argues that CEOs with higher cash compensation has more opportunity to diversify his investments outside the firm; therefore they tend to be less risk averse. We therefore expect that cash compensation positively impact firm leverage as evidence found in Coles, Daniel and Naveen (2006). As in Johnson (2003), we use firm size, profitability, fixed asset ratio, market to book, abnormal earnings, and the dummy of net operating loss carryforwards and investment tax credit as the other important independent variables determining the firm's debt policy.

In the inside debt equation, we control for managerial incentives induced from equity-based compensation including vega and delta. In their studies on managerial incentives, Coles, Daniel and Naveen (2006), Brockman, Martin and Unlu (2010), and Chava and Purnannadam (2010) argue that CEOs with high vega (delta) are less (more) risk averse. Therefore, we expect a positive (negative) relation between vega (delta) and inside debt.

We include cash compensation to control for the substitute effect between this form of compensation and inside debt. Gerakos (2007) finds that pension benefits substitute for other forms of compensation, which suggests a negative relation between them. The existing literature documents that number of years servicing as the CEO and CEO age are important determinants of inside debt. Sundaram and Yermack (2007) find that CEOs with higher tenure have more inside debt compensation and that pension increases monotonically with CEO age. Gerakos (2007) and Chen, Dou and Wang (2010) also find a positive relation between CEO age and inside debt. Therefore, we add CEO tenure and age in the inside debt equation. For firm variables, we include firm age, size, and market to book ratio. The literature provides evidence that older, larger firms pay higher inside debt compensation than younger, smaller firms (see Sundaram and Yermack, 2007; Chen, Dou and Wang, 2010; Cen, 2007; Lee and Tang, 2011). We use market to book ratio as a proxy for growth opportunities. The agency costs associated with severe asset substitution problem in the firms with high growth opportunities are relatively high, which suggests that these firms should use more inside debt compensation. Thus, we expect that inside debt is increasing in market to book. Inconsistent with this expectation, Gerakos (2007) finds a negative relation between market to book ratio and pensions.

Tax deferral would be an important motivation for firms and CEOs to prefer inside debt because, by law, both of them can defer tax until payments of inside debt compensation occur in the future. Sundaram and Yermack (2007) argue that, for some firms, pensions possibly offer net tax savings between firms and executives when either of them might expect to have different marginal tax rates in the future. However, they do not find significant relation between tax status and inside debt. To test this tax status argument, we include dummies of net operating loss carryforwards and investment tax credit as two proxies for tax status.

Theoretically, profitability, fixed asset ratio, and abnormal earnings are important determinants of capital structure decisions. However, the literature on inside debt provides no theoretical prediction on the relation between them and inside debt. Therefore, we exclude these variables in the inside debt equation. As discussed above, tenure, CEO age, and firm age are important variables of the determinants of inside debt. Therefore, we exclude these variables in the leverage equation. With restrictions of these variables, the simultaneous equation system properly identifies.

3.4.1.2 Results

Table 20 reports the second-stage results of simultaneous equation regressions for firm leverage and inside debt compensation using two-stage least squares (2SLS) approach. The endogenous variables of Model 1 are firm leverage and personal leverage. Those of Models 2&3 are firm leverage and pension ratio, and firm leverage and deferred compensation, respectively. The odd columns of Table 20 present the 2SLS results of the leverage regression, while the even columns present the results of the inside debt regression.

For the leverage regression, columns 1, 3 and 5 show the results consistent with those of univariate analysis about the positive relation between firm leverage and inside debt. To be specific, the estimated coefficients on personal leverage, pension ratio and deferred compensation ratio are positive and statistically significant at 1% level, which suggests that inside debt positively affects firm leverage. This finding is consistent with Edmans and Liu's (2011) prediction on a positive relation between inside debt and leverage. Furthermore, the significant coefficients on pensions and deferred compensation imply that both of these two components of inside debt drive the positive relation between inside debt and firm leverage.

Across the three models, the sign and significance of other control variables are almost consistent with the capital structure literature. The results show that equity-based incentives have significant effects on leverage choice. Specifically, the coefficients on both vega and delta are negative and statistically significant. Nevertheless, the negative sign of the coefficient on vega is inconsistent with empirical evidence documented in prior studies by Coles, Daniel and Naveen (2006), Brockman, Martin and Unlu (2010) and Chava and Purnannadam (2010). They find a positive relation between vega and leverage. Consistent with these studies, we find that CEOs with higher delta tend to take lower leverage.

TABLE 20: Inside debt and firm leverage

This table presents the second-stage results of simultaneous equation regressions for leverage and inside debt compensation using two-state least squares (2SLS) approach. The first-stage regression results estimating the predicted values of leverage and inside debt compensation are not reported. Three proxies for inside debt compensation are personal leverage, pension and deferred compensation ratios. Definitions of these variables are the same as in Table 18. Columns 1-2 report the estimated results for leverage and personal leverage (Model 1). The results for leverage and pension ratio are presented in columns 3-4 (Model 2). The last two columns provide the results for leverage and deferred compensation ratio (Model 3). Vega (log) is the dollar change of CEO option portfolio for 1% change in stock return volatility. Delta (log) is the dollar change of CEO stock and option portfolio for 1% change in stock price. We follow Guay (1999) and Core & Guay (2002) to estimate vega and delta. Cash compensation (log) is the sum of current salary and cash bonus. CEO tenure (log) is the number of years as the CEO of the firm. CEO age (log) is CEO present age at the fiscal year. Firm age (log) is the difference between the first year which a firm's stock first appears in CRSP and the fiscal year. Firm size is the log of net sales. Other variables are defined as in Table 18. All regressions include 2-digit SIC dummies and year dummies. Robust t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

TABLE 20 (continued)

	Model 1		Model 2		Model 3	
	Leverage	Personal leverage	Leverage	Pension ratio	Leverage	Deferred comp. ratio
	(1)	(2)	(3)	(4)	(5)	(6)
Personal leverage (predicted)	0.1335					
	(3.51)***					
Pension ratio (predicted)			0.2907			
			(4.46)***			
Deferred compensation ratio (predicted)					0.3973	
					(4.06)***	
Leverage (predicted)		0.2828		0.2123		0.0368
		(2.87)***		(2.50)**		(0.66)
Vega	-0.0056	0.0088	-0.0059	0.0056	-0.0058	0.0032
	(4.08)***	(5.58)***	(4.28)***	(4.36)***	(4.20)***	(3.36)***
Delta	-0.0049	-0.0494	-0.0040	-0.0270	-0.0043	-0.0202
	(2.43)**	(19.14)***	(2.05)**	(13.14)***	(2.22)**	(13.83)***
Cash compensation	0.0275	0.0048	0.0248	0.0083	0.0295	-0.0021
	(7.14)***	(0.98)	(6.24)***	(2.14)**	(7.84)***	(0.73)
CEO tenure		0.0200		0.0087		0.0105
		(10.02)***		(5.60)***		(8.86)***
CEO age		0.1736		0.1224		0.0449
		(13.07)***		(11.94)***		(5.96)***
Firm age		0.0174		0.0099		0.0076
		(7.38)***		(4.88)***		(6.06)***
Firm size	0.0105	0.0408	0.0095	0.0220	0.0095	0.0180
	(5.00)***	(16.12)***	(4.69)***	(10.74)***	(4.51)***	(12.38)***
Profitability	-0.1157		-0.1203		-0.1207	
	(5.79)***		(6.01)***		(6.03)***	
Fixed asset ratio	0.1007		0.0978		0.1029	
	(7.59)***		(7.36)***		(7.80)***	
Market to book	-0.0313	0.0174	-0.0294	0.0111	-0.0310	0.0042
	(18.43)***	(4.53)***	(16.71)***	(3.35)***	(18.21)***	(1.98)**
Abnormal earnings	0.0515		0.0502		0.0518	
	(5.73)***		(5.59)***		(5.80)***	
Net operating loss carryforwards dummy	0.0171	0.0085	0.0185	0.0034	0.0156	0.0042
	(6.07)***	(1.77)*	(6.49)***	(0.87)	(5.52)***	(1.42)
Investment tax credit dummy	-0.0173	-0.0050	-0.0168	-0.0077	-0.0183	0.0034
	(5.14)***	(1.30)	(5.00)***	(2.43)**	(5.39)***	(1.55)
Constant	0.0135	-0.9066	0.0301	-0.6554	0.0009	-0.2287
	(0.37)	(15.42)***	(0.81)	(13.75)***	(0.03)	(6.86)***
Observations	6748	6748	6748	6748	6748	6748
R-squared	0.41	0.33	0.41	0.27	0.41	0.15

Firm size has positive sign and is statistically significant, which is consistent with Brockman, Martin and Unlu (2010), but is not consistent with Barclay, Max and Smith (2003), Johnson (2003), and Billett, King and Mauer (2007). Consistent with the literature, profitability has negative and significant impact on leverage. In addition, the coefficient on fixed asset ratio is statistically positive, suggesting that firms with higher asset collateral use more debt. This finding is consistent with Johnson (2003) and Barclay, Max and Smith (2003), but inconsistent with Brockman, Martin and Unlu (2010). The sign and significance of market to book ratio and abnormal earnings are consistent with Johnson (2003). Again, our results confirm that tax status has significant effect on firm leverage. The net operating loss carryforwards (investment tax credit) dummy is statistically positive (negative), which supports prior research by Barclay, Max and Smith (2003), Johnson (2003), and Billett, King and Mauer (2007). The above analysis shows that, by and large, the inclusion of inside debt in the traditional leverage regression leads to the results consistent with the literature of capital structure, and that inside debt compensation is an important determinant of debt policy.

For the inside debt regression, the 2SLS results are provided in the even columns. Specifically, columns 2 and 4 are for the CEO personal leverage regression and pension ratio, respectively. Column 6 is for the deferred compensation ratio regression.

It can be seen from columns 2, 4 and 6 in Table 20 that, the estimated coefficients on leverage are all significantly positive across the three models, suggesting that CEO personal leverage, pension ratio, and deferred compensation ratio are all increasing in firm leverage. Generally, as predicted in Edmans and Liu (2011), firm leverage positively affects inside debt. This finding is also consistent with empirical evidence in Sundaram and Yermack (2007), Chen, Dou and Wang (2010), Cen (2007), and Liu, Mauer and Zhang (2012).

As shown in columns 2, 4 and 6 of Table 20, vega has positive and significant coefficients. In contrast, the coefficients on delta are negative and highly significant. This evidence implies that CEOs with high vega (delta) tend to have more (less) inside debt. This interesting finding is new to the literature of inside debt. The coefficient on cash compensation is positive for the CEO personal leverage and pension ratio regressions, but is significant for the pension ratio regression only. Column 6 shows no significant relation between cash compensation and deferred compensation ratio. Thus, there is weak evidence on the impact of cash compensation on inside debt.

The sign and significance of the well-known variables such as CEO tenure and age, firm age, and firm size are consistent with prior research (see Sundaram and Yermack, 2007; Gerakos, 2006; Chen, Dou and Wang, 2010; and Liu, Mauer and Zhang, 2012). All of these variables positively affect inside debt. In addition, market to book ratio variable has positive and significant coefficient in all three models, which implies that the firms with high growth opportunities tend to use more inside debt. This finding is consistent with Edmans and Liu's (2011) prediction and empirical evidence in Gerakos (2007) and Liu, Mauer and Zhang (2012).

Furthermore, the dummy of net operating carryforwards has positive but insignificant coefficient. The dummy of investment tax credit has negative and significant coefficient in the pension ratio regression, but has negative (positive) and insignificant coefficient in the CEO personal leverage (deferred compensation ratio) regression.

Collectively, there is weak evidence on the effect of the tax status on inside debt compensation, which is consistent with Sundaram and Yermack (2007).

3.4.2 Inside Debt and Debt Maturity Structure

3.4.2.1 Variable Selections

From the general model specification discussed earlier, we develop a simultaneous two-equation system that endogenizes short-term debt maturity and inside debt. In this equation system, the maturity equation contains inside debt as the treatment variable and other control variables suggested from the debt maturity literature. Meanwhile, the inside debt equation includes short-term debt maturity and control variables selected from previous research in inside debt. The motivations for using appropriate control variables are discussed in details as follows.

The literature finds evidence of significant relations between managerial incentives and debt maturity. Brockman, Martin and Unlu (2010) find that a positive (negative) association between CEO vega (delta) and short-term maturity. Chava and Purnannadam (2010) find that CFOs with high vega (delta) use less (more) long-term maturity. However, they do not find any impacts of CEO vega and delta on debt maturity. Following these studies, we control vega and delta in the maturity equation. We also include cash compensation and expect a negative relation between this variable and short-term debt maturity.

Following previous studies (Barclay and Smith, 1995; Johnson, 2003; Barclay, Max and Smith, 2003; Datta, Iskandar-Datta and Raman, 2005; and Billett, King and Mauer, 2007), we include other control variables including firm size, firm sized squared, market to book, leverage, asset maturity, abnormal earnings, term structure, and dummy of net operating loss carry forwards and investment tax credit in the maturity equation. We use firm size as a proxy for firms' credit quality. Diamond (1991) theoretically shows that firms with the lowest and highest credit ratings prefer short-term debt, while firms in the middle range use more long-term debt. The inclusion of firm size squared is to test this non-linear relation. To be consistent with the literature, we expect that the coefficient for firm size and firm sized squared is negative and positive respectively. Following previous studies such as Barclay and Smith (1995), Johnson (2003), and Datta, Iskandar-Datta and Raman (2005), we use market to book as a proxy for investment opportunities and expect a positive coefficient on this variable. Myers (1977) predicts that high growth firms prefer short-term debt to address the underinvestment problem, suggesting a positive relation between market to book and short-term maturity.

The capital structure literature provides strong empirical evidence of a negative relation between leverage and short-term maturity structure (see for example, Johnson, 2003; Billett, King and Mauer, 2007; and Brockman, Martin and Unlu, 2010). Following the literature, we control for firm leverage in the maturity equation and expect a negative coefficient on this variable. Myers (1977) argues that firms attempt to match their asset maturity and liabilities to address the underinvestment problem. Thus, we include the variable asset maturity and expect a negative coefficient for this variable. Following Barclay and Smith (1995), we include a measure of abnormal earnings and expect a positive coefficient for this variable because high quality firms can benefit from the monitoring efficiency associated with short-term maturity. In theories, signaling models such as Flannery (1986) and Diamond (1991) suggest that firms use maturity structure to inform their credit quality to financial markets. Finally, we control for term structure and the dummy of net operating loss carryforwards and investment tax credit to test the tax-related hypothesis.

For the inside debt equation, the motivations for selecting appropriate control variables are discussed in Sections 3.4.1 and it is not worth repeating here. To properly indentify the simultaneous equation system, we restrict zero coefficients on CEO tenure, CEO age, and firm age in the maturity equation. Previous studies (for example, Barclay and Smith, 1995; Johnson, 2003; Datta, Iskandar-Datta and Raman, 2005) find evidence that variables such as firm size squared, asset maturity, abnormal earnings, and term structure are important determinants of debt maturity. Nevertheless, the inside debt literature provides no theoretical linkages between these variables and inside debt. Thus, we exclude them in the inside debt equation.

3.4.2.2 Results

Table 21 provides the estimates of the second-stage simultaneous equation regression of short-term debt maturity and inside debt using 2SLS approach. As in the literature, we use two measures of short-term debt maturity, namely proportions of debt maturing in three years or less (ST3) and debt maturing in 5 years or less (ST5). The endogenous variables in Model 1 are short-term debt maturity (ST3 or ST5) and CEO personal leverage. Those of Models 2 and 3 are short-term debt maturity and pension ratio, and short-term debt maturity and deferred compensation ratio, accordingly. The 2SLS results for ST3 and ST5 are tabulated in the odd columns of Panel A and Panel B of Table 21, respectively. The results of inside debt are in the even columns.

TABLE 21: Inside debt and debt maturity

This table shows the second-stage results of simultaneous equation regressions for the structure of debt maturity and inside debt compensation using two-state least squares (2SLS) approach. The first-stage regression results estimating the predicted values of debt maturity and inside debt compensation are not reported. Three proxies for inside debt compensation are personal leverage, pension and deferred compensation ratios. Definitions of these variables are the same as in Table 18. Panel A (B) reports the estimated results for proportion of debt maturing in 3 years (5 years) or less and inside debt. In each panel, columns 1-2 report the estimated results for debt maturity and personal leverage (Model 1). The results for debt maturity and pension ratio are presented in columns 3-4 (Model 2). The last two columns provide the results for debt maturity and deferred compensation ratio (Model 3). Vega (log) is the dollar change of CEO option portfolio for 1% change in stock return volatility. Delta (log) is the dollar change of CEO stock and option portfolio for 1% change in stock price. We follow Guay (1999) and Core & Guay (2002) to estimate vega and delta. Cash compensation (log) is the sum of current salary and cash bonus. CEO tenure (log) is the number of years as the CEO of the firm. CEO age (log) is CEO present age at the fiscal year. Firm age (log) is the difference between the first year which a firm's stock first appears in CRSP and the fiscal year. Firm size is the log of net sales. Firm size squared is the square of firm size. Term structure is the spread between the yield on 10-year government bonds and the yield on six-month government bonds at the fiscal year end. Yield data comes from the FRED at the Federal Reserve Bank of St. Louis. Other variables are defined as in Table 18. All regressions include 2-digit SIC dummies and year dummies. Robust t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

TABLE 21 (continued)

Panel A: Regressions of the proportion of debt that matures in 3 years or less on inside debt

	Model 1		Model 2		Model 3	
	ST3 (1)	Personal leverage (2)	ST3 (3)	Pension ratio (4)	ST3 (5)	Deferred comp. ratio (6)
Personal leverage (predicted)	0.4223 (3.73)***					
Pension ratio (predicted)			0.6395 (3.53)***			
Deferred compensation ratio (predicted)					1.1931 (3.88)***	
ST3 (predicted)		-0.1467 (2.57)**		-0.1311 (2.89)***		-0.0297 (0.93)
Vega	-0.0140 (3.19)***	0.0084 (4.46)***	-0.0142 (3.21)***	0.0055 (3.63)***	-0.0138 (3.16)***	0.0029 (2.60)***
Delta	0.0070 (1.02)	-0.0640 (22.41)***	0.0052 (0.78)	-0.0382 (16.56)**	0.0079 (1.14)	-0.0238 (15.19)***
Cash compensation	-0.0203 (1.80)*	0.0122 (2.50)**	-0.0234 (2.02)**	0.0124 (3.34)***	-0.0141 (1.28)	-0.0002 (0.06)
CEO tenure		0.0256 (11.39)***		0.0133 (7.62)***		0.0115 (8.57)***
CEO age		0.2167 (12.64)***		0.1656 (11.89)**		0.0472 (5.14)***
Firm age		0.0194 (6.66)***		0.0117 (4.72)***		0.0082 (5.24)***
Firm size	-0.2104 (8.04)***	0.0452 (16.99)***	-0.2090 (7.97)***	0.0245 (11.55)**	-0.2111 (8.11)***	0.0190 (12.29)***
Firm size squared	0.0110 (7.22)***		0.0111 (7.23)***		0.0109 (7.18)***	
Market to book	-0.0058 (0.82)	0.0074 (3.15)***	-0.0058 (0.83)	0.0042 (2.27)**	-0.0053 (0.75)	0.0024 (1.90)*
Leverage	-0.5809 (14.32)**	-0.0788 (1.92)*	-0.6084 (14.70)**	-0.0284 (0.86)	-0.5305 (12.52)**	-0.0583 (2.53)**
Asset maturity	-0.0028 (4.22)***		-0.0029 (4.29)***		-0.0026 (3.97)***	
Abnormal earnings	0.0416 (2.18)**		0.0471 (2.49)**		0.0382 (1.99)**	
Term structure	0.0233 (1.71)*		0.0224 (1.64)		0.0256 (1.88)*	
Net operating loss carryforwards dummy	-0.0134 (1.47)	-0.0050 (1.24)	-0.0095 (1.03)	-0.0102 (3.10)***	-0.0207 (2.26)**	0.0047 (2.03)**
Investment tax credit dummy	-0.0189 (1.48)	0.0088 (1.59)	-0.0161 (1.27)	0.0012 (0.28)	-0.0228 (1.77)*	0.0065 (1.91)*
Constant	1.4193 (11.13)**	-0.9807 (13.15)***	1.4428 (11.04)**	-0.7355 (12.30)**	1.3703 (11.08)**	-0.2204 (5.09)***
Observations	5338	5338	5338	5338	5338	5338
R-squared	0.15	0.32	0.15	0.28	0.15	0.14

TABLE 21 (continued)

Panel B: Regressions of the proportion of debt that matures in 5 years or less on inside debt

	Model 1		Model 2		Model 3	
	ST5 (1)	Personal leverage (2)	ST5 (3)	Pension ratio (4)	ST5 (5)	Deferred comp. ratio (6)
Personal leverage (predicted)	0.4017 (3.38)***					
Pension ratio (predicted)			0.6488 (3.43)***			
Deferred compensation ratio (predicted)					1.0123 (3.12)***	
ST5 (predicted)		-0.3981 (3.62)***		-0.3539 (3.85)***		-0.0758 (1.22)
Vega	-0.0190 (4.11)***	0.0040 (1.69)*	-0.0194 (4.17)***	0.0016 (0.83)	-0.0184 (4.02)***	0.0021 (1.53)
Delta	0.0156 (2.17)**	-0.0639 (23.92)***	0.0149 (2.13)**	-0.0382 (17.59)***	0.0144 (2.01)**	-0.0237 (15.80)***
Cash compensation	-0.0194 (1.65)*	0.0094 (1.90)*	-0.0232 (1.92)*	0.0099 (2.60)***	-0.0131 (1.14)	-0.0007 (0.23)
CEO tenure		0.0266 (11.87)***		0.0142 (8.02)***		0.0117 (8.76)***
CEO age		0.2490 (12.39)***		0.1942 (11.88)***		0.0533 (4.79)***
Firm age		0.0190 (6.52)***		0.0113 (4.55)***		0.0081 (5.24)***
Firm size	-0.0849 (3.25)***	0.0375 (9.73)***	-0.0852 (3.25)***	0.0177 (5.66)***	-0.0826 (3.18)***	0.0176 (7.97)***
Firm size squared	0.0026 (1.66)*		0.0027 (1.72)*		0.0024 (1.56)	
Market to book	-0.0117 (1.63)	0.0037 (1.39)	-0.0117 (1.63)	0.0009 (0.44)	-0.0114 (1.59)	0.0017 (1.18)
Leverage	-0.3641 (8.58)***	-0.1364 (2.90)***	-0.3925 (9.04)***	-0.0793 (2.02)**	-0.3206 (7.25)***	-0.0682 (2.57)**
Asset maturity	-0.0031 (4.33)***		-0.0033 (4.47)***		-0.0028 (4.04)***	
Abnormal earnings	0.0202 (1.01)		0.0250 (1.27)		0.0186 (0.92)	
Term structure	0.0156 (1.11)		0.0147 (1.04)		0.0177 (1.26)	
Net operating loss carryforwards dummy	-0.0152 (1.59)	-0.0095 (2.16)**	-0.0110 (1.14)	-0.0141 (3.93)***	-0.0217 (2.25)**	0.0039 (1.56)
Investment tax credit dummy	-0.0347 (2.62)***	-0.0011 (0.18)	-0.0322 (2.45)**	-0.0075 (1.40)	-0.0376 (2.80)***	0.0046 (1.21)
Constant	1.1866 (8.80)***	-0.8341 (9.09)***	1.2188 (8.84)***	-0.6054 (7.96)***	1.1311 (8.61)***	-0.1932 (3.75)***
Observations	5338	5338	5338	5338	5338	5338
R-squared	0.11	0.32	0.11	0.28	0.11	0.14

For the short-term maturity regression, the odd columns of Panels A&B in Table 21 show that, for both ST3 and ST5 regressions, the coefficients on all measures of inside debt compensation (CEO personal leverage, pension ratio, and deferred compensation ratio) are positive and statistically significant at 1% level, suggesting that a positive relation between inside debt and short-term maturity exits and that both pensions and deferred compensation drive this relation. This empirical evidence is first documented in the literature. However, the results are not consistent with those of the univariate analysis which show that both ST3 and ST5 are negatively correlated with CEO personal leverage, pension ratio, and deferred compensation ratio. It is worth noting that the univariate analysis simply provides basic results because it does not consider various control variables which could determine firms' maturity choices.

It can be seen from the odd columns of Table 21 (Panels A-B) that the estimates of other control variables are consistent with the existing literature, except for equity-based incentives. Vega has significant and negative coefficients in both ST3 and ST5 regressions, implying that CEOs with higher vega will borrow less short-term debt. Whereas, delta has positive coefficients in ST3 and ST5 regressions, but the results are significant for ST5 regression only. Our results would indicate further explorations about the impacts of managerial equity incentives on firms' maturity choices. Brockman, Martin and Unlu (2010) find evidence of positive (negative) relation between CEO vega (delta) and short-term maturity. Consistently, Chava and Purnannadam (2010) find the existence of a negative (positive) association between vega (delta) and long-term maturity for a sample of CFOs. However, they do not find significant results for the CEOs of the same firms. According to them, these results can be explained by the fact that CFOs rather than CEOs are responsible for practical policy decisions such as maturity choices.

For both ST3 and ST5 regressions, the coefficients on cash compensation are negative in models 1-3, but are significant at 10 % level in Model 1 and 5% level in Model 2 only. Thus, there is weak evidence of negative relation between cash compensation and short-term debt maturity. The coefficients on firm size are statistically negative for both ST3 and ST5, whereas those of firm size squared are significantly positive for ST5 regression only. Collectively, these results support Diamond's (1991) prediction on the non-linear relation between firms' quality and maturity structure. Previous studies such as Johnson (2003), and Brockman, Martin and Unlu (2010) find the same results.

As in Brockman, Martin and Unlu (2010), we find that market to book has insignificantly negative coefficient for both ST3 and ST5 regressions. Myers (1977) predicts that firms use short-term debt to mitigate the underinvestment problem which is more severe in firms with high growth opportunities. However, the existing literature provides mixed evidence. Johnson (2003) and Billett, King and Mauer (2007) find a negative relation between market to book and short-term debt. Meanwhile, consistent with Myers (1977), Barclay and Smith (1995), Barclay, Max and Smith (2003), and Datta, Iskandar-Datta and Raman (2005) find a negative relation between market to book and long-term debt. Both leverage and asset maturity have significantly negative coefficients in ST3 and ST5 regressions, which is consistent with Johnson (2003) and Brockman, Martin and Unlu (2010).

The odd columns of Table 21 show that the coefficients on abnormal earnings are positive for all three models, but are statistically significant in ST3 regressions only. Thus, consistent with Johnson (2003) and Billett, King and Mauer (2007), we find that abnormal earnings positively affects short-term maturity choices, suggesting that good firms (high future abnormal earnings) can signal their high quality to the financial markets through borrowing more short-term debt. Regarding the tax argument hypothesis, the coefficients on term structure are positive but not significant at 5% level for both ST3 and ST5 regressions, which is not consistent with the prediction on the negative relation between term structure and short-term maturity. In addition, it can be seen from columns 1, 3 and 5 in Table 21 that the dummies of net operating loss carryforwards and investment tax credit have negative coefficients as expected but their coefficients are not statistically significant at 5% level. Therefore, consistent with the literature (see for example, Johnson, 2003; Billett, King and Mauer, 2007), our results do not support the hypotheses on the impacts of tax status on debt maturity.

For the inside debt regression, the even columns of Panels A-B in Table 21 show that the coefficients on ST3 and ST5 are negative, but are statistically significant for Models 1-2 only. This result implies that short-term debt maturity negatively affects inside debt, in general. Combined with the above result, we find the first evidence of a positive relationship between inside debt and short-term maturity. Particularly, in one direction, high inside debt leads to high short-term maturity. However, for the causation direction, an increase in short-term maturity leads to a decrease in inside debt compensation.

For the other explanatory variables, the even columns of Panels A-B in Table 21 show that the coefficient on leverage is significantly negative in all three models. Interestingly, this result is not consistent with the above finding about a positive relationship between inside debt and firm leverage in Section 3.4.1. The sign and significance of other variables are consistent with the results of the inside debt regression in Section 3.4.1. More specifically, this section confirms the significant impacts of equity-based incentives on inside debt that vega (delta) positively (negatively) affects inside debt. In addition, inside debt is increasing in cash compensation, CEO tenure, CEO age, firm size, firm age, and market to book. Again, there is no evidence on the impact of the tax status on inside debt.

3.4.3 Inside Debt and Investment Policies

3.4.3.1 Variable Selections

Following Coles, Daniel and Naveen (2006) and Billett, King and Mauer (2007), we use R&D expense (capital expenditure, CAPEX) as a proxy for high (low) risk investment policies. Based on the general model, we build a simultaneous equation system which models R&D and inside debt as endogenous and another two-equation simultaneous system in which CAPEX and inside debt are endogenous. We denote these two simultaneous equation systems as R&D system and CAPEX system, respectively.

For the R&D equation in the R&D system and CAPEX equation in the CAPEX system, the selection of control variables is motivated from Coles, Daniel and Naveen (2006). We include vega and delta to control for incentives induced from equity-based compensation packages. Coles, Daniel and Naveen (2006) find that vega positively (negatively) affects R&D (CAPEX), whereas the impacts of delta on these investment policies are mixed. Again, cash compensation is used as a proxy for risk-taking behavior. Guay (1999) argues that higher cash compensation makes managers more diversified, which induces them to be less risk averse. We expect that cash compensation has a positive impact on R&D, but a negative impact on CAPEX. Based on the entrenchment argument (see Shleifer and Vishny, 1989) which suggests that CEOs may overinvest to build their empire and avoid the threat of being fired, we thus include tenure to test this hypothesis and expect that CEOs with longer tenure spend more on both R&D and CAPEX.

Following the literature, we also include firm size, market to book, leverage, surplus cash, and stock returns in the R&D and CAPEX equations. Firm size is the log of net sales and is expected to have negative (positive) impact on R&D (CAPEX). Market to book and sale growth are used as proxies for the firm's investment opportunities. Coles, Daniel and Naveen (2006) find both R&D and CAPEX are increasing in these two variables. Because debt financing is an important source to fund investment opportunities, we include leverage as an explanatory variable in both R&D and CAPEX equations. The asset substitution hypothesis states that shareholders get most benefits from investing in risky projects if those projects succeed. So, we expect that R&D (CAPEX) is positively (negatively) related to leverage. Surplus cash is used as a proxy for capital constraints. Firms with more cash available can fund more risky R&D activities and expend more on new projects. Therefore, we expect surplus cash to have a positive effect on both R&D and CAPEX. Stock return is used to as a proxy measuring firm performance. The entrenchment argument predicts that managers who are facing with poor performance can overinvest in manager-specific investments which are costly for shareholders to replace them (Shleifer and Vishny, 1989). We expect that stock return negatively affects both R&D and CAPEX.

The control variables in the inside debt equation in both R&D system and CAPEX system are kept the same as in Sections 3.4.1 and 3.4.2. For identification purposes, we exclude CEO age, firm age, and the dummy of net operating loss carryforwards and investment tax credit from the R&D and CAPEX equations. In theory, these variables are important determinants of inside debt, but no theoretical predictions about their roles on R&D and CAPEX. Furthermore, we restrict three variables sale growth, surplus cash, and stock return to enter the inside debt equation to help identify the simultaneous equation systems.

3.4.3.2 Results

The second-stage 2SLS results of the R&D system and CAPEX system are provided in Table 22 and Table 23, respectively. In Model 1, R&D/CAPEX and personal leverage are endogenously determined. Similarly, R&D/CAPEX and pension ratio (deferred compensation ratio) are endogenous variables in Model 2 (Model 3). Results for R&D (CAPEX) equation are tabulated in the odd columns of Table 22 (Table 23). Meanwhile, the results of the inside debt equation in R&D (CAPEX) system are presented in the even columns of Table 22 (Table 23).

TABLE 22: Inside debt and high-risk investment (R&D)

This table reports the second-stage results of simultaneous equation regressions for R&D and inside debt compensation using two-state least squares (2SLS) approach. The first-stage regression results estimating the predicted values of R&D and inside debt are not reported. Three proxies for inside debt compensation are personal leverage, pension and deferred compensation ratios. Definitions of these variables are the same as in Table 18. Columns 1-2 report the estimated results for R&D and personal leverage (Model 1). The results for R&D expenditure and pension ratio are presented in columns 3-4 (Model 2). The last two columns contain the results for R&D expenditure and deferred compensation ratio (Model 3). Vega (log) is the dollar change of CEO option portfolio for 1% change in stock return volatility. Delta (log) is the dollar change of CEO stock and option portfolio for 1% change in stock price. We follow Guay (1999) and Core & Guay (2002) to estimate vega and delta. Cash compensation (log) is the sum of current salary and cash bonus. CEO tenure (log) is the number of years as the CEO of the firm. CEO age (log) is CEO present age at the fiscal year. Firm age (log) is the difference between the first year which a firm's stock first appears in CRSP and the fiscal year. Firm size is the log of net sales. Sales growth is calculated as the log of ($sales_t$ – $sales_{t-1}$). Surplus cash is cash from assets-in-place scaled by total asset. Stock return is the equity return measured over the fiscal year. Other variables are defined as in Table 18. All regressions include 2-digit SIC dummies and year dummies. Robust t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

TABLE 22 (continued)

	Model 1		Model 2		Model 3	
	R&D (1)	Personal leverage (2)	R&D (3)	Pension ratio (4)	R&D (5)	Deferred comp. ratio (6)
Personal leverage (predicted)	-0.0517 (2.21)**					
Pension ratio (predicted)			-0.1065 (3.09)***			
Deferred compensation ratio (predicted)					-0.0177 (0.26)	
R&D (predicted)		-0.2130 (2.04)**		-0.2230 (2.69)***		-0.0212 (0.38)
Vega	0.0054 (10.67)**	0.0087 (5.12)***	0.0055 (10.95)**	0.0061 (4.50)***	0.0051 (9.87)***	0.0031 (3.06)***
Delta	-0.0064 (4.90)***	-0.0545 (24.87)***	-0.0068 (6.11)***	-0.0304 (17.89)***	-0.0041 (2.68)***	-0.0211 (17.11)***
Cash compensation	0.0048 (3.63)***	0.0127 (3.09)***	0.0056 (4.12)***	0.0134 (4.32)***	0.0040 (3.07)***	-0.0003 (0.12)
CEO tenure	0.0019 (2.30)**	0.0227 (12.66)***	0.0020 (2.83)***	0.0105 (7.54)***	0.0006 (0.61)	0.0109 (10.33)***
CEO age		0.1688 (12.66)***		0.1185 (11.47)***		0.0439 (5.83)***
Firm age		0.0163 (6.86)***		0.0090 (4.41)***		0.0073 (5.81)***
Firm size	-0.0080 (5.75)***	0.0435 (19.88)***	-0.0077 (6.35)***	0.0227 (13.17)***	-0.0102 (6.26)***	0.0188 (14.73)***
Market to book	0.0028 (2.37)**	0.0107 (5.90)***	0.0031 (2.58)***	0.0079 (5.61)***	0.0023 (1.90)*	0.0025 (2.57)**
Leverage	0.0001 (0.02)	0.0326 (1.91)*	0.0045 (0.94)	0.0599 (4.45)***	-0.0015 (0.30)	-0.0272 (2.74)***
Sale growth	-0.0148 (3.15)***		-0.0148 (3.21)***		-0.0130 (2.72)***	
Surplus cash	0.2013 (15.32)**		0.1983 (15.06)**		0.2055 (15.61)**	
Stock return	-0.0880 (4.77)***		-0.0881 (4.79)***		-0.0820 (4.45)***	
Net operating loss carryforwards dummy		0.0004 (0.10)		-0.0040 (1.44)		0.0044 (2.20)**
Investment tax credit dummy		0.0073 (1.52)		0.0042 (1.08)		0.0030 (1.05)
Constant	0.0617 (5.95)***	-0.8696 (14.52)***	0.0540 (4.97)***	-0.6230 (12.84)***	0.0722 (7.53)***	-0.2242 (6.73)***
Observations	6748	6748	6748	6748	6748	6748
R-squared	0.50	0.33	0.50	0.27	0.50	0.15

For R&D regression, columns 1, 3 and 5 in Table 22 show that the estimated coefficients on personal leverage (Model 1) and pension ratio (Model 2) are negative and statistically significant. In Model 3, the estimate on deferred compensation ratio is also negative but is not significant at 5% level. These results are consistent with the univariate results and supports Edmans and Liu's prediction on a negative relation between inside debt compensation and investment policies. Furthermore, the negative and significant coefficient on pension ratio implies that pensions dominate deferred compensation in the negative relation between inside debt and R&D expense.

For capital expenditure (CAPEX) regression, the odd columns of Table 23 illustrates that all measures of inside debt compensation have negative and significant coefficients, which suggests that a negative relation between inside debt and CAPEX exists and both pensions and deferred compensation drive this relation. Again, these results are consistent with the univariate analysis and with the theoretical prediction of Edmans and Liu (2011). Thus, consistent with the stated hypothesis, we find that CEOs with more inside debt compensation tend to spend less for both high-risk and low risk investments. As a contribution to prior research on managerial compensation incentives and investment policies, this finding provides empirical evidence that risk-decreasing incentives induced from compensation packages result in more conservative investment policies. Coles, Daniel and Naveen (2006) find unclear effects of risk-decreasing incentives measured by delta on both R&D and CAPEX.

In general, the sign and significance of other control variables in both R&D and CAPEX equations are consistent with the investment literature. More specifically, the odd columns of Tables 22-23 show that vega has a positive and significant impact on

R&D, but negative for CAPEX. In contrast, delta has a negative impact on R&D. However, the impact of delta on CAPEX is not significant. Therefore, we find consistent results as in Coles, Daniel and Naveen (2006) that CEOs with high vega tend to invest more for high risk projects, but less for low risk projects. Consistent with Guay's argument (1999), we also find that cash compensation positively and negatively affect R&D and CAPEX, respectively. Except for Model 3 in the R&D regression, the coefficients on tenure are positive and statistically significant, suggesting that, consistent with the entrenchment hypothesis, CEOs with longer tenure spend more for both R&D and capital expenditure. As expected, firm size have a positive impact on R&D, but negative impact on CAPEX. In all regressions of R&D and CAPEX, the coefficients on market to book are significantly positive, which is consistent with Coles, Daniel and Naveen (2006) and Brockman, Martin and Unlu (2010). However, we find that sale growth has a negative impact on R&D, but a positive impact on CAPEX. Regarding the impacts of financing sources, consistent with Coles, Daniel and Naveen (2006), we find that the impact of leverage on R&D is insignificant, whereas its impact on CAPEX is significantly negative. In addition, the surplus cash positively affects R&D, but has an insignificant impact on CAPEX. Consistent with the literature, the odd columns of Tables 22-23 show that stock return has negative and significant coefficients, implying that poor performance negatively affects the firm's investment policies.

TABLE 23: Inside debt and low-risk investment (CAPEX)

This table reports the second-stage results of simultaneous equation regressions for net capital expenditures (CAPEX) and inside debt using two-state least squares (2SLS) approach. The first-stage regression results estimating the predicted values of CAPEX and inside debt are not reported. Three proxies for inside debt compensation are personal leverage, pension and deferred compensation ratios. Definitions of these variables are the same as in Table 18. Columns 1-2 report the estimated results for CAPEX and personal leverage (Model 1). The results for CAPEX and pension ratio are presented in columns 3-4 (Model 2). The last two columns contain the results for CAPEX and deferred compensation ratio (Model 3). Vega (log) is the dollar change of CEO option portfolio for 1% change in stock return volatility. Delta (log) is the dollar change of CEO stock and option portfolio for 1% change in stock price. We follow Guay (1999) and Core & Guay (2002) to estimate vega and delta. Cash compensation (log) is the sum of current salary and cash bonus. CEO tenure (log) is the number of years as the CEO of the firm. CEO age (log) is CEO present age at the fiscal year. Firm age (log) is the difference between the first year which a firm's stock first appears in CRSP and the fiscal year. Firm size is the log of net sales. Sales growth is calculated as the log of ($sales_t$ – $sales_{t-1}$). Surplus cash is cash from assets-in-place scaled by total asset. Stock return is the equity return measured over the fiscal year. Other variables are defined as in Table 18. All regressions include 2-digit SIC dummies and year dummies. Robust t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

TABLE 23 (continued)

	Model 1		Model 2		Model 3	
	CAPEX	Personal leverage	CAPEX	Pension ratio	CAPEX	Deferred comp. ratio
	(1)	(2)	(3)	(4)	(5)	(6)
Personal leverage (predicted)	-0.0566 (2.71)***					
Pension ratio (predicted)			-0.0726 (2.40)**			
Deferred compensation ratio (predicted)					-0.1936 (3.04)***	
CAPEX (predicted)		-0.1633 (3.13)***		-0.2211 (5.29)***		-0.0705 (0.52)
Vega	-0.0020 (4.21)***	0.0077 (4.92)***	-0.0020 (4.39)***	0.0041 (3.28)***	-0.0018 (3.85)***	0.0028 (2.89)***
Delta	-0.0004 (0.30)	-0.0524 (23.75)***	0.0005 (0.48)	-0.0302 (17.26)**	-0.0014 (1.00)	-0.0208 (16.43)***
Cash compensation	-0.0053 (3.96)***	0.0166 (4.15)***	-0.0051 (3.69)***	0.0157 (5.05)***	-0.0060 (4.64)***	-0.0009 (0.33)
CEO tenure	0.0020 (2.68)***	0.0216 (11.64)***	0.0015 (2.31)**	0.0098 (6.73)***	0.0029 (3.07)***	0.0109 (10.31)***
CEO age		0.1800 (13.63)***		0.1355 (13.11)**		0.0432 (5.66)***
Firm age		0.0236 (10.00)***		0.0142 (7.13)***		0.0073 (5.75)***
Firm size	0.0037 (3.28)***	0.0418 (23.48)***	0.0029 (3.04)***	0.0245 (17.11)**	0.0048 (3.51)***	0.0191 (16.61)***
Market to book	0.0037 (5.06)***	0.0092 (5.61)***	0.0036 (4.95)***	0.0070 (5.28)***	0.0035 (5.02)***	0.0025 (2.60)***
Leverage	-0.0165 (3.77)***	0.0539 (3.45)***	-0.0139 (3.02)***	0.0663 (5.17)***	-0.0231 (4.86)***	-0.0279 (2.72)***
Sale growth	0.0096 (3.22)***		0.0104 (3.56)***		0.0083 (2.70)***	
Surplus cash	0.0095 (1.33)		0.0093 (1.28)		0.0120 (1.74)*	
Stock return	-0.1030 (6.96)***		-0.1001 (6.87)***		-0.1052 (7.03)***	
Net operating loss carryforwards dummy		0.0001 (0.02)		-0.0047 (1.66)*		0.0041 (2.06)**
Investment tax credit dummy		0.0106 (2.44)**		0.0048 (1.37)		0.0025 (0.93)
Constant	0.0541 (5.86)**	-0.8966 (16.67)***	0.0534 (5.49)***	-0.6833 (16.19)**	0.0587 (7.03)***	-0.2182 (6.06)***
Observations	6748	6748	6748	6748	6748	6748
R-squared	0.46	0.26	0.46	0.19	0.46	0.15

The even columns of Table 22 and Table 23 present the second-stage 2SLS results for the inside debt regression in the R&D system and CAPEX system, respectively. The even columns of Table 22 show that, except for Model 3, the estimated coefficients of R&D are significantly negative. Thus, consistent with Edmans and Liu (2011) and Gerakos (2007), we find that R&D negatively affects inside debt, in general. We also find similar effect of CAPEX on inside debt. Specifically, the even columns of Table 23 indicate that, CAPEX has negative and significant coefficient in Models 1-2, which implies that CAPEX has negative effect on inside debt. Collectively, we find evidence that both high and low risk investment polices (R&D and CAPEX) have negative impacts on inside debt. Furthermore, combined with the results above, we find a negative relationship between inside debt and R&D, and between inside debt and CAPEX.

In general, the sign and significance of other control variables of the inside debt equation in R&D and CAPEX systems are consistent with Sections 3.4.1- 3.4.2. The even columns of Tables 22-23 show that, except for Model 3, firm leverage has statistically positive coefficient in Models 1-2. In general, this result is consistent with the above finding about the positive relationship between inside debt and firm leverage. Again, the odd columns of Tables 22-23 show that equity-based incentives (vega, delta), cash compensation, CEO tenure and age, firm size and age, and market to book play an important role in determining inside debt compensation. The directions of the effects of these variables are similar to the findings in Sections 3.4.1- 3.4.2. Consistently, no significant impact of the tax status on inside debt is found.

3.4.4 Robustness Checks

In this section, we provide robustness checks of the effect of inside debt on corporate policies by using the three-stage least squares (3SLS) approach and two alternative proxies for inside debt. Theoretically, the 2SLS estimators are unbiased, but not efficient because the 2SLS approach ignores correlations between errors. Instead, the 3SLS approach gives more efficient estimates than 2SLS approach (Wooldridge, 2002). In addition, previous studies also use personal debt-equity and relative debt-equity ratios as two alternative proxies for inside debt (see for example, Sundaram and Yermack, 2007; Cassell, Huang, Sanchez and Stuart, 2012; White, 2012). A concern is whether our results still hold for these two proxies. Using three previous proxies for inside debt (personal leverage, pension and deferred compensation ratios) and two alternative proxies (personal debt-equity, and relative debt-equity ratio), we re-estimate the simultaneous equation systems in Sections 3.4.1- 3.4.3 by 3SLS approach. The 3SLS results are presented in Table 24. For the sake of brevity, we report the estimated coefficients on the key variables only. In general, the sign and significance of other control variables are similar to those of 2SLS regressions.

TABLE 24: Robustness results (3SLS)

This table provides the three-stage least squares (3SLS) results for the simultaneous regressions between inside debt and corporate polices. Five proxies of inside debt are used: personal leverage (Model 1), pension ratio (Model 2), deferred compensation ratio (Model 3), personal debt-equity ratio (Model 4), and relative debt-equity ratio (Model 5). Panel A provides the 3SLS estimates of the simultaneous regressions between inside debt and firm leverage, with control variables as in Table 20. Panels B &C report the results for the simultaneous regressions between inside debt and short-term maturity (ST3 and ST5), with control variables kept the same as in Table 21. The last two panels present the results for the simultaneous regressions between inside debt and investment polices (R&D in Panel D and CAPEX in Panel E), with control variables similar to those in Tables 22&23. Variables are defined as in Table 18. To save spaces, the estimates of control variables are not reported. Robust t- statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Panel A: Inside debt and firm leverage

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Leverage	Personal leverage	Leverage	Pension ratio	Leverage	Deferred comp. ratio	Leverage	Personal DE ratio	Leverage	Relative DE ratio
Personal leverage	0.1333 (3.62)***									
Pension ratio			0.1905 (3.03)***							
Deferred compensation ratio					0.3964 (4.07)***					
Personal debt-equity ratio							0.0650 (3.95)***			
Relative debt-equity ratio									0.0087 (2.01)**	
Leverage		0.2808 (3.54)***		0.2097 (3.33)***		0.0366 (0.80)		1.2176 (5.66)***		-6.5794 (5.70)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6748	6748	6748	6748	6748	6748	6748	6748	5702	5702

TABLE 24 (continued)

Panel B: Inside debt and short-term debt maturity (ST3)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	ST3	Personal leverage	ST3	Pension ratio	ST3	Deferred comp. ratio	ST3	Personal DE ratio	ST3	Relative DE ratio
Personal leverage	0.4290 (3.86)***									
Pension ratio			0.6468 (3.63)***							
Deferred comp. ratio					1.1778 (3.75)***					
Personal debt-equity ratio							0.1777 (3.60)***			
Relative debt-equity ratio									0.0433 (3.70)***	
ST3		-0.1466 (2.75)***		-0.1310 (2.99)***		-0.0298 (0.99)		0.0607 (0.46)		-3.4360 (4.32)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5338	5338	5338	5338	5338	5338	5338	5338	5338	5338

Panel C: Inside debt and short-term maturity (ST5)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	ST5	Personal leverage	ST5	Pension ratio	ST5	Deferred comp. ratio	ST5	Personal DE ratio	ST5	Relative DE ratio
Personal leverage	0.4178 (3.58)***									
Pension ratio			0.6631 (3.55)***							
Deferred comp. ratio					1.0154 (3.11)***					
Personal debt-equity ratio							0.1738 (3.35)***			
Relative debt-equity ratio									0.0430 (3.47)***	
ST5		-0.3968 (2.99)***		-0.3519 (3.12)***		-0.0759 (1.27)		-0.0042 (0.02)		-6.4903 (3.23)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5338	5338	5338	5338	5338	5338	5338	5338	5338	5338

TABLE 24 (continued)

Panel D: Inside debt and R&D expenditure

	Model 1		Model 2		Model 3		Model 4		Model 5	
	R&D	Personal leverage	R&D	Pension ratio	R&D	Deferred comp. ratio	R&D	Personal DE ratio	R&D	Relative DE ratio
Personal leverage	-0.0507 (2.40)**									
Pension ratio			-0.1047 (3.30)***							
Deferred comp. ratio					-0.0180 (0.28)					
Personal debt-equity ratio							-0.0140 (1.41)			
Relative debt-equity ratio									-0.0074 (4.22)***	
R&D		-0.1962 (1.78)*		-0.1985 (2.24)**		0.0114 (0.17)		-0.3186 (1.11)		5.3347 (2.35)**
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6748	6748	6748	6748	6748	6748	6748	6748	5702	5702

Panel E: Inside debt and capital expenditure (CAPEX)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	CAPEX	Personal leverage	CAPEX	Pension ratio	CAPEX	Deferred comp. ratio	CAPEX	Personal DE ratio	CAPEX	Relative DE ratio
Personal leverage	-0.0556 (2.90)***									
Pension ratio			-0.0712 (2.54)**							
Deferred comp. ratio					-0.1888 (3.05)***					
Personal debt-equity ratio							-0.0282 (3.08)***			
Relative debt-equity ratio									-0.0015 (0.94)	
CAPEX		0.1655 (0.42)		-0.0255 (0.08)		0.0985 (0.43)		2.5660 (2.45)**		-9.3077 (1.32)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6748	6748	6748	6748	6748	6748	6748	6748	5702	5702

Panel A of Table 24 reports the 3SLS the estimated results for the simultaneous equation systems between firm leverage and various proxies of inside debt. Consistent with the 2SLS results, the coefficients on all proxies of inside debt in Models 1-5 are significantly positive at 5% level, suggesting that, in one direction, inside debt positively affects firm leverage. On the other hand, the coefficient on firm leverage is positive in Models 1-4, and is statistically significant at 1% and 5% levels, except for Model 2. However, firm leverage has negative and significant coefficient in Model 5 in which the relative debt-equity ratio is used as proxy for inside debt. Recall that the relative debt-equity ratio variable is calculated as the personal debt-equity scaled by firm debt-equity ratio. Therefore, debt appears in two sides of each equation in the systems in which firm leverage and relative debt-equity ratio are endogenous. As a consequence, using this proxy might not estimate correctly the relation between inside debt and firm leverage. Collectively, except for one case (Model 5), the 3SLS results confirm a positive relationship between inside debt and leverage.

Panels B & C in Table 24 provide the 3SLS results for the simultaneous regressions between inside debt and short-term maturity (ST3 and ST5). For both two measures of debt maturity, the coefficients on personal leverage, pension and deferred compensation ratios are significantly positive and have values similar to the 2SLS counterparts. In addition, the estimated coefficients on personal debt-equity and relative debt-equity ratios are also positive and significant at 1% level. Thus, the 3SLS results support the above finding that, in one direction, inside debt positively affects short-term debt maturity. In other direction, the coefficients on ST3 and ST5 in the inside debt regression are significantly negative, except for Models 3 &4. In general, this result is also consistent with the finding in Section 3.4.2 that short-term maturity leads to lower inside debt compensation.

The results of the simultaneous regressions between inside debt and high risk investment (R&D) are provided in Panel D of Table 24. Overall, the 3SLS results of Models 1-3 are consistent with the above finding about a negative relationship between inside debt and R&D. The result of Model 4 shows that there is no evidence on a negative relationship between personal debt-equity ratio and R&D. Meanwhile, in Model 5, the coefficient on relative debt-equity ratio is significantly negative, suggesting that, in one direction, inside debt negatively affects R&D. In other causation direction, column 10 of Panel D shows that the estimated coefficient on R&D is significantly positive. Unexpectedly, this result is not consistent with the results based on other proxies of inside debt (personal leverage, pension and deferred compensation ratios).

Panel E of Table 24 presents the 3SLS results for the simultaneous regressions between inside debt and low risk investment (CAPEX). The odd columns show that all proxies of inside debt have negative and significant coefficient, except for the relative debt-equity ratio in Model 5. In general, the 3SLS results indicate that, in one direction, capital expenditures decrease in inside debt. However, the even columns show that the sign of the coefficient on CAPEX is mixed for different proxies of inside debt, implying weak evidence of the causal relation between CAPEX and inside debt. Combined with the 2SLS results, we conclude that the evidence of the positive relationship between inside debt and low risk investment (capital expenditures) is statistically weak.

3.5 Conclusion

This study is among the line of growing research which investigates the importance of inside debt (i.e., pensions and deferred compensation) as an alternative mechanism to mitigate the debt-related agency costs. The goal of this study is to investigate how inside debt compensation affects corporate policy decisions. More specifically, we examine the effects of inside debt on three important corporate policies, namely leverage, debt maturity, and investment policies. To address the concern about the endogeneity between inside debt and corporate policies, we employ simultaneous equations systems and estimate the systems by two-stage least squares (2SLS) approach. For the purpose of robustness checks, we also re-estimate the simultaneous equations systems by 3SLS approach. The study comes up with several main findings as follows.

First, we find a positive relationship between inside debt compensation and firm leverage, suggesting that CEOs with high inside debt holdings tend to use higher leverage. Further analysis shows that both pensions and deferred compensation drive this relationship. Second, our results show that, in one direction, inside debt positively affects short-term maturity, indicating that CEOs with high inside debt compensation borrow more short-term debt. In other direction, we find empirical evidence that inside debt decreases in short-term maturity. The results are consistent for two components of inside debt (pensions and deferred compensation).

Third, we find that, in general, inside debt compensation induces CEOs to have conservative investment policies, which supports the prediction by Edmans and Liu (2011). In particular, we find strong evidence on the negative relationship between inside debt and R&D activities, which implies that CEOs with inside debt tend to invest less in high-risk investments. However, there is weak evidence on the negative relationship between inside debt and low risk investments (capital expenditures). Furthermore, pensions rather than deferred compensation drive the negative relation between inside debt and R&D. Meanwhile, the weak relationship between inside debt and capital expenditures are driven by both pensions and deferred compensation.

Finally, a by-product of this study is to provide new evidence of the determinants of inside debt compensation. This study is the first to document a significant relation between inside debt and equity-based incentives. In particular, we find that inside debt compensation is significantly increasing (decreasing) in vega (delta). This result is important because it indicates that excessive risk taking induced by high vega can be deterred by high inside debt in the compensation packages. Therefore, this result is also consistent with the prediction of Edmans and Liu (2011) that inside debt can mitigate the agency costs associated with debt borrowing. We also document first evidence that inside debt is negatively related to short-term maturity, which would imply that the role of inside debt compensation in addressing the debt-related agency costs is reduced when the firms use more short-term debt in their capital structure.

Given the results of this study, we suggest future research examine in further the relation between inside debt and other corporate policies such as hedging policy. It is interesting to know how inside debt compensation affects firms’ policies for hedging activities such as using financial derivatives.

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APPENDIX

TABLE A: The characteristics of new debt issues

Our sample includes 988 firms with new debt issued in the period of 1993-2007. These firms had 7,422 new bank debt packages, 1,576 non-bank private debt issuances (144A) and 4,112 public debt issuances during this period. For multiple debt issuances, we aggregate them into a single issue by type on a yearly basis. This table provides the detailed characteristics of original new debt issues (before aggregation) by year. Panel A reports the characteristics of bank debt issues, Panel B for non-bank private debt, and Panel C for public debt. We collect new bank debt issues from Loan Pricing Corporation's Dealscan database, and non-bank private debt and public debt from Securities Data Corporation's (SDC) New Issues Database. We use hyphens (-) to denote zero.

Variable	*All*	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Panel A: Bank debt issues (N=7,422)																
No. Packages	*7,422*	293	346	325	450	566	477	523	549	599	601	644	679	644	551	175
No. Facilities	*10,342*	413	481	451	637	782	719	758	777	825	821	879	908	900	725	266
No. Firms	*988*	222	274	269	345	393	362	400	420	444	475	496	522	506	444	163
Issue details																
Package amount ($M)	*645.4*	355.1	442.5	598.8	507.0	528.1	498.5	560.9	632.1	703.0	603.4	523.9	658.9	827.5	1033.4	1500.9
Facility amount ($M)	*459.9*	252.2	320.9	435.6	354.0	372.6	326.9	383.4	445.2	507.2	435.4	383.9	491.1	584.5	782.6	976.9
Maturity (months)	*46.5*	46.5	47.9	49.8	51.7	56.8	52.1	43.5	28.9	27.6	26.2	32.8	44.3	50.9	96.8	56.4
Spread over default base (bps)	*209.6*	328.0	216.8	214.8	212.8	213.5	217.5	209.6	204.5	198.0	211.8	201.2	201.7	199.2	197.9	193.9
Loan type (%)																
364-day Facility	*24.5*	9.9	14.5	13.5	10.0	13.6	27.5	34.8	47.9	49.4	46.4	34.8	16.9	8.1	5.1	3.4
Revolver <1 year	*2.3*	3.8	1.7	1.5	4.0	1.4	1.3	2.1	3.1	3.0	2.5	2.0	3.1	2.0	1.6	0.6
Multi- year revolver	*54.4*	55.3	61.6	64.0	64.9	56.9	46.1	39.0	34.4	33.1	36.4	45.2	64.2	78.6	79.9	78.3
Term loan	*8.4*	14.7	11.9	8.6	8.2	6.2	5.0	5.7	6.7	6.5	8.0	9.5	11.5	7.3	8.7	14.9
Miscellaneous	*10.4*	16.4	10.4	12.3	12.9	21.9	20.1	18.4	7.8	8.0	6.7	8.5	4.3	4.0	4.7	2.9
Primary purpose (%)																
General corporate purposes	*49.1*	56.7	59.8	44.3	33.3	31.6	20.3	20.3	27.1	33.9	54.1	61.8	68.9	78.0	77.3	70.9
Debt payment	*16.3*	19.5	12.4	30.5	42.0	35.9	29.8	27.7	22.0	14.9	6.0	4.5	2.4	3.4	2.4	1.1

TABLE A (continued)

Variable	*All*	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Takeover/LBO	*14.3*	8.5	11.6	15.4	16.7	22.1	29.1	23.1	12.9	11.9	8.3	7.3	9.7	9.3	14.3	22.9
Capital expenditure	*1.2*	0.3	0.6	0.3	0.7	1.2	2.7	1.3	1.6	2.2	1.3	0.5	1.0	1.2	0.5	0.6
CP backup/Enhance	*15.0*	6.8	7.2	5.2	2.4	5.8	14.9	23.9	31.5	32.6	26.6	20.4	14.7	5.4	2.4	2.9
Stock buyback/Recap	*1.7*	7.5	5.2	2.8	2.7	1.6	1.3	1.2	1.1	0.3	0.2	0.6	1.5	0.8	2.4	1.1
Other	*2.5*	0.7	3.2	1.5	2.2	1.8	1.9	2.5	3.6	4.3	3.5	4.8	1.8	1.9	0.7	0.6
Panel B: Non-Bank Debt (144A) Issues (N=1,576)																
No. Issues	*1,576*	26	13	24	43	85	127	106	84	195	112	252	194	136	74	105
No. Firms	*716*	15	13	24	26	68	93	76	58	165	97	201	155	105	65	83
Types of debt (%)																
Convertible	31.0	19.2	46.2	41.7	18.6	27.1	11.0	16.0	23.8	31.3	32.1	42.9	35.1	21.3	52.7	41.9
Debentures	63.5	69.2	53.9	54.2	48.8	63.5	77.2	76.4	58.3	64.1	67.0	56.0	61.9	75.0	47.3	58.1
Medium-term Note	2.7	11.5	-	4.2	11.6	2.4	7.9	6.6	8.3	0.5	0.9	0.4	3.1	2.9	-	-
Other	2.9	-	-	-	20.9	7.1	3.9	0.9	9.5	4.1	-	0.8	-	0.7	-	-
144A debt details																
Principal amount ($M)	307.9	68.9	114.8	121.1	153.8	184.0	243.5	367.0	498.3	452.8	321.7	264.8	236.6	283.4	373.0	400.7
Offer yield to maturity (%)	6.9	12.4	17.7	12.5	10.1	7.9	7.9	7.8	8.2	7.2	7.0	5.9	5.3	6.2	5.3	5.4
Coupon (%)	6.4	7.2	8.0	9.0	8.5	7.4	7.3	7.5	7.1	6.5	6.7	5.7	5.3	6.1	5.3	5.6
Maturity (years)	9.8	16.5	7.5	8.2	10.7	9.8	9.9	9.4	7.7	9.1	8.6	10.2	10.9	10.1	12.0	8.5
Primary purposes (%)																
General corporate purposes	78.7	100.0	20.0	-	-	66.7	69.2	70.0	96.9	96.2	81.8	75.8	75.3	66.9	73.0	77.1
Debt payment	1.5	-	-	-	-	-	7.7	16.7	1.6	1.1	2.7	2.0	1.0	-	-	-
Takeover/LBO	4.1	-	80.0	100.0	100.0	-	15.4	-	-	-	3.6	2.4	3.1	1.5	8.1	11.4
Capital expenditure	0.3	-	-	-	-	-	7.7	-	-	0.6	-	0.4	-	-	1.4	-
Refinancing	14.9	-	-	-	-	33.3	-	13.3	1.6	2.2	11.8	19.1	19.6	29.4	17.6	11.4
Stock buyback/Recap	0.3	-	-	-	-	-	-	-	-	-	-	0.4	-	1.5	-	-
Other	0.3	-	-	-	-	-	-	-	-	-	-	-	1.0	0.7	-	-

TABLE A (continued)

Variable	*All*	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Panel C: Public Debt Issues (N= 4,112)																
No. Issues	4,112	327	201	237	310	405	546	291	253	365	326	223	128	108	167	225
No. Firms	*596*	160	94	114	132	143	167	130	100	150	122	131	80	74	116	142
Types of debt (%)																
Convertible	4.1	8.0	2.0	2.5	5.8	1.2	1.5	2.1	4.0	4.7	1.2	4.5	7.0	4.6	6.6	12.4
Debenture	59.2	62.7	43.3	49.4	49.7	44.9	41.6	57.0	43.9	72.6	70.6	76.2	79.7	85.2	83.2	84.0
Medium-term Note	33.3	20.8	42.8	43.5	35.2	52.4	53.7	39.5	49.8	21.1	27.0	19.3	13.3	8.3	9.0	3.6
Others	3.4	8.6	11.9	4.6	9.4	1.5	3.3	1.4	2.4	1.6	1.2	-	-	1.9	1.2	-
Public debt details																
Principal amount ($M)	237.6	158.4	114.4	114.4	147.1	133.4	135.4	235.8	242.6	307.7	236.3	331.8	333.9	374.5	582.2	567.8
Offer yield to maturity (%)	6.5	7.0	7.9	7.3	7.4	7.1	6.4	6.9	7.7	6.4	5.7	4.9	5.1	5.3	5.9	5.7
Coupon (%)	6.5	6.8	7.8	7.2	7.2	7.1	6.3	6.9	7.5	6.3	5.6	4.9	5.0	5.2	5.9	5.7
Maturity (years)	10.1	14.0	10.4	13.0	11.4	12.6	11.9	9.4	6.3	8.1	7.5	8.3	8.2	8.8	8.0	8.2
Primary purposes (%)																
General corporate purposes	64.0	39.9	53.0	42.1	53.2	61.8	59.8	56.9	74.5	72.3	73.3	44.0	71.9	88.9	83.2	85.3
Debt payment	5.4	-	3.4	3.8	6.5	11.2	11.0	19.3	3.7	1.9	4.3	2.7	0.8	6.5	3.6	0.4
Takeover/LBO	2.8	0.8	0.9	3.0	1.9	7.1	4.9	4.1	3.7	1.9	0.9	1.4	2.3	0.9	5.4	2.2
Capital expenditure	0.5	-	-	1.5	-	0.8	1.2	0.5	-	1.1	0.6	-	0.8	-	-	-
Refinancing	26.4	58.5	42.7	49.6	37.5	14.9	22.5	18.8	17.3	21.9	20.6	51.1	21.1	2.8	7.2	12.0
Stock buyback/Recap	0.5	0.8	-	-	0.9	4.2	0.3	-	0.8	-	-	-	-	-	-	-
Other	0.4	-	-	-	-	-	-	0.5	-	0.8	0.3	0.9	3.1	0.9	0.6	-

TABLE B: The likelihood of debt source: investment grade vs. speculative grade firms

This table reports the results of multinomial logistic regressions predicting the probability of debt source separated into an investment grade and a speculative grade sample. The data source is the incremental sample (N=5,079). Columns 1 & 4 and columns 2 & 5 report the log-odds ratios of the probability of issuing non-bank debt (144A) and public debt versus bank debt, respectively. Columns 3 & 6 report the log-odds ratio of the probability of issuing public debt relative to non-bank private debt. Variables are defined as in Table 3. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Investment firms			Speculative firms		
	Non-bank vs. Bank (1)	Public vs. Bank (2)	Public vs. Non-bank (3)	Non-bank vs. Bank (4)	Public vs. Bank (5)	Public vs. Non-bank (6)
Firm age (log)	-0.398	0.216	0.614	-0.047	-0.025	0.022
	(0.148)***	(0.084)**	(0.162)***	(0.074)	(0.119)	(0.132)
Firm size	-0.038	0.565	0.603	0.080	0.313	0.233
	(0.168)	(0.078)***	(0.177)***	(0.079)	(0.115)***	(0.130)*
Fixed asset ratio	-0.028	0.417	0.445	-0.179	0.642	0.821
	(0.536)	(0.244)*	(0.566)	(0.240)	(0.357)*	(0.404)**
Profitability	-3.196	-0.383	2.814	-2.974	-4.549	-1.575
	(2.389)	(1.504)	(2.652)	(0.797)***	(1.321)***	(1.438)
Altman's Z-score <1.81	0.148	0.055	-0.093	0.299	0.202	-0.097
	(0.494)	(0.210)	(0.519)	(0.194)	(0.292)	(0.329)
Earnings volatility	-3.840	-11.729	-7.888	-0.379	-2.973	-2.594
	(3.574)	(3.600)***	(4.913)	(0.656)	(1.727)*	(1.814)
A or better rating	-0.302	0.438	0.741			
	(0.309)	(0.144)***	(0.327)**			
B or better rating				0.887	2.215	1.327
				(0.175)***	(0.323)***	(0.352)***
Market to book	0.400	0.020	-0.380	0.255	0.181	-0.075
	(0.145)***	(0.101)	(0.162)**	(0.069)***	(0.123)	(0.130)
Leverage	-0.407	-0.226	0.181	0.134	-0.974	-1.108
	(1.490)	(0.810)	(1.608)	(0.532)	(0.853)	(0.950)
Principal amount (log)	-0.596	-1.135	-0.539	-0.148	-0.527	-0.379
	(0.154)***	(0.078)***	(0.161)***	(0.080)*	(0.112)***	(0.129)***
No outstanding public or private debt (t-1)	0.502	-0.081	-0.583	0.848	0.198	-0.651
	(0.345)	(0.189)	(0.372)	(0.172)***	(0.274)	(0.304)**
Regulated industry	-18.187	-22.652	-0.466	0.034	1.628	1.594
	(2.767)***	(1.222)***	(2.899)	(1.147)	(1.010)	(1.369)
Prime interest rate	-0.082	0.545	0.627	-0.907	0.062	0.969
	(0.185)	(0.086)***	(0.196)***	(0.109)***	(0.148)	(0.176)***
Slope	-0.298	0.260	0.558	-1.199	-0.140	1.058
	(0.319)	(0.144)*	(0.337)*	(0.183)***	(0.252)	(0.297)***
GDP growth	-0.235	-0.262	-0.027	-0.451	-0.346	0.105
	(0.133)*	(0.070)***	(0.145)	(0.072)***	(0.114)***	(0.127)
Interest rate volatility	0.248	-0.871	-1.120	0.146	-0.826	-0.972
	(0.339)	(0.195)***	(0.372)***	(0.197)	(0.339)**	(0.369)***
Constant	20.063	19.487	-4.574	5.889	-3.784	-9.674
	(0.000)	(1.646)***	(0.000)	(1.833)***	(2.285)*	(2.743)***
Observations	2208	2208	2208	2312	2312	2312
Pseudo R-squared	0.25	0.25	0.25	0.17	0.17	0.17

TABLE C: The likelihood of debt source: samples of 5-year periods

This table reports the results of multinomial logistic regressions predicting the probability of debt source for the samples of different 5-year periods. The data source is the incremental sample (N=5,079). Columns 1, 4 &7 and columns 2, 5 &8 report the log-odds ratios of the probability of issuing non-bank debt (144A) and public debt versus bank debt, respectively. Columns 3, 6&9 report the log-odds ratio of the probability of issuing public debt relative to non-bank private debt. Variables are defined as in Table 3. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	1993-1997			1998-2002			2003-2007		
	Non-bank vs. Bank	Public vs. Bank	Public vs. Non-bank	Non-bank vs. Bank	Public vs. Bank	Public vs. Non-bank	Non-bank vs. Bank	Public vs. Bank	Public vs. Non-bank
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Firm age (log)	0.293	0.207	-0.086	-0.354	0.149	0.502	-0.077	0.002	0.079
	(0.305)	(0.133)	(0.327)	(0.115)***	(0.121)	(0.160)***	(0.095)	(0.118)	(0.140)
Firm size	-0.067	0.448	0.515	0.065	0.441	0.376	0.128	0.778	0.650
	(0.238)	(0.112)***	(0.255)**	(0.117)	(0.116)***	(0.158)**	(0.106)	(0.117)***	(0.145)***
Fixed asset ratio	0.294	0.996	0.702	-0.205	-0.295	-0.090	-0.406	0.643	1.049
	(0.901)	(0.419)**	(0.968)	(0.398)	(0.368)	(0.516)	(0.294)	(0.344)*	(0.417)**
Profitability	-4.125	0.770	4.895	-3.074	-2.588	0.487	-1.432	-4.466	-3.034
	(2.662)	(2.070)	(3.228)	(1.260)**	(2.023)	(2.278)	(1.126)	(1.697)***	(1.854)
Altman's Z-score <1.81	0.665	-0.300	-0.965	0.196	0.035	-0.161	0.232	0.241	0.009
	(0.763)	(0.351)	(0.812)	(0.335)	(0.314)	(0.441)	(0.239)	(0.304)	(0.356)
Earnings volatility	-1.158	-2.463	-1.306	0.893	-11.770	-12.662	-0.720	-5.918	-5.198
	(1.786)	(1.950)	(2.581)	(1.067)	(5.226)**	(5.306)**	(1.027)	(3.393)*	(3.484)
Unrated firm	-2.454	-4.608	-2.154	-2.100	-3.022	-0.921	-1.014	-1.537	-0.523
	(0.701)***	(0.687)***	(0.963)**	(0.348)***	(0.812)***	(0.869)	(0.239)***	(0.409)***	(0.435)
Investment grade	-0.396	0.577	0.973	-0.511	1.354	1.866	-1.415	0.422	1.837
	(0.743)	(0.330)*	(0.792)	(0.287)*	(0.332)***	(0.419)***	(0.282)***	(0.284)	(0.370)***
Market to book	-0.092	-0.069	0.024	0.410	0.119	-0.291	0.211	0.590	0.379
	(0.248)	(0.176)	(0.288)	(0.092)***	(0.140)	(0.158)*	(0.111)*	(0.146)***	(0.165)**
Leverage	-3.957	-1.711	2.247	0.409	1.199	0.790	0.429	0.434	0.005
	(2.359)*	(1.131)	(2.538)	(0.914)	(1.094)	(1.363)	(0.716)	(1.045)	(1.168)
Principal amount (log)	-0.760	-1.117	-0.357	-0.086	-0.934	-0.848	-0.565	-1.169	-0.604
	(0.258)***	(0.115)***	(0.271)	(0.120)	(0.118)***	(0.161)***	(0.114)***	(0.125)***	(0.154)***
No outstanding public	0.745	-0.172	-0.917	0.850	-0.032	-0.882	1.385	0.501	-0.884
or private debt (t-1)	(0.581)	(0.255)	(0.617)	(0.248)***	(0.281)	(0.355)**	(0.232)***	(0.363)	(0.391)**

TABLE C (continued)

Regulated industry	-20.696	-18.945	-0.228	0.104	-17.774	-16.667	-0.953	-0.037	0.916
	(107.726)	(39.597)	(0.000)	(1.174)	(7.214)**	(10.836)	(1.629)	(1.187)	(1.908)
Prime interest rate	-23.354	-6.235	17.119	-1.636	-4.866	-3.230	2.129	3.901	1.772
	(10.391)**	(3.820)	(10.840)	(1.088)	(0.912)***	(1.366)**	(0.485)***	(0.587)***	(0.710)**
Slope	-35.309	-8.860	26.449	-2.807	-8.096	-5.289	3.281	5.089	1.809
	(15.581)**	(5.747)	(16.260)	(1.617)*	(1.341)***	(2.013)***	(0.735)***	(0.870)***	(1.064)*
GDP growth	-2.568	-0.943	1.626	-0.386	0.129	0.515	-0.878	-0.521	0.357
	(1.480)*	(0.532)*	(1.540)	(0.414)	(0.307)	(0.495)	(0.184)***	(0.201)***	(0.257)
Interest rate volatility	7.344	0.884	-6.459	1.113	2.546	1.433	5.671	6.423	0.752
	(3.623)**	(1.305)	(3.774)*	(0.853)	(0.737)***	(1.087)	(1.451)***	(1.418)***	(1.875)
Constant	238.930	88.668	-150.088	15.501	23.237	8.525	-30.983	-50.672	-20.688
	(0.000)	(0.000)	(0.000)	(8.793)*	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1143	1143	1143	1519	1519	1519	1858	1858	1858
Pseudo R-squared	0.44	0.44	0.44	0.30	0.30	0.30	0.30	0.30	0.30

TABLE D: The likelihood of debt source: low vs. high interest rate volatility

This table reports the results of multinomial logistic regressions predicting the probability of debt source for the samples of low and high interest rate volatility. The data source is the incremental sample (N=5,079). Columns 1 & 4 and columns 2 & 5 report the log-odds ratios of the probability of issuing non-bank debt (144A) and public debt versus bank debt, respectively. Columns 3 & 6 report the log-odds ratio of the probability of issuing public debt relative to non-bank private debt. Variables are defined as in Table 3. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Low interest rate volatility			High interest rate volatility		
	Non-bank vs. Bank (1)	Public vs. Bank (2)	Public vs. Non-bank (3)	Non-bank vs. Bank (4)	Public vs. Bank (5)	Public vs. Non-bank (6)
Firm age (log)	-0.073	0.104	0.177	-0.160	0.144	0.304
	(0.116)	(0.099)	(0.147)	(0.085)*	(0.088)	(0.115)***
Firm size	-0.020	0.406	0.427	0.111	0.593	0.482
	(0.114)	(0.087)***	(0.137)***	(0.089)	(0.084)***	(0.116)***
Fixed asset ratio	-0.253	0.534	0.787	-0.304	0.689	0.993
	(0.358)	(0.297)*	(0.445)*	(0.278)	(0.262)***	(0.360)***
Profitability	-2.406	-0.317	2.089	-1.976	-3.775	-1.799
	(1.238)*	(1.567)	(1.903)	(0.960)**	(1.278)***	(1.483)
Altman's Z-score <1.81	0.171	-0.100	-0.271	0.404	0.057	-0.348
	(0.309)	(0.258)	(0.385)	(0.224)*	(0.225)	(0.298)
Earnings volatility	-0.267	-8.806	-8.538	-0.400	-4.775	-4.375
	(0.933)	(3.354)***	(3.456)**	(0.908)	(2.565)*	(2.683)
Unrated firm	-2.077	-4.868	-2.791	-1.019	-1.587	-0.568
	(0.311)***	(0.760)***	(0.811)***	(0.216)***	(0.345)***	(0.387)
Investment grade	-1.126	0.497	1.624	-0.852	0.680	1.532
	(0.303)***	(0.247)**	(0.372)***	(0.230)***	(0.213)***	(0.292)***
Market to book	0.106	0.108	0.002	0.316	0.122	-0.194
	(0.123)	(0.129)	(0.167)	(0.072)***	(0.094)	(0.109)*
Leverage	0.011	-0.251	-0.262	-0.118	-0.767	-0.649
	(0.854)	(0.872)	(1.165)	(0.647)	(0.748)	(0.926)
Principal amount (log)	-0.225	-0.999	-0.774	-0.389	-1.003	-0.614
	(0.123)*	(0.091)***	(0.146)***	(0.093)***	(0.088)***	(0.119)***
No outstanding public	1.080	0.109	-0.971	1.045	-0.004	-1.049
or private debt (t-1)	(0.268)***	(0.211)	(0.325)***	(0.195)***	(0.226)	(0.280)***
Regulated industry	-0.097	0.108	0.205	-1.087	-0.032	1.056
	(1.259)	(1.486)	(1.876)	(1.287)	(0.995)	(1.537)
Prime interest rate	2.296	2.205	-0.092	-0.773	0.229	1.002
	(2.275)	(0.797)***	(2.369)	(0.146)***	(0.113)**	(0.179)***
Slope	7.114	4.350	-2.764	-0.654	0.415	1.069
	(5.320)	(1.845)**	(5.533)	(0.223)***	(0.202)**	(0.291)***
GDP growth	2.413	0.962	-1.451	-1.204	-1.000	0.204
	(1.120)**	(0.408)**	(1.170)	(0.134)***	(0.112)***	(0.163)
Interest rate volatility	39.715	14.103	-25.612	-2.454	-3.003	-0.549
	(22.498)*	(7.605)*	(23.357)	(0.406)***	(0.395)***	(0.528)
Constant	-44.265	-44.899	-1.634	-2.869	3.631	7.500
	(32.197)	(0.000)	(0.000)	(0.000)	(1.852)**	(0.000)
Observations	1907	1907	1907	2613	2613	2613
Pseudo R-squared	0.34	0.34	0.34	0.24	0.24	0.24

TABLE E: Estimating the proportions of debt mix: investment grade vs. speculative grade firms

This table reports the results of the fractional multinomial logistic model (FMLM) estimating the proportions in the debt mix for the samples of investment grade and speculative grade firms. The data source comes from the debt mix sample (N=11,329). The dependent variables are the proportions of outstanding bank debt, non-bank private debt, and public debt. Their definitions are as in Table 6. Columns 1 & 4 and columns 2 & 5 provide the log-odds ratios of the proportions of outstanding non-bank private debt and public debt relative to the proportion of outstanding bank debt, respectively. For comparison, columns 3 & 6 report the log-odds ratios of the proportion of outstanding public debt versus non-bank private debt. A or better rating is a dummy variable, taking 1 if the firm has a rating of A or above. Similarly, B or better rating is a dummy variable, equal to 1 if the firm has a rating of B or above. Other control variables are defined as in Table 3. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Investment firms			Speculative firms		
	Non-bank vs. Bank (1)	Public vs. Bank (2)	Public vs. Non-bank (3)	Non-bank vs. Bank (4)	Public vs. Bank (5)	Public vs. Non-bank (6)
Firm age (log)	-0.142	0.100	0.242	-0.099	0.197	0.296
	(0.041)***	(0.027)***	(0.046)***	(0.026)***	(0.039)***	(0.043)***
Firm size	-0.102	0.082	0.183	-0.213	0.033	0.246
	(0.035)***	(0.021)***	(0.038)***	(0.025)***	(0.031)	(0.038)***
Fixed asset ratio	-0.647	0.436	1.084	-0.175	0.161	0.336
	(0.141)***	(0.083)***	(0.158)***	(0.080)**	(0.115)	(0.133)**
Profitability	-3.215	-1.072	2.143	-3.938	-2.743	1.195
	(0.817)***	(0.512)**	(0.931)**	(0.338)***	(0.426)***	(0.474)**
Altman's Z-score <1.81	-0.068	-0.284	-0.216	0.137	0.428	0.291
	(0.125)	(0.069)***	(0.134)	(0.069)**	(0.082)***	(0.101)***
Earnings volatility	-0.516	0.556	1.072	0.821	0.853	0.032
	(1.513)	(0.955)	(1.636)	(0.364)**	(0.461)*	(0.542)
A or better rating	-0.113	0.363	0.476			
	(0.090)	(0.047)***	(0.095)***			
B or better rating				0.142	0.183	0.041
				(0.065)**	(0.082)**	(0.096)
Market to book	0.169	0.012	-0.157	0.265	-0.025	-0.290
	(0.053)***	(0.037)	(0.061)***	(0.032)***	(0.052)	(0.058)***
Leverage	-0.472	0.908	1.380	-0.526	-2.220	-1.694
	(0.453)	(0.271)***	(0.502)***	(0.198)***	(0.255)***	(0.302)***
No outstanding public or private debt (t-1)	-0.907	-2.013	-1.106	-1.873	-3.458	-1.585
	(0.158)***	(0.116)***	(0.194)***	(0.087)***	(0.165)***	(0.185)***
Regulated industry	-0.288	-0.613	-0.326	-1.718	1.217	2.935
	(0.211)	(0.328)*	(0.364)	(0.384)***	(0.323)***	(0.545)***
Prime interest rate	-0.616	0.324	0.939	-0.750	0.787	1.537
	(0.055)***	(0.027)***	(0.059)***	(0.038)***	(0.044)***	(0.054)***
Slope	-0.631	0.619	1.250	-1.078	1.301	2.379
	(0.092)***	(0.047)***	(0.098)***	(0.063)***	(0.075)***	(0.091)***
GDP growth	-0.207	0.021	0.228	-0.150	0.112	0.262
	(0.037)***	(0.020)	(0.040)***	(0.026)***	(0.030)***	(0.036)***
Interest rate volatility	0.244	-0.123	-0.367	-0.020	-0.275	-0.256
	(0.105)**	(0.058)**	(0.111)***	(0.081)	(0.092)***	(0.113)**
Constant	6.019	-4.732	-10.751	7.532	-8.092	-15.624
	(0.957)***	(0.475)***	(1.053)***	(0.681)***	(0.587)***	(0.768)***
Observations	4600	4600	4600	5652	5652	5652

TABLE F: Estimating the proportions of debt mix: low vs. high interest rate volatility

This table reports the results of the fractional multinomial logistic model (FMLM) estimating the proportions in the debt mix for the samples of low and high interest rate volatility. The data source comes from the debt mix sample (N=11,329). The dependent variables are the proportions of outstanding bank debt, non-bank private debt, and public debt. Their definitions are as in Table 6. Control variables are defined as in Table 3. Columns 1 & 4 and columns 2 & 5 provide the log-odds ratios of the proportions of outstanding non-bank private debt and public debt relative to the proportion of outstanding bank debt, respectively. For comparison, columns 3 & 6 report the log-odds ratios of the proportion of outstanding public debt versus non-bank private debt. All regressions include industry dummies based on the Fama-French 48 industry classifications. Standard errors are in parenthesis. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	Low interest rate volatility			High interest rate volatility		
	Non-bank vs. Bank	Public vs. Bank	Public vs. Non-bank	Non-bank vs. Bank	Public vs. Bank	Public vs. Non-bank
	(1)	(2)	(3)	(4)	(5)	(6)
Firm age (log)	-0.121	0.090	0.211	-0.090	0.190	0.280
	(0.036)***	(0.032)***	(0.045)***	(0.027)***	(0.029)***	(0.037)***
Firm size	-0.237	0.053	0.290	-0.202	0.159	0.361
	(0.033)***	(0.023)**	(0.038)***	(0.024)***	(0.022)***	(0.031)***
Fixed asset ratio	-0.452	0.295	0.747	-0.061	0.562	0.623
	(0.116)***	(0.097)***	(0.142)***	(0.082)	(0.092)***	(0.118)***
Profitability	-4.016	-1.829	2.188	-3.684	-2.449	1.234
	(0.498)***	(0.444)***	(0.609)***	(0.388)***	(0.474)***	(0.543)**
Altman's Z-score <1.81	0.057	0.004	-0.052	0.034	0.049	0.016
	(0.102)	(0.076)	(0.118)	(0.073)	(0.072)	(0.096)
Earnings volatility	1.067	0.997	-0.071	1.193	0.396	-0.796
	(0.471)**	(0.453)**	(0.636)	(0.567)**	(0.640)	(0.750)
Unrated firm	-0.933	-0.184	0.750	-0.056	0.277	0.332
	(0.118)***	(0.101)*	(0.147)***	(0.074)	(0.094)***	(0.110)***
Investment grade	-0.359	0.602	0.961	-0.324	0.747	1.071
	(0.093)***	(0.074)***	(0.108)***	(0.068)***	(0.065)***	(0.087)***
Market to book	0.167	0.017	-0.151	0.288	0.052	-0.236
	(0.042)***	(0.043)	(0.057)***	(0.034)***	(0.037)	(0.046)***
Leverage	-1.238	-1.329	-0.092	-0.184	-0.660	-0.476
	(0.295)***	(0.264)***	(0.374)	(0.224)	(0.257)**	(0.319)
No outstanding public or private debt (t-1)	-1.553	-2.764	-1.211	-1.688	-2.649	-0.961
	(0.112)***	(0.122)***	(0.165)***	(0.113)***	(0.155)***	(0.190)***
Regulated industry	-0.733	-1.702	-0.970	-0.463	-0.323	0.140
	(0.372)**	(0.481)***	(0.626)	(0.261)*	(0.393)	(0.541)
Prime interest rate	-0.833	0.554	1.387	-0.679	0.423	1.102
	(0.165)***	(0.119)***	(0.190)***	(0.046)***	(0.034)***	(0.055)***
Slope	-0.888	0.911	1.800	-0.761	0.678	1.439
	(0.356)**	(0.258)***	(0.413)***	(0.068)***	(0.057)***	(0.085)***
GDP growth	0.093	0.007	-0.086	-0.416	0.189	0.605
	(0.069)	(0.048)	(0.079)	(0.039)***	(0.034)***	(0.049)***
Interest rate volatility	0.984	-0.114	-1.099	-0.888	0.442	1.330
	(1.229)	(0.843)	(1.406)	(0.122)***	(0.121)***	(0.162)***
Constant	7.794	-4.704	-12.498	7.431	-7.854	-15.286
	(2.094)***	(1.500)***	(2.382)***	(0.697)***	(0.515)***	(0.830)***
Observations	5012	5012	5012	5240	5240	5240