Exploring the Hidden Risks in Firm Operations and their Financial Impacts

by

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Abstract

In this thesis, we explore the hidden risks in a firm's real operating process and the financial adjustments made as the risk changes. We investigate the risks associated with a firm's vertical channel (chapter 2 and 3) and geographic location (chapter 4), and analyze what financial consequences these risks bring. We firstly show strong evidence that a firm's cost of equity decreases as supplier immobility translates into a decrease in operating leverage and systematic risk. Next, we show that as the specificity of customers induces more cash flow instability, the firm's idiosyncratic risk increases with customer specificity. As a result, firms with more specific customers choose more conservative dividend payout policies to adjust for the risk changes. In the third essay, we examine the information risk from firm's geographic location. We find that this information risk affects a firm's capital structure choice and that centrally located firms have lower leverage ratios than do remotely located ones.

Co-Authorship

Chapter 2 (Essay 1) is co-authored with Jin Wang (Wilfrid Laurier University, Canada)

Chapter 4 (Essay 3) is co-authored with Jin Wang (Wilfrid Laurier University, Canada) and Lewis Johnson (Queen's University, Canada)

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Chapter 1

Introduction

A firm will adjust its financial strategies to changes in associated risks. It is important to link the risk changes to the fundamental operating processes which determine the risk. In this thesis, we provide a new viewpoint from a firm's vertical channel and investigate the firms' operating risk changes induced by their specific relationships with suppliers and customers. We also examine another relatively unexplored risk - the information risk associated with a firm's geographic location.

A firm's operating and financing policies should be closely related to the firm's vertical players - suppliers and customers. This is especially true if the economic linkages among the firms in the vertical chain entail significant relationship-specific investments (Kale, Kedia and Williams 2011). Previous research in product market and corporate finance shows that asset specificity and relationship-specific investments have an impact on firms' financial policies. Titman (1984) and Titman and Wessels (1988) find that firms which produce unique products have low leverage. Kale and Shahrur (2007) and Banerjee, Dasgupta, and Kim (2008) further show that the existence of bilateral customer-supplier relationships represented by relationship-specific investments negatively affects a firm's leverage ratio. However, there has been no study to investigate whether specific relationships with suppliers and customers have an impact on a firm's business risk and what financial consequences are associated with these risks. In this thesis, we decompose the specific vertical players' impacts on a firm's systematic risk and idiosyncratic risk. The first essay of my thesis shows strong evidence that a firm's cost of equity decreases as the supplier specificity translates into a decrease in the firm's operating leverage and a decrease in its systematic risk. The negative relation between supplier specificity and firm's cost of equity is robust to different measures of cost of equity. Moreover, cross-sectional analysis, industry level analysis and deleveraging analysis all support our results. Specifically, the decrease of the firm's systematic risk is associated with the negative impact from supplier specificity on the value (HML book-to-market) beta in the Fama-French three factor pricing model (Fama, French 1993).

The second essay shows that the more specific a firm's customers are, in other words, the less flexibly a firm can choose among its customers, the more likely the firm is subject to future cash flow instability transferred from the vertical relationship. Meanwhile, the idiosyncratic risk of a firm which mirrors its underlying cash flow volatility should also increase. The risk changes associated with customer specificity will induce adjustments of financial policies such as dividend payment. A firm should choose a more conservative dividend payment policy when the specificity of its customers is high. I exclude the explanation about the increasing idiosyncratic risk from the firm's horizontal competition. All the results are consistent over different time periods and robust to different combinations of controls.

In the third essay, we explore the information risk from a firm's geographical location and the impact on the firm's capital structure. Our study is closely related to the literature that examines how firms' geographic locations affect corporate decisions. Loughran (2008) finds it is difficult to sell equity for rural firms which have a significant information disadvantage. Another study on geography and bondholders (Francis, Hasan, and Waisman, 2007) shows that rural firms exhibit significantly higher agency costs and thus costs of debt in comparison to urban companies. Additionally, John, Knyazeva and Knyazeva (2008) show that rural firms pay more dividends and hold less cash to compensate for the asymmetric information costs for investors. However, in previous studies there has not been a focus on the geographic impact on capital structure. Our study contributes to this literature by providing evidence that geographic location affects one of the most important corporate decisions – the capital structure choice. We show that centrally located firms have lower leverage ratios than do remotely located ones. Moreover, consistent with the hypothesis that those remotely located firms face more severe adverse selection problems, the effect of geographic location on capital structure is more pronounced when information asymmetry risk is higher.

Overall, these essays provide useful information by suggesting that a firm's risks hidden in the real operating process matter to its financial strategies.

Chapter 2:

Supplier Immobility, Operating Leverage, and Cost of Equity

Abstract

In this paper we investigate how supplier immobility affects the customer firm's cost of equity. We use relationship-specific investments (RSI) undertaken by supplier firms as a proxy for supplier immobility. We find that high supplier immobility is associated with both low operating leverage and low cost of equity. These results are robust to a variety of model specifications and alternative measures of supplier RSI and cost of equity. Our findings suggest that the decision of a firm's input providers is an important determinant of its systematic risk.

Key Words: supplier immobility, cost of equity, operating leverage, relationship-specific investment, systematic risk

2.1 Introduction

The ability to reallocate resources across economy mitigates negative shocks and thus decreases the volatility of aggregate output. For individual firms, however, the mobility of the input factors may weaken their ability to withstand negative shocks and, consequently, increase their systematic risk and cost of equity. This issue is important as linking the decision of input providers to cost of equity sheds light on the source of a firm's systematic risk loading. Albeit its importance, prior studies on this issue are still relatively scant. An exception is the recent study by Donangelo (2011), who provides both theoretical and empirical evidence that the mobility of a firm's labor input is an important determinant of its equity risk and cost of equity. While this study enhances our understanding of the interaction between the mobility of a firm's input factors and its risk profile, it only addresses this interaction from the perspective of labor input. In particular, we know little about the impact of the mobility of a firm's physical input providers - its upstream suppliers on its equity risk and cost of equity.

In this paper we attempt to fill this gap by investigating how the immobility of a firm's suppliers affects its cost of equity. The idea of this supplier immobility effect can be summarized as follows: Firms compete for input from suppliers in the upstream industries. Some suppliers, such as automobile engine manufacturers, offer products tailored to customers' specific needs. Competition for inputs from these "immobile" suppliers is limited to downstream firms that use the customized products. Other industries, such as steel manufacturers, provide standardized products, which can be used by all firms in downstream industries. These suppliers are less "immobile" since they can sell products to other customers when negative customer-specific shocks occur. Therefore, customer firms that rely on mobile suppliers face more competition for inputs from the suppliers, which leads to input costs that are less affected by customer firm-specific performance and thus increase the customer firms' exposure to systematic risk.

In our empirical tests, we use proxies for relationship-specific investments (RSI) undertaken by a firm's suppliers to measure the firm's supplier immobility. A firm that relies more on suppliers' RSI faces relatively low supplier mobility because its suppliers are less able to sell products to other customers. Following Kale and Shahrur (2007), we use the weighted average R&D intensity of a firm's supplier industries to measure the firm's reliance on suppliers' RSI during the sample period 1990-2010.

To examine the impact of relationship-specific investments undertaken by a firm's suppliers on its cost of equity, we first examine the univariate association between suppliers' RSI and the implied cost of equity. In each year, we sort companies into three portfolios based on their supplier RSI. We observe a decreasing pattern in the cost of equity as the portfolio moves from the lowest supplier RSI to the highest supplier RSI. The difference in the implied cost of equity between the lowest supplier RSI portfolio and highest supplier RSI portfolio is statistically significant and equal to 60 (20) basis points per year for the mean (median) values.

Next, we confirm the existence of the negative relationship between supplier RSI and cost of equity using multivariate regressions. The results hold after we control for known determinants of cost of equity, such as total assets, leverage ratio, asset tangibility, firm age, sales growth rate, competition intensity, sales beta and stock return volatility, as well as industry and year fixed effects. The impact of supplier RSI on cost of equity is economically significant as well. In particular, the cost of equity decreases by approximately 70 basis points if the firm moves from the 5th percentile supplier RSI to the 95th percentile supplier RSI, holding other firm characteristics constant. The decrease represents about eight percent of the sample average for the cost of equity.

To further determine the nature of the negative relationship between supplier RSI and cost of equity, we conduct two additional tests. In the first test, we investigate how this relationship is affected by the likelihood of financial distress. If the negative relationship arises because a high level of supplier RSI increases the firm's ability to reduce input costs when negative shocks occurs, this negative relationship should be more pronounced for firms that are more likely to enter financial distress. We use the cash flow ratio, the interest coverage ratio, the leverage ratio, and default probability to capture a firm's likelihood of entering financial distress. Consistent with expectations, we find that the negative relationship between supplier RSI and cost of equity is more pronounced for firms that are more likely to enter financial distress.

In the second test, we examine that how supplier RSI affects a firm's operating leverage. Operating leverage indicates the sensitivity of a firm's operating cash flows to its total sales (Mandelker and Rhee (1984)). If a high level of supplier RSI leads to reduced input costs when firm-specific negative shock occurs, then a negative relationship between supplier RSI and operating leverage should arise. Consistent with this conjecture, we find a negative relationship between supplier RSI and operating leverage. Prior studies show that a firm's operating leverage has a significant impact on its cost of equity (Lev (1974), Booth (1991)). Thus, our results regarding the negative relationship between supplier RSI and operating leverage further support the evidence on the negative effect of supplier RSI on cost of equity.

To verify the validity of our results, we perform a number of robustness tests. First, we use an alternative measure of cost of equity. Specifically, we use the Fama-French three factor model (Fama, French 1993) to estimate expected stock returns. Consistent with our prior results, we find a negative relationship between supplier RSI and expected stock return. Furthermore, we examine on which factor loadings supplier RSI has impact. In particular, we investigate the relationship between supplier RSI and each of the loadings on the Fama-French three factors: market excess return, SMB, and HML. Our results indicate that supplier RSI reduces a firm's systematic risk mainly by lowering HML beta. Prior studies suggest that the book-to-market ratio explains the cross section of stock returns because it is correlated with operating leverage (e.g., Carlson et al. (2004), Cooper (2006), and Gourio (2007)). Thus, the evidence that supplier RSI affect systematic risk through HML beta is consistent with the conjecture that supplier immobility reduces customer firms' operating leverage and thus the cost of equity.

Second, we use an alternative measure of supplier firms' RSI. Following Fee, Hadlock, and Thomas (2005), and Kale and Shahrur (2007), for each supplier industry, we use the intensity of strategic alliances and joint ventures (SA/JVs) with downstream industries instead of that of R&D as an alternative measure of supplier RSI. Suppliers that undertake more RSI are more likely to establish SA/JVs with the downstream firms as well. Using this alternative measure of RSI, we again find a negative relation between the intensity of customer-supplier SA/JVs and cost of equity.

Third，we use an operating cost-based measure of operating leverage to examine that how it is affected by supplier RSI. We follow Novy-Marx (2011) to define operating leverage as annual operating costs divided by total assets. If a high level of supplier RSI leads reduces input costs when firm-specific negative shock occurs, then the firm's total operating costs is also reduced and a negative relationship between supplier RSI and the cost-based operating leverage should exist. Consistent with our expectation, we find a negative relationship between supplier RSI and operating leverage. Prior studies show that a firm's operating leverage has a significant impact on its cost of equity (Lev (1974), Booth (1991)). Thus, our results regarding the negative relationship between supplier RSI and operating leverage further support the evidence on the negative effect of supplier RSI on the cost of equity.

Fourth, since we use the average R&D expenses of a firm's supplier industries to capture the RSI undertaken by its actual suppliers, one concern is that the RSI measure may be subject to the measurement error problem. To address this concern, we perform industry-level analyses, where all of the variables are the average of the firms in the same IO industries. Consistent with the results from the firm-level analyses, both cost of equity and operating leverage are negatively related to supplier RSI.

Finally, given the negative relation between supplier RSI and financial leverage ratio documented by Kale and Shahrur (2007), we are concerned that the negative effect of supplier RSI on cost of equity might be driven by the low leverage ratios in firms with high supplier RSI. To mitigate this concern, we test the relationship between supplier RSI and the unlevered cost of equity. The negative relationship between supplier RSI and the cost of equity still holds.

To the best of our knowledge, our paper is the first study on the relation between supplier firms' mobility and cost of equity. The paper is closely related to Donangelo (2011), who shows that labor mobility has a positive effect on cost of equity. Consistent with his results, our findings suggest that firms with less mobile supplier firms are subject to lower cost of equity. More broadly, our paper is related to the literature on the relation between labor-induced operating leverage and cost of equity. Examples are Danthine and Donaldson (2002) on operating leverage induced by fixed labor costs, and Chen, Kacperczyk, and Ortiz-Molina (2011) on operating inflexibility caused by labor union. Similar to those studies, we find that supplier firms' inability to switch customers decreases the customer firms' operating flexibility, which in turn reduces customer firms' cost of equity.

This paper is also related to the literature on how a firm's relationship with its non-financial stakeholders influences a wide spectrum of corporate policies, such as capital structure choice (Titman, 1984; Titman and Wessels, 1988; Maksimovic and Titman, 1991; Kale and Shahrur, 2007; Banerjee, Dasgupta, and Kim, 2008; Bae, Kang, and Wang, 2011), payout policies (Wang, 2012), cash holding policies (Bae and Wang, 2012), corporate governance choice (Cen, Dasgupta, and Sen, 2012; Johnson, Karpoff, and Yi, 2012), the design of CEO compensation (Arora and Alam, 2005), information disclosure (Almazan, Suarez and Titman, 2006), and earnings management (Raman and Shahrur, 2008). While these studies focus on how the relationships with non-financial stakeholders affect corporate policies, our paper offers direct evidence on the benefits of establishing such relationships.

The rest of the paper proceeds as follows. In Section 2, we provide details of the data sources and details of variable construction. In Section 3, we present the main empirical results. We perform a number of robustness tests in Section 4. Section 5 concludes the paper.

2.2 Variable definitions and sample construction

In this section, we first provide details about the definitions of the variables used in this paper, including supplier R&D intensity, implied cost of equity, and other variables. Then we describe the procedure to construct our main sample.

2.2.1. Supplier R&D intensity

We start from the Use table of the benchmark input-output (IO) accounts from the US Bureau of Economic Analysis. For any pair of supplier and customer industries, the Use table reports estimates of the dollar value of the supplier industry's output that is used as an input in the production of the customer industry's output. The Use table thus enables us to identify a firm's supplier industries and the importance of each supplier industry to the firm. The Use tables are updated every five years, with 2002 version the most recent one. Since 1997, benchmark accounts are constructed based on the North American Industry Classification System (NAICS) instead of the SIC coding system. To be consistent across the sample period, we only use the NAICS-based Use tables. In particular, we use the 1997 and 2002 Use tables for the sample periods 1990–1999 and 2000-2010, respectively. As a robustness check, we also use the 1992 SIC-based Use table for the entire sample period and obtain similar results.

Following the method in Kale and Shahrur (2007), for each IO industry, we measure its supplier R&D intensity as the weighted average of the R&D intensities of the supplier industries. The weight is retrieved from IO Use tables and captures the importance of the input purchased from each supplier industry in the production of the customer industry's output. The supplier R&D intensity is given by the following equation:

$$\text{Supplier Industries R\&D Intensity}$$
$$= \sum \text{Supplier Industry R\&D Intensity}_j \; * \textit{Industry Input Coefficient}_{j,i}$$

where Supplier Industry R&D Intensity$_j$ is the j^{th} supplier industry's R&D expenditures divided by its total assets, and Industry Input Coefficient$_{j,i}$ is the dollar amount of the j^{th} supplier industry's output used as an input to produce one dollar of the output of the i^{th} industry. The supplier R&D intensity measure is high if the firm outsources a significant part of its inputs from R&D intensive supplier industries. Kale and Shahrur (2007) argue that a high level of supplier R&D intensity is associated with more RSI undertaken by supplier firms.

Ideally, one should use the R&D of a firm's actual suppliers as a proxy for the RSI undertaken by the suppliers. Unfortunately, the information about a firm's major suppliers is not publicly available.[1] Using industry-level data on customer-supplier relationships not only allow us to build a large-scale sample, but also mitigates the potential endogeneity problem. As pointed out by Kale and Shahrur (2007) and Kale, Kedia, and Williams (2011), endogeneity issues that are endemic to corporate finance research are likely to be significantly less severe in tests that relate a firm characteristic to variables measured for supplier industries than to variables measured for supplier firms.

Table 2-1 lists the ten industries with the highest and the lowest supplier R&D intensity. In the cross section, we observe a significant variation in supplier R&D intensity across different industries. Electronic computer, biological product and

[1] Before 1997, firms are required to report the identities of their major customers according to the Statement of Financial Accounting Standard (SFAS) No 14. Thus, if a firm is reported as a major customer, one can obtain the information about the reporting supplier. However, only a very small number of firms in our sample are reported as a major customer by their suppliers. Furthermore, after 1997, SFAS No. 14 is replaced by SFAS No. 131 and, consequently, firms are no longer required to report the identities of their major customers.

medicinal manufacturing are among those with the highest supplier R&D intensity, with average supplier R&D intensity above 6% during the period 1990–2010. In contrast, service-related and farm-related industries have an average supplier R&D intensity of about 0.2%.

Table 2-1: Supplier R&D Intensity for Selected Industries: 1990-2010

The table reports R&D intensity of industries defined by the benchmark input-output (IO) accounts for the US economy on the Bureau of Economic Analysis website. We compute the R&D intensity of each industry as the sum of the R&D expenses of all firms in the industry scaled by the sum of total assets of those firms. According to the average industry R&D intensity over the period 1990-2010, we identify the ten most and ten least R&D intensive industries.

Panel A: Industries with Highest R&D Intensity

IO Industry Code	Average R&D Intensity	Industry
334111	0.066	Electronic computer manufacturing
325414	0.063	Biological product (except diagnostic) manufacturing
334418	0.058	Printed circuit assembly (electronic assembly) manufacturing
334112	0.058	Computer storage device manufacturing
325411	0.058	Medicinal and botanical manufacturing
325413	0.052	In-vitro diagnostic substance manufacturing
334113	0.050	Computer terminals and other computer peripheral equipment manufacturing
334220	0.049	Broadcast and wireless communications equipment
334515	0.047	Electricity and signal testing instruments manufacturing
334210	0.046	Telephone apparatus manufacturing

Panel B: Industries with Lowest R&D Intensity

IO Industry Code	Average R&D Intensity	Industry
31161A	0.001	Animal (except poultry) slaughtering, rendering, and processing
515100	0.002	Radio and television broadcasting
311210	0.002	Flour milling and malt manufacturing
311615	0.002	Poultry processing
31131A	0.002	Sugar cane mills and refining
321912	0.002	Cut stock, resawing lumber, and planing
311911	0.002	Roasted nuts and peanut butter manufacturing
324110	0.002	Petroleum refineries
221200	0.002	Electric power generation, transmission, and distribution
311225	0.003	Fats and oils refining and blending

2.2.2 Implied cost of equity

To estimate a firm's cost of equity, we follow Gebhardt, Lee, and Swaminathan (GLS, 2001)'s valuation model that has been commonly used in academic research (for example, Chen, Kacperczyk, and Ortiz-Molina (2011), Lee, Ng, and Swaminathan (2009), and Pastor, Sinha and Swaminathan (2008)).[2] The implied cost of equity is inferred from equity prices and other variables in the model, such as future cash earnings. We use estimation period of 12 years (k = 12) to construct the implied cost of equity for the regressions in our study. We rearrange GLS (2011)'s cost of equity estimation formula as following,

$$M_t = B_t + \sum_{k=1}^{11} \frac{E_t[(ROE_{t+k} - R) * B_{t+k-1}]}{(1+R)^k} + \frac{E_t[(ROE_{t+12} - R) * B_{t+11}]}{R * (1+R)^{11}}$$

Where we solve for R as a firm's implied cost of equity. M_t is market price of a firm at year t. We estimate the expected ROE in years $t+1$ to $t+3$ using the analysts' earnings forecasts (from I/B/E/S) and book equity determined based on clean surplus accounting ($B_{t+k} = B_{t+k-1} + E_{t+k} - D_{t+k}$, where E_{t+k} is the earnings in year $t+k$, D_{t+k} is the dividend in year $t+k$, computed using the current dividend payout ratio for firms with positive earnings, or using current dividends divided by 0.06 × total assets as an estimate of the payout ratio for firms with negative earnings). After year $t+3$, we assume that the expected ROE mean-reverts to the historical industry median value by year $t+k$. We exclude those resulting values of cost of equity over 0.5 and less than 0.

[2] Guay, Kothari, and Shu (2006) point out that this model outperforms other models in their survey.

2.2.3. Other variables

Following Chen, Kacperczyk, and Ortiz-Molina (2011), we control for a set of firm characteristics, including total assets, R&D intensity, leverage ratio, asset tangibility, firm age, sales growth rate, and stock return volatility, as well as industry characteristics, including competition intensity and revenue cyclicality. Total assets is defined as the natural logarithm of the book value of total assets (item: AT). R&D intensity is the ratio of R&D expenses (item: XRD) to the book value of total assets (item: AT). We set it to zero if its value is missing. Leverage ratio is calculated as the book value of long term debt (item: DLTT) divided by total assets (item: AT). Asset tangibility is defined as the ratio of net fixed assets (item: PPENT) to book value of total assets (item: AT). Firm age is the natural logarithm of the number of years a firm has been listed in CRSP until year t. Sales growth rate is the change in the natural logarithm of a firm's net sales (item: SALE). Stock return volatility is the standard deviation of a firm's monthly stock returns during the calendar year. Competition intensity is measured by Herfindahl-Hirschman Index in the IO industry. It is calculated by squaring the market share of each firm in an IO industry, and then summing the resulting numbers. Sales beta is the cyclicality of revenues in the IO industry. It is computed using quarterly data as the slope from a full-sample time-series regression of changes in log industry net sales over the one-year period on log GDP growth. To ensure that our results are not driven by micro firms, we drop those observations with total assets smaller than 10 million dollars. To reduce the impact of outliers, we also winsorize sales beta at the 5% level, and R&D intensity, leverage ratio, asset tangibility, sales growth rate, competition intensity, and stock return volatility at the 1% level. Table 2-2 reports summary statistics for the variables we use in main regression.

Table 2-2: Summary Statistics

The table reports summary statistics for the variables we use in main regression. The sample covers all Compustat firm during the period 1990-2010 and contains 46737 firm-year observations. We exclude financial institutions (SIC codes 6000 to 6999) and utilities (SIC codes 4900 to 4999) from the sample. The Appendix provides a detailed description of the construction of all of the variables used in the table.

Variable	Mean	Median	Std. Dev.	5^{th}	95^{th}
Implied cost of equity	0.096	0.088	0.051	0.039	0.175
Supplier R&D intensity	0.016	0.011	0.014	0.004	0.047
Total assets	6.173	5.989	1.819	3.477	9.521
R&D intensity	0.041	0.000	0.074	0.000	0.187
Leverage ratio	0.175	0.135	0.178	0.000	0.516
Asset tangibility	0.291	0.226	0.229	0.035	0.776
Firm age	2.258	2.303	1.092	0.000	3.951
Sales growth rate	0.135	0.102	0.281	-0.230	0.606
Stock return volatility	0.136	0.119	0.077	0.051	0.281
Competition intensity	0.238	0.164	0.215	0.043	0.739
Sales beta	2.462	1.962	2.271	-1.126	7.915

2.2.4. Sample construction

To construct the sample, we use all U.S. firms covered by Compustat and CRSP from 1990 to 2010 that have non-missing value in implied cost of equity. We exclude financial firms (SIC codes between 6000 and 6999) and utility firms (SIC codes between 4900 and 4999) because their cost of equity may be affected by regulations rather than the economic reasons studied in this paper. We restrict our sample to firms in the CRSP-Compustat merged database with non-missing value on the cost of equity, supplier RSI, and the set of control variables. Our final sample includes 46,737 firm-year observations, corresponding to 6,475 firms during the period 1990–2010.

2.3 Empirical results

In this section, we first investigate whether supplier RSI affect cost of equity using both univariate and multivariate approaches. We use supplier R&D intensity as the measure of supplier RSI and examine its impact on GLS (2001)'s implied cost of equity. To further determine the nature of the effect, we examine 1) how the effect varies across firms with different likelihood of entering financial distress, and 2) whether supplier RSI affect a firm's operating leverage.

2.3.1. The relation between supplier RSI and the implied cost of equity

We first examine the univariate association between supplier RSI and a firm's implied cost of equity. For each year, we sort firms into three portfolios based on their supplier R&D intensity. We then compute the average implied cost of equity for each portfolio. The results in Table 2-3 indicate a decreasing pattern in the cost of equity as we move from the low to the high supplier R&D intensity portfolio for the whole sample period. Specifically, the difference in the implied cost of equity between the lowest supplier RSI portfolio and highest supplier RSI portfolio is statistically significant and equal to 60 (20) basis points per year for the mean (median) values. We further divide the whole sample period into four subperiods and check this pattern for each subperiod. We find that the decreasing pattern holds consistently over each subperiod. The differences in the implied cost equity between the high and the low supplier RSI portfolios are statistically significant in all subperiods.

Table 2-3: Supplier R&D Intensity and Cost of Equity – Univariate Evidence

The table reports average cost of equity of subsamples sorted by supplier R&D intensity. For each year, we divide the sample firms into three subgroups according to their supplier R&D intensity. We compute the average implied cost of equity for each subgroup, and then take the average and median across the whole sample period 1990-2010 and different periods over 1990-1994, 1995-1999, 2000-2004 and 2005-2010.

Variables	All	1990-1994	1995-1999	2000-2004	2005-2010
	Mean	Mean	Mean	Mean	Mean
Low supplier R&D intensity	0.096	0.093	0.098	0.095	0.098
Medium supplier R&D intensity	0.094	0.092	0.096	0.093	0.094
High supplier R&D intensity	0.090	0.092	0.088	0.088	0.093
Low-high difference (*p*-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	Median	Median	Median	Median	Median
Low supplier R&D intensity	0.093	0.092	0.094	0.094	0.090
Medium supplier R&D intensity	0.091	0.090	0.093	0.092	0.090
High supplier R&D intensity	0.091	0.090	0.091	0.088	0.086
Low-high difference (*p*-value)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Next, we conduct multivariate analyses to investigate the relationship between supplier RSI and implied cost of equity using a panel OLS approach. Following Chen, Kacperczyk and Ortiz-Molina (2011), we use total assets, leverage ratio, asset tangibility, firm age, sales growth rate, competition intensity, sales beta, and stock return volatility as the set of control variables. To ensure that supplier R&D intensity is not simply a proxy of the firm's own R&D intensity, we also include the firm's own R&D intensity as a control variable. In addition, we control for differences in the cost of equity across industries by including two-digit NAICS industry dummies and control for differences in the cost of equity across time by including year dummies. The regression results are presented in Table 2-4.

Table 2-4: Supplier R&D Intensity and Cost of Equity - Panel Regressions

This table reports the results from panel regressions of firms' implied cost of equity on their Supplier R&D Intensity and a set of control variables. The dependent variable is the implied cost of equity (ICE). The Appendix provides a detailed description of the construction of all of the variables used in the table. All regressions include year and major NAICS industry fixed effects. For the sake of brevity, the coefficient estimates on industry and year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at the firm level.

Variables	Dependent variable: Implied cost of equity			
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-0.099	-0.169	-0.179	-0.181
	(0.04)	(0.00)	(0.00)	(0.00)
Total assets		-0.005	-0.003	-0.003
		(0.00)	(0.00)	(0.00)
R&D intensity		-0.017	-0.024	-0.024
		(0.06)	(0.00)	(0.00)
Leverage ratio			0.034	0.034
			(0.00)	(0.00)
Asset tangibility			-0.001	-0.001
			(0.79)	(0.76)
Firm age			-0.002	-0.002
			(0.00)	(0.00)
Sales growth rate			-0.009	-0.009
			(0.00)	(0.00)
Stock return volatility			0.105	0.104
			(0.00)	(0.00)
Competition intensity				-0.001
				(0.71)
Sales beta				0.000
				(0.68)
Intercept	0.109	0.135	0.117	0.118
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	46,737	46,737	46,737	46,737
R^2	0.034	0.055	0.089	0.089

Column (1) presents the results from regressing firm's implied cost of equity on supplier R&D intensity without any controls. The coefficient for supplier R&D intensity is negative and significant at the 5% level. This result further supports our findings in the univariate tests.

In the rest of columns, we expand the set of control variables by including firm/industry characteristics that may affect the firm's cost of equity. We firstly control for the basic firm characteristics such as total assets and firm's own R&D intensity that are likely to affect the relation between the R&D-based supplier RSI measure and cost of equity. Column (2) shows that the coefficient estimate on supplier RSI remains negative and significant at the 1% level. In addition, both total assets and R&D intensity are negatively related to cost of equity. These predictions are consistent with prior studies that larger firms and more R&D intensive firms are associated with lower cost of equity capital.

Next, we augment the model in column (2) by adding controls for additional firm characteristics such as leverage ratio, asset tangibility, firm age, sales growth rate, and stock return volatility. As shown in column (3), adding these controls does not weaken the impact of supplier RSI on cost of equity. The negative supplier RSI impact holds significant at the 1% level. Moreover, consistent with expectation, the coefficient estimates on leverage ratio and stock return volatility are positive and significant. The coefficients on firm age and sales growth rate are negative and significant, suggesting that more mature and better performed firms have lower cost of equity.

In column (4), we add industry characteristics such as competition intensity and sales beta. The coefficient for supplier R&D intensity is -0.181 and remains statistically significant at the 1% level.

2.3.2. The effect of financial distress likelihood on the negative relation between supplier RSI and implied cost of equity

In the previous section, we document a negative relation between a firm's supplier RSI and its cost of equity. If this negative relation arises because suppliers that undertake more RSI are more likely to accept reduced input prices when negative customer firm-specific shocks occur, we expect that such a relation is more pronounced when the customer firm is more likely to enter financial distress. This is because as the negative customer firm-specific shocks occur, RSI undertaken by supplier firms lose more value if the customer is closer to financial distress.

To explore this issue, we investigate the cross-sectional variation in the negative relationship between supplier RSI and cost of equity across firms with different likelihood of financial distress. In doing so, we augment the baseline regression model by adding measures of the likelihood of financial distress and its interaction with supplier RSI. We expect the coefficient estimates on the interaction terms to be significant and have a sign consistent with the above conjecture.

We use four proxies for the likelihood of financial distress. The first proxy is the ratio of a firm's operating cash flow to total assets. A higher cash flow ratio indicates that the firm has more resources to survive the negative shock and thus is less likely to enter financial distress. We expect that the negative impact of supplier RSI on cost of equity is less pronounced for firms that are less vulnerable to negative shock. Thus, the coefficient estimate on the interaction between supplier RSI and the cash flow ratio is predicted to be positive.

The second proxy is the interest coverage ratio, defined as earnings before interest and taxes divided by the interest expenses. A firm with higher interest coverage ratio tends to have more liquid assets to fulfill its short-term financial obligations and therefore is less likely to enter financial distress. Thus, the coefficient estimate on the interaction between supplier RSI and the interest coverage ratio is predicted to be positive too.

The third proxy is the leverage ratio. A firm with higher level of debt is more likely to face financial distress, which should strengthen the effect of supplier RSI on cost of equity. Therefore, the coefficient estimate on the interaction between supplier RSI and the leverage ratio is predicted to be negative.

Our last proxy is a comprehensive measure of default probability, estimated from Campbell, Hilscher, and Szilagyi (2010)'s dynamic logit model using eight most related accounting and market variables. The coefficient estimate on the interaction between supplier RSI and the default probability is predicted to be negative.

We present regression results in Table 2-5. The variables of interest are those interaction terms between supplier RSI and the proxies for the likelihood of financial distress. For the sake of brevity, we omit the coefficient estimates on the control variables.

Table 2-5: Cross-Sectional Variation in the Supplier R&D Intensity Effect

This table reports how the effect of supplier R&D intensity on cost of equity varies across firms with different likelihood of entering financial distress. We use cash flow ratio, interest coverage ratio, leverage ratio and default probability from Campbell, Hilscher, and Szilagyi1 (2010) as proxies for firms' likelihood of entering financial distress. The dependent variable is the implied cost of equity, which is regressed on supplier R&D intensity, the interaction term between supplier R&D intensity and proxies for firms' financial distress likelihood and a set of control variables. The Appendix provides a detailed description of the construction of all of the variables used in the table. All regressions include year and major NAICS industry fixed effects. For the sake of brevity, coefficient estimates are reported only on supplier R&D intensity and interaction variables. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at the firm level.

	Dependent variable: Implied cost of equity			
Variables	*Cash flow ratio*	*Interest coverage ratio*	*Leverage ratio*	*Default probability*
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-0.179	-0.230	-0.064	-0.014
	(0.00)	(0.00)	(0.20)	(0.74)
Supplier R&D intensity	0.163			
* *Cash flow ratio*	(0.01)			
Supplier R&D intensity		0.190		
**Interest coverage ratio*		(0.01)		
Supplier R&D intensity			-0.116	
**Leverage ratio*			(0.09)	
Supplier R&D intensity				-0.131
* *Default probability*				(0.02)
All regressions include the full set of control variables used in Table 5: Total assets, R&D intensity, Leverage ratio, Asset tangibility, Firm age, Sales growth rate, Stock return volatility, Competition intensity and Sales beta.				
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	46737	46456	46737	46,223
R^2	0.082	0.080	0.070	0.070

Columns (1) and (2) show that the coefficient estimates on *supplier R&D intensity*cash flow ratio* and on *supplier R&D intensity*interest coverage ratio* are both positive and statistically significant. These results suggest that the negative impact of supplier RSI on cost of equity is weaker for firms that are less likely to enter financial distress.

Consistent with the results in columns (1) and (2), columns (3) and (4) show that the coefficient estimates on *supplier R&D intensity*leverage ratio* and on *supplier R&D intensity*default probability* are significantly negative, suggesting that the negative impact of supplier RSI on cost of equity is stronger for firms that are more likely to enter financial distress.

2.3.3. Supplier RSI and firm operating leverage

Our hypothesis implies a negative relation between supplier RSI and operating leverage. Operating leverage captures the sensitivity of a firm's operating cash flows to its total sales. If suppliers with high RSI are more likely to accept reduced input prices, customer firm's operating cash flow should be less sensitive to total sales when customer firm-specific negative shocks occur. To explore this issue, we estimate the multivariate regression model to examine the relationship between supplier RSI and customer operating leverage.

Following Mandelker and Rhee (1984), we estimate total operating leverage as the elasticity of a firm's operating income after depreciation with respect to its sales, using the 15 most recent quarterly observations. For firms with positive EBIT, we calculate this elasticity by estimating the time-series quarterly regression of log EBIT on log SALES.

For firms with at least one negative value of EBIT within a given series, we approximate the elasticity by estimating a similar regression of EBIT on sales and then multiplying the coefficient on sales by the ratio of average sales to average operating income calculated over the estimation period. Rather than obtaining only one number by regressing cash flows against sales using all time period observations, this method provides a dynamic operating leverage measure. We further winsorize this operating leverage measure at the 5% level.

Following Chen, Kacperczyk, and Ortiz-Molina (2011), we use total assets, market-to-book ratio, asset tangibility, leverage ratio, firm age, and competition intensity as controls to conduct a group of tests. Among them, market-to-book ratio is estimated as the market value of the firm's common equity over the book value of the firm's common equity, which is the market value of common equity (PRCC_F*CSHO) divided by the book value of common equity (CEQ) and winsorized at the 1% level. Other variables are defined as before. In addition, as our supplier RSI is an R&D-based measure, we control for the firm's R&D intensity to ensure that the effect of supplier RSI on cost of equity is not driven by the customer firm's own R&D activities. We report results in Table 2-6.

Table 2-6: Supplier R&D Intensity and Firm Operation Leverage

The table reports the results from panel regressions of firm operating leverage on its Supplier R&D intensity and a set of control variables. The Appendix provides a detailed description of the construction of all of the variables used in the table. All regressions include year and major NAICS industry fixed effects. For the sake of brevity, the coefficient estimates on industry and year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at the firm level.

Variables	Dependent variable: operating leverage			
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-4.444	-2.836	-2.764	-2.450
	(0.00)	(0.04)	(0.04)	(0.08)
Total assets		-0.072	-0.058	-0.093
		(0.00)	(0.00)	(0.00)
R&D intensity		-1.248	-1.153	-1.099
		(0.00)	(0.00)	(0.00)
Market to Book ratio			-0.035	-0.034
			(0.00)	(0.00)
Leverage ratio			-0.445	-0.360
			(0.00)	(0.00)
Asset tangibility				-0.145
				(0.05)
Firm age				0.167
				(0.00)
Competition intensity				-0.021
				(0.74)
Intercept	1.322	1.712	1.775	1.584
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	37,260	37,260	37,260	37,260
R^2	0.023	0.029	0.036	0.044

Consistent with the prediction, results in column (1) indicate that supplier RSI has a negative effect on operating leverage. The coefficient estimate on supplier RSI is equal to -4.444 and statistically significant at the 1% level. We expand the model by adding different controls of firm characteristics in columns (2)-(4). The results show that for all the model specifications, the coefficient estimates on supplier RSI remain negative and statistically significant. Since prior studies suggest that a firm's operating leverage is positively related to its systematic risk and cost of equity, the evidence reported in Table 2-6 that supplier RSI is negatively related to operating leverage is consistent with our prior evidence that higher supplier RSI results in lower cost of equity.

2.4 Additional tests

In this section, we perform a number of additional tests to verify the negative relation between supplier RSI and cost of equity. We first conduct two tests using alternative measures of cost of equity and supplier RSI, respectively. Next, we replicate estimation of the baseline model at the industry level as opposed to the firm level. Finally, we address the concern that the relatively low debt ratio in customer firms may affect our results.

2.4.1. Supplier RSI, Fama-French cost of equity, and systematic risk

In previous analyses on the relation between supplier R&D intensity and the cost of equity, we use GLS's (2001) methodology to estimate a firm's implied cost of equity. In this section, we use the cost of equity derived from the Fama-French (1993) three factor model as an alternative measure, which assumes firm's cost of equity is a linear combination of returns on factors including market, size, and value. Moreover, to uncover how systematic risk changes with supplier RSI, we investigate the relationship between supplier RSI and each of the Fama-French factor loadings. We refer to the loadings on these factors as market beta, SMB beta, and HML beta, respectively.

We estimate the Fama-French three factor time-series regression model using monthly data from year $t + 1$ to year $t + 3$.The model is as follows:

$$R_j - R_f = \alpha_{j,t} + Market\ Beta_{j,t} * MKT + SMB\ Beta_{j,t} * SMB + HML\ Beta_{j,t} * HML$$

where $R_j - R_f$ is the monthly return on stock j minus the risk-free rate, *MKT* is the excess return of the market portfolio over the risk-free rate, *HML* is the return difference between stocks with high and low book-to-market ratios, and *SMB* is the return difference between small and large capitalization stocks. From the regressions, we get the time-series loadings on the factors as $Market\ Beta_{j,t}$, $SMB\ Beta_{j,t}$, and $HML\ Beta_{j,t}$ in the model.

We then construct the Fama-French cost of equity in year t as follows:

$$Fama\text{-}French\ Cost\ of\ Equity_t$$

$$= R_f + Market\ Beta_{j,t} * \overline{MKT} + SMB\ Beta_{j,t} * \overline{SMB} + HML\ Beta_{j,t} * \overline{HML}$$

Where R_f, $\overline{MKT}$, $\overline{SMB}$, *and* $\overline{HML}$ are the average annualized returns of the risk-free asset and three Fama-French factors over the period 1926–2010. $Market\ Beta_{j,t}$, $SMB\ Beta_{j,t}$, and $HML\ Beta_{j,t}$ are the loadings we estimate from the previous model.

We subsequently relate Fama-French cost of equity to supplier RSI using the same baseline regression model as that in column (4) of Table 2-4. We report the regression results in column (1) of Table 7. Consistent with the results in Table 2-4, the coefficient estimate on supplier RSI is negative and statistically significant at the 1% level.

To obtain a picture as to how systematic risk decreases with supplier RSI, we further decompose Fama-French cost of equity into three components associated with market factor, SMB, and HML, respectively. We then examine how the factor loadings on these factors are associated with supplier RSI.

Recent theoretical work on asset pricing in the production economy provides some guidance as to how we could potentially identify the effects on equity risk associated with operating leverage. This literature suggests that the book-to-market ratio explains the cross section of stock returns because it is correlated with both firms' operating leverage (e.g., Carlson et al. (2004), Cooper (2006), and Gourio (2007)). 2005)). As book-to-market ratio is positively related to the loadings on the HML factor, if supplier RSI reduces the cost of equity through the role of operating leverage, then supplier RSI should also have a negative effect on HML beta.

Table 2-7: Supplier R&D Intensity and the Fama-French Cost of Equity

This table reports the results from panel regressions of Fama-French cost of equity and the three factor loadings on firm's Supplier R&D intensity and a set of control variables. The dependent variables are the Fama-French cost of equity, Market beta, SMB beta, and HML beta, respectively. The Appendix provides a detailed description of the construction of all the variables used in the table. All regressions include year and major NAICS industry fixed effects. For the sake of brevity, the coefficient estimates on industry and year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at firm level.

Variables	Fama-French cost of equity	Market beta	SMB beta	HML beta
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-0.037	-0.649	0.498	-8.432
	(0.00)	(0.55)	(0.66)	(0.00)
Total assets	-0.000	0.060	-0.093	-0.089
	(0.00)	(0.00)	(0.00)	(0.00)
R&D intensity	0.002	0.953	1.124	-1.677
	(0.07)	(0.00)	(0.00)	(0.00)
Leverage ratio	0.005	0.271	0.233	0.675
	(0.00)	(0.00)	(0.00)	(0.00)
Asset tangibility	0.000	-0.083	-0.062	0.255
	(0.42)	(0.093)	(0.317)	(0.001)
Firm age	-0.000	-0.072	-0.072	0.034
	(0.00)	(0.00)	(0.00)	(0.02)
Stock return volatility	0.026	3.004	2.632	0.206
	(0.00)	(0.00)	(0.00)	(0.30)
Sales growth rate	-0.001	-0.034	-0.112	-0.179
	(0.00)	(0.45)	(0.01)	(0.07)
Competition intensity	0.000	-0.081	-0.072	0.224
	(0.56)	(0.05)	(0.16)	(0.00)
Sales beta	0.000	-0.002	-0.008	0.002
	(0.33)	(0.41)	(0.04)	(0.73)
Intercept	0.015	0.559	1.680	1.151
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	57,000	57,000	57,000	57,000
R^2	0.068	0.044	0.063	0.036

Consistent with this argument, the results in columns (2)–(4) of Table 2-7 indicate that the supplier RSI have a significantly negative impact only on the HML beta. In contrast, supplier RSI has insignificant effect on both market beta and SMB beta. Thus, the negative impact from supplier RSI on the Fama-French cost of equity work primarily through its effect on HML beta. Given that previous studies have linked the book-to-market ratios to operating leverage, these results provide further evidence that supplier RSI decreases customer firms' systematic risk through reducing operating leverage.

2.4.2. Suppliers' SA/JV intensity as an alternative measure of supplier RSI

So far we have used supplier firms' R&D intensity as a proxy for RSI undertaken by supplier firms. To ensure that our results are not sensitive to the choice of the proxy for RSI, we use supplier SA/JV intensity as an alternative proxy for RSI. Fee, Hadlock, and Thomas (2005) and Kale and Shahrur (2007) argue that supplier RSI are likely to be higher if the firm and its suppliers have established strategic alliances and/or joint ventures.

For each firms, we obtain data on SA/JV deals during the period 1990-2010 from the Merge and Acquisition database provided by the Securities Data Company (SDC). Using the SIC-based 1992 IO Use tables and the firm's SIC code, we determine whether at least one of the other participants in the SA/JV arrangement operates in a supplier industry. And then, for each four-digit SIC code industry, we define SA and JV intensity as the number of SAs and JVs formed by firms in that industry with firms in a supplier industry divided by the number of firms in the industry. We conduct multivariate analyses to investigate the relationship between supplier SA/JV intensity and implied cost of equity using the same models in Table 2-4. The regression results are reported in Table 2-8.

Table 2-8: Strategic Alliances and Joint Venture Intensity and Cost of Equity

This table reports the results from panel regressions of firms' implied cost of equity on their Strategic Alliances and Joint Venture Intensity and a set of control variables. The dependent variable is the implied cost of equity (ICE). The Appendix provides a detailed description of the construction of all of the variables used in the table. All regressions include year and major SIC industry fixed effects. For the sake of brevity, the coefficient estimates on industry and year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at the firm level.

Variables	Dependent variable: Implied cost of equity			
	(1)	(2)	(3)	(4)
SA/JV intensity	-0.007	-0.005	-0.005	-0.005
	(0.00)	(0.01)	(0.01)	(0.01)
Total assets		-0.004	-0.003	-0.003
		(0.00)	(0.00)	(0.00)
R&D intensity		-0.025	-0.034	-0.033
		(0.00)	(0.00)	(0.00)
Leverage ratio			0.036	0.036
			(0.00)	(0.00)
Asset tangibility			-0.003	-0.004
			(0.18)	(0.17)
Firm age			-0.002	-0.002
			(0.00)	(0.00)
Sales growth rate			-0.010	-0.010
			(0.00)	(0.00)
Stock return volatility			0.109	0.109
			(0.00)	(0.00)
Competition intensity				0.002
				(0.47)
Sales beta				-0.000
				(0.71)
Intercept	0.111	0.137	0.118	0.118
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	49,651	49,651	49,651	49,651
R^2	0.030	0.050	0.086	0.086

Consistent with our hypothesis that supplier RSI is negatively related to cost of equity, the coefficient estimates on SA/JV intensity are negative and statistically significant for all of the model specifications. Specifically, in column (1), the coefficient on supplier SA/JV intensity is equal to -0.007, and statistically significant at the 1% level. In columns (2) and (3), in which additional firm characteristics are included as control variables, the coefficient estimates on supplier SA/JV intensity remains significantly negative. In the full-specification model in column (4), the coefficient on supplier SA and JV intensity continues to be negative and significant at the 5% level. As a higher intensity of SAs and JVs with suppliers is associated with higher levels of supplier RSI, (Fee, Hadlock, and Thomas, 2005; Kale and Shahrur, 2007),these results provide further evidence that the supplier RSI has a negative impact on cost of equity.

2.4.3. Cost-based operating leverage and Supplier RSI

We conjecture that a negative relationship between supplier RSI and operating leverage supports the evidence on the negative effect of supplier RSI on cost of equity. To better understand the mechanism through which supplier RSI reduces operating leverage, we further use a cost-based operating leverage to examine its relationship with supplier RSI. We follow Novy-Marx (2011) and define operating leverage as annual operating costs divided by total assets (AT), where operating costs is cost of goods sold (COGS) plus selling, general, and administrative expenses (XSGA). As input cost is part of the total cost of goods, if a high level of supplier RSI leads to reduced input costs when firm-specific negative shock occurs, then the firm's total operating costs is also reduced. Thus, we expect a negative relationship between supplier RSI and the cost-based operating leverage.

We apply the same models in Table 2-6 but instead use the cost-based operating leverage as dependent variable to conduct multivariate analysis. We report the results in Table 2-9. Consistent with the prediction, results in column (1) show that supplier RSI has a negative effect on the cost-based operating leverage. The effect is statistically significant at the 1% level. Columns (2)-(4) show that after including additional controls in our regression model, the coefficient estimates on supplier RSI remain statistically significant.

Table 2-9: Supplier R&D Intensity and Firm Cost-based Operating Leverage

The table reports the results from panel regressions of firm cost-based operating leverage on its Supplier R&D intensity and a set of control variables. The Appendix provides a detailed description of the construction of all of the variables used in the table. All regressions include year and major NAICS industry fixed effects. For the sake of brevity, the coefficient estimates on industry and year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at the firm level.

Variables	Dependent variable: cost-based operating leverage			
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-3.902	-5.403	-6.090	-6.256
	(0.00)	(0.00)	(0.00)	(0.00)
Total assets		-0.069	-0.059	-0.072
		(0.00)	(0.00)	(0.00)
R&D intensity		0.032	-0.135	-0.129
		(0.75)	(0.20)	(0.23)
Market to Book ratio			0.002	0.002
			(0.40)	(0.40)
Leverage ratio			-0.440	-0.376
			(0.00)	(0.00)
Asset tangibility				-0.266
				(0.00)
Firm age				0.065
				(0.00)
Competition intensity				0.064
				(0.07)
Intercept	1.666	2.076	2.110	2.080
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	43,104	43,104	43,102	43,102
R2	0.348	0.372	0.382	0.392

Thus, the negative relationship between supplier RSI and operating leverage we document before is not driven by a specific measure of operating leverage. Again, as theoretical evidence has already shown that operating leverage is positively related to cost of equity, our results regarding the negative relationship between supplier RSI and cost-based operating leverage supports the our finding on the negative effect of supplier RSI on cost of equity.

2.4.4. Industry-level analysis on the relation between supplier RSI and cost of equity/operating leverage

Since industry-based supplier RSI is an inaccurate measure of the firm-level supplier RSI, a measurement error problem may arise. To mitigate the concern about the measurement error problem, we perform industry-level analyses on the impact of supplier RSI on cost of equity (Panel A) and operating leverage (Panel B) in Table 2-10.

Table 2-10:
Supplier R&D Intensity, Cost of Equity and Operation leverage: Industry-Level Regression

In this table, Panel A reports results from panel regressions of industry-level cost of equity on industry-level supplier R&D intensity and a set of industry-level control variables. Panel B reports results from the panel regression of industry-level operating leverage on industry level supplier R&D intensity and a set of industry-level control variables. Industry-level implied cost of equity is computed as the value-weighted average of cost of equity of firms in the IO industry, where the weight is the market value of the firm (market price*numbers of shares outstanding). All the industry level control variables are calculated as the average values of the corresponding firm-level variables in that IO industry. The constructions of these firm-level variables are described in the Appendix. All regressions include year fixed effects. For the sake of brevity, the coefficient estimates on year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at IO industry level.

Panel A: Industry-level Supplier RD Intensity and Cost of Equity

Variables	Dependent variable: Industry-level implied cost of equity			
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-1.401	-1.181	-1.283	-1.038
	(0.00)	(0.00)	(0.00)	(0.00)
Total assets		-0.001	-0.001	-0.000
		(0.06)	(0.32)	(0.75)
R&D intensity		-0.110	-0.115	-0.092
		(0.00)	(0.00)	(0.01)
Leverage ratio			0.049	0.047
			(0.00)	(0.00)
Asset tangibility			-0.017	-0.013
			(0.03)	(0.07)
Firm age			-0.001	-0.003
			(0.28)	(0.07)
Sales growth rate			-0.013	-0.011
			(0.00)	(0.00)
Stock return volatility			0.111	0.114
			(0.00)	(0.00)
Competition intensity				0.016
				(0.00)
Sales beta				-0.000
				(0.01)
Intercept	0.103	0.110	0.100	0.087
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Number of observations	4,443	4,443	4,443	4,443
R^2	0.090	0.099	0.144	0.157

Panel B: Industry-level Supplier RD Intensity and Operation Leverage

Variables	Dependent variable: Industry-level operating leverage			
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-13.460	-19.250	-18.990	-20.420
	(0.08)	(0.01)	(0.00)	(0.01)
Total assets		-0.102	-0.080	-0.109
		(0.00)	(0.01)	(0.00)
R&D intensity		-0.175	-0.724	-0.972
		(0.89)	(0.51)	(0.45)
Market to Book ratio			-0.020	-0.020
			(0.02)	(0.03)
Leverage ratio			-0.704	-0.536
			(0.00)	(0.01)
Asset tangibility				-0.172
				(0.52)
Firm age				0.124
				(0.00)
Competition intensity				-0.125
				(0.03)
Intercept	1.842	2.519	2.586	2.588
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Number of observations	4360	4360	4360	4360
R^2	0.015	0.034	0.044	0.053

In Panel A, we replicate the regressions in Table 2-4 on a sample of 538 industries over the period 1990–2010, except that all variables are measured at the IO industry level. Specifically, the dependent variable is value-weighted average cost of equity of firms in each IO industry, where the weight is a firm's market capitalization. Explanatory variables are calculated as the average of the corresponding firm-level variables for each IO industry. All of these industry-level regressions include year fixed effects. The *p*-values are based on robust standard errors clustered at IO industry level. We find that the industry-level regressions results are similar to those at the firm level: the coefficient estimates on supplier RSI is negative and statistically significant at the 1% level for all of the four model specifications.

We further examine the relationship between supplier RSI and operating leverage on industry-level. In Panel B, we replicate the regressions in Table 2-5, still measuring both dependent and explanatory variables as the average of the corresponding firm-level variables for each IO industry. Consistent with the firm-level results, we find that supplier RSI is negatively correlated with operating leverage using different model specifications and the relationship remains statistically significant for each model.

2.4.5. Controlling for financial leverage

Kale and Shahrur (2007) find that firms with higher supplier RSI maintain lower debt level. Thus, it is possible the negative relation between supplier RSI and cost of equity arises because firms with higher supplier RSI are financially less levered, which in turn leads to lower cost of equity. In our baseline models in Table 2-4, we mitigate this concern by controlling for firm leverage ratio and find significantly negative coefficient estimates on supplier RSI.

To further disentangle the effect of financial leverage on cost of equity from that of supplier RSI, we examine the relationship between supplier RSI and unlevered cost of equity. We estimate the unlevered cost of equity by de-leveraging the implied cost of equity using the following equation:

$$r_{jt}^{u} = r_t^f + \left(r_{j,t} - r_t^f\right)(1 - leverage\,ratio_{j,t-1})$$

where $r_{j,t}$ denotes the implied cost of equity of firm j over year *t*, r_t^f denotes the risk free rate of year *t*, and $leverage\,ratio_{j,t-1}$ denotes the book leverage ratio of firm *j* over year *t-1*. We then estimate regression models similar to those in Table 2-4, but use the unlevered cost of equity as the dependent variable and exclude leverage ratio from the set of explanatory variables.

We report the regression results controlling the full set of firm characteristics and industry characteristics in Table 2-11.

Table 2-11: Supplier R&D Intensity and Unlevered Cost of Equity

This table reports the results from panel regressions of unlevered implied cost of equity and unlevered FF 3-factor cost of equity on firm's Supplier R&D intensity and a set of control variables. The unlevered cost of equity measures are calculated using the deleveraging formula in Part 4.2.The Appendix provides a detailed description of the construction of all the other variables used in the table. All regressions include year and major NAICS industry fixed effects. For the sake of brevity, the coefficient estimates on industry and year dummies are not reported. The p-values (in parentheses) are based on heteroskadasticity-robust standard errors and allow for clustering at firm level.

	Dependent variable: Unlevered cost of equity			
Variables	unlevered implied cost of equity		unlevered FF 3-factor cost of equity	
	(1)	(2)	(3)	(4)
Supplier R&D intensity	-0.074	-0.080	-0.026	-0.026
	(0.10)	(0.07)	(0.00)	(0.00)
Total assets	-0.004	-0.004	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
R&D intensity	0.000	-0.001	0.004	0.004
	(0.95)	(0.90)	(0.00)	(0.00)
Asset tangibility	-0.012	-0.012	-0.001	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Firm age	-0.002	-0.002	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Sales growth rate	-0.006	-0.006	-0.001	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)
Stock return volatility	0.072	0.071	0.019	0.019
	(0.00)	(0.00)	(0.00)	(0.00)
Competition intensity		-0.002		0.000
		(0.43)		(0.88)
Sales beta		0.000		0.000
		(0.83)		(0.56)
Intercept	0.112	0.112	0.015	0.015
	(0.00)	(0.00)	(0.00)	(0.00)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	46,603	46,603	57,119	57,119
R^2	0.098	0.098	0.063	0.063

Columns (1) and (2) show how supplier RSI impacts firm's unlevered implied cost of equity. We find that the coefficient estimates on supplier RSI remain negative and statistically significant at the 10% level. We also de-leverage the Fama-French cost of equity using the same equation and obtain similar results shown in columns (3) and (4). The negative relationship between supplier RSI and unlevered Fama-French cost of equity is significant at the 1% level. Thus, it is unlikely that financial leverage explain the negative relationship between of supplier RSI and cost of equity.

2.5 Conclusion

Our study investigates the impact of the mobility of a firm's input providers on its equity risk and cost of equity. We use relationship-specific investments (RSI) undertaken by supplier industries as a proxy for supplier immobility, where RSI is measured by the R&D expenses incurred in the supplier industries. We find that supplier immobility decreases a firm's operating leverage and cost of equity.

Specifically, we find that firms with higher supplier RSI exhibit a statistically and economically lower implied cost of equity. This relation is more pronounced when firms are more likely to enter financial distress. Furthermore, supplier RSI also has a significantly negative impact on operating leverage.

Our findings are robust to an alternative measure of cost of equity as we use the Fama-French three factor model to estimate cost of equity. Not only does the negative relation between supplier RSI and cost of equity holds, the analysis also suggests that the effect of supplier RSI on cost of equity work primarily through the book-to-market channel.

As an alternative measure of supplier RSI, we also construct supplier RSI measure based on the intensity of strategic alliances and joint ventures between firms in vertical supply chains. We find that our results hold for this alternative measure of supplier RSI.

Overall, our results suggest that the decision of a firm's input providers is an important determinant of its systematic risk and cost of equity.

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Chapter 3

Customers' Specificity, Cash Flows, Idiosyncratic Risk and Dividend Payout

Abstract:

This paper investigates whether and how the specificity of a firm's customers affects its earnings and idiosyncratic risk. With a comprehensive analysis of industry and firm characteristics from 1980 to 2010, this study leads to the conclusion that the customers' inflexibility induces more cash flow instability and the firm's idiosyncratic risk increases with customers' specificity. As a result, firms with more specific customers choose more conservative dividend payout policies to adjust for the risk changes. This paper contributes to the empirical literature on firm operating risk and dividend policy by relating the relationship to the fundamentals which determine firm risk and by providing a new viewpoint from a firm's vertical surroundings.

Key Words: specific customers, idiosyncratic risk, cash flow volatility, dividend payment

3.1 Introduction

Firms' increasing idiosyncratic risk over history is linked to their horizontal relationships in real operating activities by recent studies in both asset-pricing and corporate finance. Irvine and Pontiff (2009) explain the increased idiosyncratic risk by the increased horizontal market competition. They show by both time-series and cross-sectional evidence that idiosyncratic risk increases when firms face more intense competition. Booth and Zhou (2009) provide evidence that the competitive structure of the industry within which the firm operates impacts on the firm's business risk in terms of both cash flow volatility and stock return volatility. They find that more competitive firms are riskier and show poorer operating cash flow performance in the future. These studies show that, horizontally, firms face competition from peers in the same industry which impart risk to them and impact their financial decisions; the higher market power or less competition a firm has, the more capable it is to handle business risk from competition with peers. However, there is no study to answer the question about whether and how a firm's vertical relationships impact its future business performance, risk and financial policies.

In this study, I fill the gap by showing that a firm with more specific customers faces higher idiosyncratic risk and future cash flow volatility and eventually they would choose a more conservative dividend policy to adjust for the risk. Vertically, firms as suppliers need to sell products or services to customers to generate sufficient and sustainable earnings. Some suppliers, such as automobile engine manufacturers, offer products tailored to customers' specific needs. Only a specific group of downstream firms use these customized products. Other industries, such as steel manufacturers, provide standardized products, which can be used by all firms in downstream industries. These firms as suppliers have more flexibility since they can sell products to other customers when negative customer-specific shocks occur. In an extreme case, if only one specific customer consumes the output of the firm, then the firm will fall bankruptcy if this customer stops buying. Therefore, the business risk associated with the downstream firms may be transmitted to the upstream, which increases the instability of the suppliers. The impacts from customers are especially inevitable if the economic linkages among the firms in the vertical chain entail significant relationship-specific investments.

In real life, there are numerous examples that illustrate how firms can lose considerable sums of money owing to decisions made by downstream firms which entail relationship-specific investments. For example, in the automobile industry, auto parts maker Getrag Transmission Manufacturing LLC put its unfinished Indiana plant into bankruptcy protection in the end of 2008, blaming Chrysler LLC's termination of an exclusive contract. The Tipton plant, 80% complete, was being built specially to supply Chrysler with dual clutch transmissions before Chrysler announced in October it was terminating the deal over financial issues. Getrag said it owes more than $500 million to more than 200 parties related to construction costs, according to a court filing. Examples are not restricted to the automobile industry, but also many other technology intensive industries.

Therefore, an upstream firm's operating performance could be adversely impacted by the loss of flexibility in choosing customers who are the main income providers. Following Kale and Shahrur (2007), I use industry-level data from the Use table of the benchmark input-output (IO) accounts for the US economy on the Bureau of Economic

Analysis to calculate customer R&D intensity as a proxy for relationship specific investments with customers. Higher customer R&D intensity stands for more specific relationships with customers. Using data of industry and firm characteristics from 1980 to 2010, I show that firm's cash flow risk increases when the specificity of customers is higher. The idiosyncratic risk of a firm which mirrors its underlying cash flow volatility will also increase with customer specificity.

When it comes to the financial policies with risk changes, both survey work (Linter (1956), Brav et al (2005, 2008)) and empirical study (Chay and Suh (2008), Hoberg and Prabhala (2009), Grullon et al. (2002), etc.) show that idiosyncratic risk or cash flow volatility should negatively affect dividend payment. Therefore, in my study, I also examine whether and how the firm adjusts its dividend policies to accommodate changes from its operating risk changes with vertical chain inflexibility. I further show evidence that a firm will choose a more conservative dividend payment policy to adjust the increasing risk associated with high customer specificity. Managers of a firm with higher cash flow instability and higher idiosyncratic risk face more difficulties to maintain a certain dividend level or decide to payout dividends.

As previous research shows that firm earnings, idiosyncratic risk and dividend levels are all affected by the firm's horizontal competition, I will further control for the firm's competition intensity within its industry measure by using its Herfindahl–Hirschman Index (HHI). Table 8 reports the results of regression models with additional control for HHI. The coefficients for customer R&D intensity are consistent with the previous results. A firm's horizontal competition does not explain the impacts from customer specificity on earnings, idiosyncratic risk and dividend levels. Moreover, all the results are consistent over different time periods and robust to different combinations of controls.

This paper contributes to the literature in several ways. First, it contributes to the explanation of firm's idiosyncratic risk changes by providing a new viewpoint from a firm's vertical surroundings. Secondly, it contributes to the empirical evidence supporting the link between idiosyncratic risk and dividend policy demonstrated in previous work. Third, a growing literature suggests the desirability of integrating operating and financing policies. The findings in this paper contribute to this stream of research. It supports the recent evidence that various changes in dividend policy can be related to the fundamental changes in business surroundings that affect a firm's real operations. Fourth, this study contributes to the literature that links industrial organization and finance, such as Booth (1981) on equity costs, Booth and Zhou (2009) on dividend policy, and Gaspar and Massa (2006) and Irvine and Pontiff (2009) on idiosyncratic volatility.

The rest of the paper proceeds as follows. In Section II, I review the literature and develop the empirical hypotheses. In Section III, I provide details of the data sources and details of variable construction. In Section IV, I present the empirical results. Section V concludes the paper.

3.2 Literature and Hypotheses:

Irvine and Pontiff (2009) document a significant increase over time in the idiosyncratic volatility of stock returns, firm-level earnings, cash flows, and sales. They suggest that the puzzling upward trend in idiosyncratic volatility is related to an increasingly competitive environment in which firms have less market power. When the success of one firm in an industry comes at the expense of another firm in that industry, competition contributes to a negative covariance in firm performance. They construct proxies for competition and conduct both cross-sectional and time-series tests. They find firms in industries with more competition experience more idiosyncratic risk, and time-series plots show that the level of competition faced by the typical domestic firm has dramatically increased. Examining cross-country trends in idiosyncratic volatility, they show that countries with greater growth in idiosyncratic stock-return volatility tend to have more competitive economies and undergo faster change in technological innovation. This mosaic of evidence lends support to the notion that economy-wide competition plays a role in the trend toward higher levels of idiosyncratic stock-return risk.

Booth and Zhou (2009) construct three measures of market power suggested in the literature from Industrial Organization and International Trade and they provide evidence that the competitive structure of the industry within which the firm operates is important for financial policy. They find that firms with more competition will expect poorer and more instable earnings in the near future, and are associated with more stock return volatility. From the viewpoint of a firm's horizontal relationships, they show a firm's market power to be fundamental in determining a firm's operating instability.

Irvine and Pontiff (2009) also document that the trend in idiosyncratic cash-flow volatility mirrors the trend in idiosyncratic stock-return volatility, consistent with market efficiency. Idiosyncratic return volatility forecasts idiosyncratic cash-flow volatility in the near future. Huang (2009) confirms the cross-sectional close relationship between idiosyncratic risk and underlying cash flow volatility.

There has been no study to link a firm's idiosyncratic volatility of stock returns, firm-level earnings, and cash flows to its vertical channel. Thus the first goal of this paper is to investigate whether specific relationships with customers have an impact on the firm's idiosyncratic risk and cash flow changes. These findings may contribute to the question about what in the real operations make firms subject to greater idiosyncratic risk in fundamental cash flows.

I expect the more specific a firm's customers are, in other words, the less flexibly a firm can choose among customers, the more likely the firm is subject to cash flow instability transferred from the vertical relationship. Meanwhile, a firm's idiosyncratic risk generated from stock performance is also increased. Based on the risk perspective, I will further examine what financial policies a firm will make to adjust for the risk changes associated with this vertical channel.

Existing literature has demonstrated that there is a strong link between firm idiosyncratic risk and dividend policy. To make it clearer and more informative for both investors and management, it is important to relate these results to the fundamentals that determine firm risk and matter to a firm's operations, which Booth and Zhou (2009) conjecture is in part the existence of market power. From a risk perspective, Booth and Zhou (2009) provide evidence that the competitive structure of the industry within which the firm operates is important for financial policy. They find that more competitive firms are riskier and less likely to pay dividends than firms with market power. From a viewpoint of a firm's horizontal relationships, they show a firm's market power to be fundamental in determining a firm's business risk. It remains interesting to test how dividend policies change with a firm's vertical surroundings.

As idiosyncratic risk and cash flow volatilities are expected to increase with the specificity with customers, I also expect that the more risk that results from customer specificity, the more conservative dividend policy the firm will take.

In the literature, survey studies have indicated the importance of risk as an important determinant of dividend policy. The field survey conducted by Linter (1956) shows that conservative managers usually are reluctant to increase dividends that will subsequently have to be reversed due to negative cash flow shocks. Brav, Graham, Harvey and Michaely (2005) find that more than two-thirds of the CFOs of dividend-paying firms regard the stability of future earnings as a very important factor to their dividend policies. Moreover, Brav et al (2008) find in a survey on the impact of the May 2003 dividend tax cut that the stability of future cash flows is regarded as the most important factor for dividend initiators. They consistently point out that the stability of future operating cash flows is a very important factor to dividend policies and firms tend to select some conservative dividend rate when facing negative cash flow shocks.

Supporting empirical evidence using comprehensive data is of great interest following this field work. The most comprehensive study is by Chay and Suh (2008), who use worldwide firm-level data to show that a firm's cash flow uncertainty negatively affects both its decision to pay a dividend and the amount of dividend payment. The impact of cash-flow uncertainty on dividends is generally stronger than the impact of other potential determinants of payout policy—such as the earned/contributed capital mix, agency conflicts, investment opportunities, firm size, and profitability. This international empirical research is supported by Hoberg and Prabhala (2009), who find that firms with higher risk are less likely to pay dividends and that risk can explain almost 40% of the Fama-French disappearing dividends puzzle. As to the decomposition of firm risk, they also show that the explanatory power of idiosyncratic risk is economically more important than that of systematic risk. In reexamining the information content of dividend changes, Grullon et al. (2002) further argue that dividend changes convey information regarding the change in the future riskiness of a firm's cash flow.

To test my hypotheses about risk changes and financial policy adjustments with vertical channel specificity, I follow literature to use measures of relationship-specific investments as a proxy for the specificity of customers. I use the intensity of R&D expenditure of customers as proxy for the extent of customer RSI. The use of R&D intensity as a proxy for asset specificity is prevalent in the empirical literature on transactions cost economics (Boerner and Macher (2001). Titman (1984), Kale and Shahrur (2007) and Banerjee, Dasgupta and Kim (2008) argue that specific customers and suppliers with high R&D intensity often require firms to undertake R–S investments, which will in turn lead to higher financial distress costs. In particular, Allen and Phillips (2000) suggest that R&D-intensive industries are more likely to create relationship-specific assets; Levy (1985) argues that research-intensive industries tend to involve specialized inputs that require transaction-specific investments by suppliers. In addition, vertical chains that are R&D intensive are likely to have complex inter-stage interdependencies (Armour and Teece, 1980) which restrict the flexibility of firm operations. Firms that deal with R&D-intensive customers have more specific relationships with customers. Basing on comprehensive data analysis of firm and its customers, I expect to see the following:

Hypothesis 1: A firm's cash flow instability increases as the specificity of customers increases.

Hypothesis 2: A firm's idiosyncratic risk increases as the specificity of customers increases.

Hypothesis 3: From a risk perspective, the more cash flow and idiosyncratic risk that result from inflexible customers, the more conservative dividend policy the firm will take.

3.3 Data and variables

3.3.1 Specific Customers

I rely on three data sources, the Use table of the benchmark input-output (IO) accounts for the US economy on the Bureau of Economic Analysis website, Compustat and CRSP. For any pair of supplier and customer industries, the Use table reports estimates of the dollar value of the supplier industry's output that is sold to its customer industry. The Use table enables us to identify a firm's customer industries and the importance of each customer industry to the firm. Following Fan and Lang (2000) and Kale and Shahrur (2007), I construct the supplier and customer industry variables using these IO use tables. I use the 1982, 1987, 1992, 1997 and 2002 Use tables (the latest table is 2002) for the periods 1980-1984, 1985–1989, 1990–1994, 1995–1999, and 2000-2010 respectively. I compute the R&D intensities using weights from IO Use tables, firm accounting variables from Compustat, and price information from CRSP to get stock volatility. To construct the sample, I use all US firms covered by Compustat and CRSP from 1980 to 2010, excluding financial firms (SIC codes between 6000 and 6999) and utility firms (SIC codes between 4900 and 4999).

Using industry-level data of customer-supplier relationships offers distinct benefits relative to firm-level data. As suggested by Kale, Shahrur (2007) and Kale, Kedia, Williams (2011): First, the sample of firms in the industry-level data set is much larger.

Second, endogeneity issues that are endemic to corporate finance research are likely to be significantly less severe in tests that relate a firm's financial policies to variables measured for supplier and customer industries than to variables measured for supplier and customer firms.

Following the method in Kale and Shahrur (2007), I measure customer R&D intensity as the weighted average of the R&D intensities of all the firm's customer industries. The weight is retrieved from IO Use tables and stands for the importance of the output bought by each customer industry in the firm's total output. The customer R&D intensity is given by the following equation:

$$\text{Customer Industries R\&D Intensity}$$
$$=\sum \text{Customer industry R\&}D \text{ intensity } j \text{ *Industry Percentage Sold } ji$$

where Customer Industry R&Dj is the j^{th} customer industry's R&D expenditures divided by its total assets, and the weight-Industry Percentage Soldji is the percentage of the i^{th} industry's output that is sold to the j^{th} customer industry. The latter measures the importance of the j^{th} customer industry as a buyer of the output of the firm's industry. The more R&D intensive the customers are, the more specific the relationship they have with the firm as supplier. The firm may rely on these R&D intensive customers to consume their special fit products or to commit to exclusive contracts.

3.3.2 Dividend measures, idiosyncratic risk measures and control variables

Given the ubiquity of the FF-3 model in empirical financial applications, I follow Ang, Hodrick, Xing, Zhang (2006, 2009) to measure idiosyncratic volatility relative to the FF-3 factor model as follows:

$$R_{it}=\alpha_{it}+ Marketbata_i * MKT_t+Smbbeta_i * SMB_t+Hmlbeta_i * HML_t + \varepsilon_{it}$$

where R_{it} is monthly excess returns of stock *i* in year *t*. I define idiosyncratic risk as the standard deviation of the residuals ($\sqrt{var(\varepsilon_{it})}$) after estimating the FF-3 factor model using monthly excess returns over that year

Then, I use the stability of future firm performance to measure cash flow risk (Brav et al 2005, 2008; Booth, Zhou 2009), and two measures of operating performance are chosen consistent with Barber, Lyon (1996). The first measure is the return on assets (ROA), defined as the operating income before depreciation scaled by book value of total assets. In order to avoid the bias introduced by potential earnings manipulations of the accrual-based operating income, Barber, Lyon (1996) and Booth, Zhou (2009) suggest using the cash-flow return on assets (CFROA), defined as the operating cash flow scaled by the average of beginning and ending period book value of total assets. The operating cash flow in CFROA is equal to the operating income before depreciation plus the decrease in receivables, the decrease in inventory, the increase in accounts payable, the increase in other current liabilities, and the decrease in other current assets. Level of future operating performance is measured as the mean of ROA and mean of CFROA during year [t+1, t+5]. Risk of future operating performance is measured by the standard deviation of ROA (σ(ROA)) and the standard deviation of CFROA (σ(CFROA)) during year [t+1, t+5]. Firm future business stability and performance are expected to be adversely affected by the inflexibility of downstream players.

I expect to see that firms with less flexible customers may face higher cash flow volatility and idiosyncratic risk. Thus, they would choose a more conservative dividend policy to adjust for the risk. I examine the impact from customers on both the decision to pay dividends and the level of dividend payments. For probability models estimated, the dependent variable is a dummy for payment decision, which equals one if firm *i* pays dividends in year *t* and zero otherwise. For level models, the dependent variable is the common dividend scaled by total assets.

To control for firm specific risk characteristics in the tests with cash flow risk changes, I follow Booth, Zhou (2009) to include size, profitability, and growth opportunities, leverage ratio and stock return volatility. I calculate Size as the log value of firm total assets and Profit as earnings before interest and taxation over total assets. Market to book (MTB) ratio is calculated as firm market value divided by book value. Asset growth rate is measured as total assets value over its lag and also measures the growth of a firm. Leverage is the ratio of firm long term debt level to firm market value. To control for Current volatility of stock return, I use the standard deviation of a firm's monthly returns during a one-year period. As the market-to-book ratio contains the mixture of information on assets in place and future growth opportunities, which have opposite impacts on a firm's cash flow risk in the future, I exclude MTB in the regression for firm risk analysis, but keep it in the dividend policy regressions. For the tests with idiosyncratic risk itself, I also exclude stock volatility which is nearly perfectly correlated with idiosyncratic risk. And, I include cash flow risk which fundamentally determines the changes of idiosyncratic risk. As the vertical specificity measure is related to R&D intensity, I also include the R&D level of firms in all the regressions to examine the R&D-based specificity impact from customers additional to the R&D effect from firms themselves.

3.4 Empirical results

The purpose of this study is to examine the integration of firm operating and financing policies from the viewpoint of a firm's vertical channel. Following the studies on how horizontal relationship for a firm in the market impacts its financing policies, I want to show that the firm's vertical relationship with customers also matters to its real risk and to its financing decisions. The firm's specific relationships with its suppliers may somehow reduce its systematic risk and increase its bargaining power (Wang, Wang 2012). However, when the firms are suppliers, how will the relationships with customers impact the firm's business risk or idiosyncratic risk? And how will it ultimately impact the firm's financial decisions? The focus is to test whether a firm with less flexible customers faces higher idiosyncratic risk and future cash flow volatility and whether they would choose a more conservative dividend policy to adjust for the risk.

Using customer R&D intensity as a measure for customers specificity, Table 3-1 lists the top 10 industries with highest and lowest supplier/customer R&D intensity. Those with highest customer R&D intensity are concentrated in high-tech industries such as computer science, electronic engineering, and biology science. However, those with lowest customer R&D intensity are concentrated in light or service industries such as water supplier facilities, prepared food and social services. We observe a significant variation in customer R&D intensity across different industries in the cross section, with 8% for the highest and close to zero for the lowest.

Table 3-1: Top Industry with Highest Customer Specificity

This table shows industries with highest customer specificity, which is defined as customer R&D intensity. IO code is from the Use table of the benchmark input-output (IO) accounts for the US economy on Bureau of Economic Analysis website. Measure of customer specificity is the weighted average R&D intensity of all customers. Panel A shows Top 10 industries with highest average customer specificity over 1980 to 2010. Panel B shows Top 10 industries with lowest average customer specificity over 1980 to 2010.

Panel A: Top industry with highest customer specificity

IO Code	Customer R&D Intensity (Customer Specificity)	Industry Name
334113	0.086	Computer terminals and other computer peripheral equipment manufacturing
334111	0.073	Electronic computer manufacturing
334112	0.071	Computer storage device manufacturing
511200	0.065	Software publishers
33461A	0.048	Software, audio, and video media reproducing
334512	0.047	Automatic environmental control manufacturing
334290	0.047	Other communications equipment manufacturing
33441A	0.045	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing
334413	0.044	Semiconductor and related device manufacturing
334220	0.044	Broadcast and wireless communications equipment

Panel B: Top industry with lowest customer specificity

IO Code	Customer R&D Intensity (Customer Specificity)	Industry Name
337920	0.000	Blind and shade manufacturing
623000	0.000	Nursing and residential care facilities
120209	0.000	Water supply facilities
315119	0.000	Other hosiery and sock mills
770900	0.000	Social services, n.e.c.
331314	0.000	Secondary smelting and alloying of aluminum
760206	0.000	Other amusement and recreation services
339995	0.000	All other miscellaneous manufacturing
360600	0.000	Vitreous china plumbing fixtures
141200	0.000	Prepared fresh or frozen fish and seafoods

Table 3-2 provides summary statistics of all the variables over the sample. I drop firms with total assets less than $10 million. All other variables are winsorized at the 1% level to exclude the outliers.

Table 3-3 reports the correlation matrix among all the variables. It shows that the risk measures are positively related with the vertical customer specificity measure. Also, the dividend level is negatively related to risk. Risk measures are positively correlated with each other. Other correlations are consistent with theory and previous empirical evidence.

Table 3-2: Summary Statistics

The table reports summary statistics for the variables we use in the regressions of the cash flow risk, idiosyncratic risk and dividend payments on customer R&D intensity and control variables. The sample covers the period 1980-2010 and excludes financial institutions (SIC codes 6000 to 6999) and utilities (SIC codes 4900 to 4999) from the sample. The Appendix provides a detailed description of the construction of all of the variables used in the table.

Variable	Mean	Median	Std	p5	p95
Customer R&D intensity	0.021	0.011	0.023	0.001	0.072
Size	5.281	4.995	1.915	2.662	8.861
R&D level	0.044	0.000	0.087	0.000	0.216
MTB	1.854	1.373	1.425	0.755	4.724
Profit	0.035	0.071	0.176	-0.317	0.229
Asset growth	0.169	0.068	0.467	-0.279	0.962
Current volatility	0.149	0.127	0.089	0.053	0.324
Leverage	0.143	0.087	0.162	0.000	0.485
Idiosyncratic risk	0.139	0.117	0.085	0.052	0.305
ROA risk	0.052	0.035	0.053	0.009	0.160
ROA performance	0.103	0.119	0.126	-0.126	0.261
CFROA risk	0.071	0.054	0.059	0.016	0.187
CFROA performance	0.102	0.114	0.115	-0.089	0.254
Dividend level	0.009	0.000	0.019	0.000	0.042

Table 3-3: Variable Correlation Matrix

The table reports the correlations among customer R&D intensity and all other control variables. The sample covers the period 1980-2010. I exclude financial institutions (SIC codes 6000 to 6999) and utilities (SIC codes 4900 to 4999) from the sample. The Appendix provides a detailed description of the construction of all of the variables used in the table.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Customer R&D intensity	1.000													
Size	-0.132	1.000												
R&D level	0.498	-0.184	1.000											
MTB	0.205	-0.055	0.364	1.000										
Profit	-0.196	0.201	-0.530	0.021	1.000									
Asset growth	0.046	-0.032	-0.020	0.257	0.110	1.000								
Current volatility	0.257	-0.317	0.314	0.178	-0.352	0.126	1.000							
Leverage	-0.233	0.166	-0.279	-0.385	-0.036	-0.063	-0.064	1.000						
Idiosyncratic risk	0.222	-0.321	0.290	0.164	-0.351	0.108	0.960	-0.050	1.000					
ROA risk	0.253	-0.319	0.452	0.256	-0.390	0.070	0.334	-0.182	0.325	1.000				
ROA performance	-0.258	0.230	-0.488	-0.060	0.689	-0.047	-0.340	0.070	-0.328	-0.544	1.000			
CFROA risk	0.163	-0.315	0.314	0.134	-0.339	0.046	0.270	-0.098	0.266	0.692	-0.459	1.000		
CFROA performance	-0.251	0.266	-0.483	-0.077	0.669	-0.061	-0.337	0.102	-0.325	-0.488	0.943	-0.397	1.000	
Dividend level	-0.134	0.241	-0.146	0.060	0.282	-0.105	-0.327	-0.120	-0.314	-0.160	0.290	-0.157	0.294	1.000

3.4.1 Customer specificity, firm cash flows and idiosyncratic risk

Table 3-4 reports the regression results of the impact of a firm's customer specificity on a firm's cash flow risk including both cash flow instability and level during the next five years [t+1, t+5]. I use two measures of cash flows as operating performance. The first measure is the return on assets (ROA), defined as the operating income before depreciation scaled by book value of total assets. To avoid potential earnings manipulation in ROA, an alternative measure CFROA is also used. Following Barber and Lyon (1996), I define CFROA as the operating cash flow scaled by the average of beginning and ending period book value of total assets (details in Section II). Regardless of which measure of operating performance is used, results from Panels A and B support the predictions that a firm with less flexibility with customers will have less stable and weaker cash flow performance in the future. The coefficients for customer R&D intensity with the instability of a firm's future earnings are significantly positive. For ROA risk, although adding the set of controls reduces the magnitude of the coefficient on supplier/customer R&D intensity, the effect remains statistically significant at the 1% level. For CFROA risk, the relations are generally strongly positive and significant. The coefficients for customer R&D intensity with the level of a firm's future earnings are significantly negative. For both ROA and CFROA level, although adding the set of controls reduces the magnitude of the coefficient on customer R&D intensity, the effect remains statistically significant at the 1% level. Besides, coefficient estimates of the control variables show that more profitable, larger firms have more stable and better performance in the future. Firms with high growth rates or currently riskier firms have higher business risk in terms of more volatile and weaker future earnings. I exclude market-to-book ratio (MTB) from the regression specifications, as it contains the mixture of information on assets in place and future growth opportunities, which have opposite impacts on a firm's earnings risk in the future. I calculate the standard errors by clustering at the firm level to account for within-firm correlation of the error terms. I also check the results by clustering errors at industry level and the results are consistent.

Table 3-4: Customer Specificity and Cash Flow Risk

This table presents the impact of a firm's customer specificity, without and with controls, on a firm's cash flow risk including both cash flow instability and level in the near future. The dependent variable in Panel A is cash flow instability- ROA risk and CFROA risk. The dependent variable in Panel B is cash flow level- ROA performance and CFROA performance. Measure of the specificity of the relationship with downstream players is Customer R&D intensity. Control variables include: Size, R&D level of the firm, Profit, Current volatility, Asset growth and Leverage. The Appendix provides a detailed description of the construction of all of the variables used in the table. Coefficients are estimated by OLS regression. Clustered robust standard errors are at firm level and used to account for within-firm correlation of the error terms. Year fixed effects and two-digit IO Industry fixed-effects are included for all the regressions.

Panel A: Customer Specificity and Cash Flow Future Volatility

Variables	Dependent variable: ROA risk		Dependent variable: CFROA risk	
	(1)	(2)	(3)	(4)
Customer R&D intensity	0.575***	0.037*	0.429***	0.00
	(21.73)	(1.68)	(15.26)	(0.10)
Size		-0.005***		-0.006***
		(-27.41)		(-23.84)
R&D level		0.163***		0.102***
		(18.78)		(10.00)
Profit		-0.072***		-0.086***
		(-19.17)		(-18.71)
Current volatility		0.079***		0.081***
		(17.16)		(13.45)
Asset growth		0.008***		0.006***
		(11.09)		(6.71)
Leverage		-0.022***		-0.011***
		(-9.73)		(-3.07)
Constant	0.031***	0.060***	0.053***	0.087***
	(9.73)	(16.08)	(13.04)	(20.38)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	63529	53903	58737	50017
R-squared	0.08	0.33	0.04	0.22

Panel B: Customer Specificity and Cash Flow Future Level

Variables	Dependent variable: ROA performance		Dependent variable: CFROA performance	
	(1)	(2)	(3)	(4)
Customer R&D intensity	-1.434***	-0.311***	-1.259***	-0.238***
	(-19.33)	(-7.210)	(-18.09)	(-5.77)
Size		0.005***		0.006***
		(11.22)		(14.60)
R&D level		-0.188***		-0.153***
		(-10.45)		(-8.646)
Profit		0.503***		0.473***
		(59.05)		(54.45)
Current volatility		-0.063***		-0.061***
		(-6.737)		(-6.625)
Asset growth		-0.029***		-0.031***
		(-20.62)		(-22.31)
Leverage		0.018***		0.041***
		(3.96)		(8.79)
Constant	0.147***	0.073***	0.133***	0.043***
	(21.48)	(9.57)	(19.35)	(6.10)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	63529	53903	58737	50017
R-squared	0.10	0.53	0.09	0.51

Next, I examine whether a firm's idiosyncratic risk increases as customer specificity increases. The results are reported in Table 3-5. Column (1) shows that the R&D intensity of a firm's customers has significantly positive impact on the firm's idiosyncratic risk, without controls for firm characteristics. Column (2) shows consistent results after controlling for Size, R&D level of the firm, Profit, Asset growth and Leverage. For Columns (3) and (4), I further control for ROA risk or CFROA risk. The impacts from customer R&D intensity are still significantly positive at the 1% level. This result indicates that specificity of customers have additional contribution to the increase of firm's idiosyncratic risk controlling for the cash flow risk. Also consistent with studies (Irvine and Pontiff (2009) and Huang (2009)) which show that idiosyncratic cash-flow volatility mirrors the trend in idiosyncratic stock-return risk, the cash flow volatilities are positively related to idiosyncratic risk in Table 3-5 results. In the regressions for idiosyncratic risk, I calculate the standard errors by clustering at the firm level to account for within-firm correlation of the error terms. I also check the results by clustering errors at industry level and the results are consistent.

Table 3-5: Customer Specificity and Idiosyncratic Risk

This table presents the impact of a firm's customer specificity, without and with controls, on a firm's idiosyncratic risk. The dependent variable is Idiosyncratic risk. Measure of the specificity of the relationship with downstream players is Customer R&D intensity. Control variables include: Size, R&D level of the firm, Profit, Asset growth, Leverage. I also sequentially control ROA risk and CFROA risk. The Appendix provides a detailed description of the construction of all of the variables used in the table. Coefficients are estimated by OLS. Clustered robust standard errors are at firm level and used to account for within-firm correlation of the error terms. Year fixed effects and two-digit IO Industry fixed-effects are included for all the regressions.

Variables	Dependent variable: Idiosyncratic risk			
	(1)	(2)	(3)	(4)
Customer R&D intensity	0.483***	0.211***	0.236***	0.254***
	(24.12)	(12.43)	(10.83)	(11.28)
Size		-0.013***	-0.011***	-0.011***
		(-66.56)	(-45.10)	(-44.57)
R&D level		-0.00	0.017**	0.045***
		(-0.238)	(2.00)	(5.06)
Profit		-0.120***	-0.094***	-0.095***
		(-47.26)	(-24.19)	(-23.19)
Asset growth		0.017***	0.018***	0.019***
		(25.76)	(19.27)	(20.36)
Leverage		0.037***	0.031***	0.029***
		(15.91)	(9.96)	(8.83)
ROA risk			0.166***	
			(17.42)	
CFROA risk				0.114***
				(13.63)
Constant	0.126***	0.173***	0.153***	0.149***
	(40.99)	(51.61)	(29.72)	(34.78)
Year dummies	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Observations	116164	100679	53903	50017
R-squared	0.16	0.35	0.37	0.37

3.4.2 Customer specificity and firm dividend policy

Now, the interesting question left is: how will this negative relationship between firm's inflexibility with its customers and firm's idiosyncratic risk and cash flow risk affect firm's financial policies. Tables 3-6 and 3-7 show a negative relationship between a firm's customer specificity and the firm's dividend payments.

Table 3-6: Logit Analysis of the Decision to Pay Dividends As a Function of Customer Specificity

This table reports the coefficient estimates of multivariate logit regressions. The logit models investigate the impact from customer specificity on a firm's decision to pay dividends. The dependent variable is a dummy of payment decision, which equals one if firm pays dividends in year *t* and zero otherwise. Measure of customer specificity is Customer R&D intensity. Control variables include: Size, R&D level of the firm, MTB, Profit, Asset growth, Leverage. I also sequentially control Idiosyncratic risk, ROA risk and CFROA risk. The Appendix provides a detailed description of the construction of all of the variables used in the table. Firm fixed effects and year dummy are controlled. Coefficients and P-values are reported.

Variables	Dependent variable: Dividend Payment Decision					
	(1)	(2)	(3)	(4)	(5)	(6)
Customer R&D intensity	-4.097***	-1.240	-3.300	-5.101**	-1.030	-2.720
	(0.00)	(0.45)	(0.12)	(0.03)	(0.64)	(0.24)
Size		0.522***	0.574***	0.660***	0.547***	0.629***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R&D level		3.004***	1.450	1.670	1.630	2.070
		(0.00)	(0.23)	(0.20)	(0.19)	(0.12)
Leverage		-1.664***	-2.160***	-2.306***	-1.697***	-1.790***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Profit		4.162***	3.757***	3.679***	3.095***	3.081***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
MTB		-0.090***	-0.056*	0.010	0.010	0.074**
		(0.00)	(0.07)	(0.78)	(0.67)	(0.03)
Asset growth		0.00	0.106*	0.090	0.110	0.100
		(0.96)	(0.09)	(0.18)	(0.11)	(0.17)
Idiosyncratic risk		-9.446***			-10.17***	-9.871***
		(0.00)			(0.00)	(0.00)
ROA risk			3.747***		4.091***	
			(0.00)		(0.00)	
CFROA risk				0.89		1.096*
				(0.11)		(0.05)
Observations	41134	31056	15497	14050	15405	13981
Number of gvkey	3049	2254	1209	1125	1204	1121

Table 3-7: One-sided Tobit Model on Dividend Payment and Customer Specificity

This table presents the impact of a firm's customer specificity, without and with controls, on a firm's dividend payment level. The dependent variable is Dividend level. Measure of customer specificity is Customer R&D intensity. Control variables include: Size, R&D level of the firm, MTB, Profit, Asset growth, Leverage. I also sequentially control Idiosyncratic risk, ROA risk and CFROA risk. The Appendix provides a detailed description of the construction of all of the variables used in the table. Coefficients are estimated by one-sided Tobit regression (censored at zero). Clustered robust standard errors are at firm level and used to account for within-firm correlation of the error terms. Year fixed effects and two-digit IO Industry fixed-effects are included for all the regressions.

Variables	Dependent Variable: Dividend level					
	(1)	(2)	(3)	(4)	(5)	(6)
CustomerR&D intensity	-0.378***	-0.082***	-0.103***	-0.102***	-0.072***	-0.071***
	(-16.24)	(-4.08)	(-4.30)	(-4.14)	(-3.17)	(-3.05)
Size		0.005***	0.006***	0.006***	0.004***	0.004***
		(25.75)	(25.74)	(24.75)	(18.66)	(17.57)
R&D level		-0.105***	-0.106***	-0.116***	-0.0923***	-0.097***
		(-9.31)	(-7.28)	(-7.79)	(-6.62)	(-6.82)
Leverage		-0.032***	-0.042***	-0.041***	-0.034***	-0.033***
		(-14.67)	(-15.01)	(-14.14)	(-12.73)	(-11.93)
Profit		0.102***	0.118***	0.116***	0.097***	0.096***
		(22.15)	(20.08)	(19.34)	(17.52)	(16.95)
MTB		0.001**	-0.000	-0.001	0.001	0.000
		(2.37)	(-0.79)	(-1.19)	(1.15)	(0.91)
Asset growth		-0.019***	-0.020***	-0.021***	-0.018***	-0.019***
		(-21.87)	(-19.13)	(-18.55)	(-17.73)	(-17.06)
Idiosyncratic risk		-0.208***			-0.216***	-0.219***
		(-29.65)			(-24.39)	(-24.02)
ROA risk			-0.084***		-0.034***	
			(-7.69)		(-3.24)	
CFROA risk				-0.057***		-0.026***
				(-6.93)		(-3.36)
Constant	0.006***	-.020***	-0.041***	-0.039***	-0.013***	-0.009***
	(3.70)	(-7.69)	(-10.77)	(-9.88)	(3.49)	(2.53)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	117,606	100,469	54,108	50,192	53,821	49,947

Table 3-6 presents the results from a panel Logit model which investigates whether the decision to pay a dividend or not is affected by customers. Firm and year fixed effects are reported. The results are consistent with the prediction that a firm with more specific customers, demonstrated by a high probability of making relationship-specific investments with their high R&D intensity, is less likely to pay a dividend. I investigate the explanatory power of customer specificity without and with controlling for other firm characteristics and the negative relationship holds in both cases. When control variables are added, the results remain robust. Moreover, we can see that firms that are larger, more profitable or with lower growth rate are more likely to pay dividends.

Then, in Table 3-7, I instead use dividend level as dependent variable to show that the more specific a firm's customers are, the lower dividend payment it will apply to adjust for the changes in operation. Since common dividends cannot be negative, estimating the model by ordinary least squares (OLS) will lead to biased estimates of the coefficients. Following the research design of Fenn and Liang (2001) and Booth and Zhou (2009), I use a one-sided Tobit model for dividend payments (censored at zero).

A significant negative relationship with customer specificity and a firm's dividend payment level is shown in Table 3-7. Although including additional controls in the regression models reduces the magnitude of the coefficient on customer R&D intensity, the effect remains statistically significant at the 1% level. The results are also economically significant. After controlling both idiosyncratic risk and cash flow volatility (ROA risk) and all other control variables in column (5), a one standard deviation increase in customer specificity (2.3% from Table 3) is associated with a 0.16% (coefficient -.07 from Table 3 multiplied by 2.3%) decrease in dividend payment level, which corresponds to about 18% of its average across all firm-years (0.9% from Table 2). This result shows that inflexibility of customers matters to the firm's dividend policy, and the firm will choose a lower dividend level. The magnitude of impact from suppliers is more than from customers, which to some extent indicates that the flexibility with suppliers could be more important than with customers. All the standard errors are clustered at the firm level to account for within-firm correlation of the error terms. Clustering errors at industry level gives consistent results.

3.5 Additional Tests

As previous research shows that firm earnings, idiosyncratic risk and dividend levels are all affected by the firm's horizontal competition, I will further control for the firm's competition intensity within its industry measure by using its Herfindahl–Hirschman Index (HHI). Table 3-8 reports the results of regression models with the additional control for HHI. Columns (1)-(2) report how a firm's customer specificity impacts a firm's cash flow risk after controlling for HHI. The dependent variables are ROA risk and CFROA risk. The coefficients for customer R&D intensity are consistent with the original results. The firm's horizontal competition does not explain the impact from the vertical channel on firm's cash flow volatilities. Columns (3)-(4) report how a firm's customer specificity impacts a firm's idiosyncratic risk and Columns (5)-(6) report how a firm's vertical player specificity impacts a firm's Dividend level, all controlling for HHI. Again, the results hold robust and a firm's horizontal competition does not explain the impact from the firm's downstream players on its idiosyncratic risk and dividend payment levels.

Table 3-8: Customer Specificity Impact on Cash Flow Volatility, Idiosyncratic Risk and Dividend Level - Controlling for Horizontal Competition

This table presents the impact of a firm's customer specificity on a firm's Cash Flow Volatility, Idiosyncratic Risk and Dividend Level, controlling for firm's horizontal competition which is measured by Herfindahl–Hirschman Index (HHI). For column (1)-(2), the dependent variables are ROA risk and CFROA risk. For column (3)-(4), the dependent variable is firm's idiosyncratic risk. For column (5)-(6), the dependent variable is Dividend level. Measure of customer specificity is Customer R&D intensity. Control variables include: Size, R&D level of the firm, MTB, Profit, Asset growth, Leverage, Idiosyncratic risk, ROA risk and CFROA risk. The Appendix provides a detailed description of the construction of all of the variables used in the table. Coefficients for (1)-(4) are estimated by OLS regression and for (5)-(6) are estimated by one-sided Tobit regression (censored at zero). Clustered robust standard errors are at firm level and used to account for within-firm correlation of the error terms. Year fixed effects and two-digit IO Industry fixed-effects are included for all the regressions.

	Dependent Variables					
Variables	ROA risk	CFROA risk	Idiosyncratic risk		Dividend level	
	(1)	(2)	(3)	(4)	(5)	(6)
CustomerR&D intensity	0.037*	0.000	0.237***	0.255***	-0.073***	-0.071***
	(1.67)	(0.10)	(10.86)	(11.32)	(-3.18)	(-3.05)
Size	-0.005***	-0.006***	-0.011***	-0.011***	0.004***	0.004***
	(-27.36)	(-23.82)	(-45.23)	(-44.72)	(18.64)	(17.57)
R&D level	0.163***	0.102***	0.017**	0.045***	-0.093***	-0.097***
	(18.78)	(10.00)	(2.04)	(5.10)	(-6.63)	(-6.83)
Profit	-0.072***	-0.086***	-0.094***	-0.095***	0.096***	0.096***
	(-19.18)	(-18.71)	(-24.14)	(-23.15)	(17.51)	(16.93)
Current volatility	0.079***	0.081***				
	(17.16)	(13.45)				
Asset growth	0.008***	0.006***	0.018***	0.019***	-0.018***	-0.019***
	(11.08)	(6.71)	(19.28)	(20.37)	(-17.73)	(-17.05)
Leverage	-0.022***	-0.011***	0.031***	0.029***	-0.034***	-0.033***
	(-9.73)	(-3.07)	(9.99)	(8.86)	(-12.77)	(-11.98)
HHI	-0.000	-0.000	0.004***	0.004***	-0.002**	-0.002***
	(-0.53)	(-0.28)	(2.60)	(2.67)	(-2.45)	(-2.84)
ROA risk			0.166***		-0.033***	
			(17.42)		(-3.23)	
CFROA risk				0.114***		-0.026***
				(13.63)		(-3.37)
MTB					0.001	0.000
					(1.14)	(0.90)
Idiosyncratic risk					-0.216***	-0.219***
					(-24.37)	(-24.00)
Constant	0.060***	0.089***	0.152***	0.149***	-0.012***	-0.009**
	(16.07)	(20.94)	(29.52)	(34.56)	(-3.37)	(-2.48)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	53903	50017	53903	50017	53821	49947
R-squared	0.33	0.22	0.37	0.37	0.37	0.37

To ensure that the previous results are not driven by the sample selection bias caused by the requirement used to construct every IO table, I checked whether the results hold for different periods. As the industry level variables are constructed from IO Use tables which are updated every five years from 1982 to 2002, I control for the time periods by adding a dummy variable to all these models (results are not reported here). All the relationships between customer specificity, cash flow risk, idiosyncratic risk and dividend payment remain robust. Therefore, all the results are stable over time. These robust results also exclude the concern about the inconsistency of data merging caused by the fact that the IO industry codes are merged with SIC before 1995 and NAICS after 1995.

3.6 Conclusion

This paper investigates whether a firm's customer specificity affects its earnings and idiosyncratic risk and, if so, how this is achieved and what consequences will follow this. For the empirical models, I use comprehensive industry-level customer data from the Use table of the benchmark input-output (IO) accounts for the US economy on Bureau of Economic Analysis website, along with firm characteristics from Compustat and CRSP, over the period from 1980 to 2010. The data analysis leads to the conclusion that the firm's cash flow risk and idiosyncratic risk increases when the specificity of its customers is higher. To adjust for the risk changes in real operations, I further show evidence that a firm will choose a more conservative dividend payment policy when the specificity of its customers are high. Managers of a firm with higher cash flow instability and higher idiosyncratic risk will face more difficulties to maintain a certain dividend level or decide to payout dividends. Moreover, the firm's horizontal competition does not explain the impacts from the vertical channel on the firm's earnings, idiosyncratic risk and dividend levels. All the results are consistent over time and robust to different combinations of controls.

The results are informative to management in that the flexibility with firm's downstream players matters to firm future cash flow performances and volatilities. Additionally, the findings provide an explanation of the idiosyncratic risk changes for firms from a point of view in its vertical channel position. Recent literature suggests the desirability of integrating operating and financing policies. This paper also contributes to this stream of research. The findings of this paper support the recent evidence that various changes in dividend policy can be related to the fundamental changes in business surroundings that affect the firm's real operations.

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Chapter 4

Geography and Capital Structure

Abstract:

In this paper, we investigate the impact of geographic location on firms' capital structure decisions. We find strong evidence that location of a firm influences its capital structure. In particular, we find that centrally located firms have lower leverage ratios than remotely located ones. Moreover, consistent with the hypothesis that those remotely located firms face more severe adverse selection problems, the effect of geographic location on capital structure is more pronounced when information asymmetry is higher.

Keywords: location, information asymmetry, capital structure.

4.1. Introduction

Modigliani and Miller's (1958) capital-structure irrelevance proposition suggests that, under certain assumptions, a firm's capital structure has no effect on firm value. One of their assumptions is that information asymmetry does not exist between corporate insiders and outsiders. Relaxing this assumption, Myers and Majiluf (1984) show that firm's financing decision should follow a pecking order. The pecking-order theory of capital structure predicts that when information asymmetry exists between managers and investors, firms should prefer internal financing over external financing. Moreover, when internally generated funds cannot cover investment needs, firms should issue debt. Equity issuance is the last resort for financing only when debt capacity is exhausted. Myers and Majiluf's theory suggests that information asymmetry between insiders and outsiders is a key factor that determines firms' capital structure decisions.

Information asymmetry also intensifies the problem of agency which also determines a pecking order of financing. Based on Jensen and Meckling's (1976) agency theory and the fact on separation of ownership and control in modern firms, firms will choose internal funds over external funds to internalize management private benefits. Also, debt is easier to issue than equity as new shareholders will bear part of agency costs while insiders will retain entire benefits. Agency problem results from the imperfect alignment of managers and shareholders, and will be intensified by severe information asymmetry. Imagine if an investor cannot effectively monitor the behavior of the manager who has large freedom to use his money and interests, can the investor invest his money to the firm without hesitation? The amount and transparency of information are key factors for investors' decisions.

Evidence from extant studies (e.g. Malloy, 2005; Loughran, 2008; John, Knyazeva and Knyazeva, 2008) suggests that distance increases information acquisition costs. To the extent that investors are concentrated in financial centers and/or big cities, firms located in remote areas are likely to face more severe information asymmetry problem because the long distance between these firms and financial centers/big cities may hinder investors from acquiring information about those firms. In this study, we investigate how a firm's geographic location, in particular, its distance to financial centers/big cities, affects its capital structure decisions. Since it is relatively easier for investors to acquire and verify information about firms located near financial centers/big cities, centrally located firms are likely to face less adverse selection problem when they issue equities. As a result, everything else equal, centrally located firms are more likely to use equity as a source of financing than are remotely located firms. Thus, we hypothesize that centrally located firms maintain a lower degree of leverage.

Our empirical results strongly support the hypothesis that firms' leverage ratios are positively correlated with their distance to financial centers/big cities. The results are statistically and economically significant. To further determine whether the effect of geographic location on leverage is a consequence of an adverse selection problem, we examine how this effect is affected by firms' information environment. We find that our results are more pronounced when information asymmetry is high. Specifically, the effect of geographic location on leverage ratios is more pronounced for firms that are covered by fewer financial analysts and that do not have a credit rating.

One concern is that geographic location may be correlated with unobservable firm characteristics which also affect capital structure. We use the Instrument Variable approach to address this potential endogeneity issue. We use rent and administration expenses which are closely related to firm location but not with leverage as instrument variables and apply two-stage least square regressions. Our results still hold robustly.

We also exclude other explanations about the capital structure decision and firm location. We firstly prove that it is not because rural firms have sufficient funds so that they will not relocate to urban areas, in other words, they won't care too much about external financing. We show that rural firms are more financially constrained than urban firms. Thus, rural firms have to face the difficulty of external financing. This result is also confirmed by additional regression tests controlling for cash flows. Secondly, we exclude the industry clustering effect argued by Almazan et al (2010) showing that firms located within an industry cluster will prefer to maintain low debt ratios to attract the opportunities for merges and acquisitions.

Our paper is closely related to the literature that examines how firms' geographic locations affect corporate decisions. Loughran (2008) finds it is difficult to sell equity for rural firms which have a significant information disadvantage. Another study on geography and bondholders (Francis, Hasan, and Waisman, 2007) shows that rural firms exhibit significantly higher costs of debt capital in comparison to urban companies. Additionally, John, Knyazeva and Knyazeva (2008) show that rural firms issue more dividends and hold less cash to compensate for the asymmetric information costs for investors. However, there has not been in previous studies a focus on the geographic impact on capital structure. Our paper contributes to this literature by providing evidence that geographic location affects one of the most important corporate decisions – the capital structure choice.

The plan of the paper is as follows. We review the literature and develop our hypotheses in Section II. Section III describes our sample and variables and provides descriptive statistics. Section IV presents the empirical results on the role of distance in leverage ratio on the changing role of distance in capital structure with different subsamples, and offers interpretations. Section V presents the additional test results. Section VI concludes the study.

4.2 Literature, Hypothesis and Methodology

Geographic location of a firm is a good measure of information asymmetry, as much evidence in the literature shows. We have identified five factors in the literature about location and information environment. Location of firms may affect investors' decisions, analysis quality, equity issuance, debt collection, and payout policy.

Geographic proximity preference of investors is well documented. Judging from the domestic evidence in a study by Coval and Moskowitz (1999), geographic proximity preference contributes to the home bias phenomenon. Their paper firstly found that mutual fund managers were investing in securities geographically closer to them than the average security in their benchmark portfolio. Individual investors are even more biased toward local equities than funds. Ivkovic and Weisbenner (2005) examine the stock investments of over 30,000 households in the continental United States from 1991 to 1996. They find that the average household invests 31% of its portfolio in stocks located within 250 miles while only 13% of the average household's investments would be this close if investors had held the market portfolio instead. These home bias facts imply that companies located in central areas have more potential shareholders than firms located in remote areas.

A possible explanation for preference for firms in central areas is that those firms have a meaningful advantage in exposing information through analysts' work, which is a main information resource for investors (Malloy, 2005; Bae, Stulz, and Tan, 2008). Malloy (2005) finds evidence that geographically proximate analysts are more accurate and have a greater impact on security prices than do other analysts. This is because proximate analysts can get some soft yet important information that can only be obtained by direct observation, and also because they bear lower cost in collecting the information out of their physically short distance to the company. Bae, Stulz, and Tan (2008) extend this research to a cross-country study of the performance of local analysts and foreign analysts and they find an economically and statistically significant analyst local advantage. Easy intuition can be made that better analyst performance is offered to firms located centrally as analysts usually gather in central areas. And, those firms' public financing ability may accordingly vary from firms located far away and with information disadvantage.

Financing choices of firms, whether equity or debt issuance, are both affected by geographic factors which affects information environment. It is obvious that when severe information asymmetry exists between outside investors and insiders, selling equity will be difficult. Fortunately, underwriters of equity offerings are doing their main business in reducing this kind of information asymmetry. And the comparative advantage of investment bankers in underwriting local companies suggests that it is easier for them to obtain information. Loughran (2008) finds it is difficult to sell equity for rural firms which tend to use a lower-quality underwriter than otherwise similar urban firms. Those remote firms are also less likely to retain a prestigious underwriter for their IPOs than urban firms, and even less likely to have a prestigious underwriter. A rural location may make it more difficult or expensive for underwriters to gather information on issuers because underwriters would be forced to spend more time travelling to conduct needed due diligence. He also provided evidence that rural firms are less likely to conduct SEOs than firms located in urban areas, because it is relatively hard for them to re-enter the capital market when investors find it difficult to get information. Therefore, remote firms face difficulty in both initial and seasoned equity financing.

Moreover, remotely located firms exhibit significantly higher costs of debt capital in comparison to centrally located companies (Francis, Hasan, and Waisman, 2007). Since bondholders are mainly concerned with the default risk of the firm, and correspondingly, its ability to make scheduled interest and principal payments over the life of the bond, better access to information should signal a higher probability of payment over the life of the bond and more chances to reveal unfavorable information that might increase the default risk of the company (Sengupta 1998). As a result, bondholders take into consideration the information set of the company when assessing its information risk and incorporate it into their required at-issue yields. Information quality may be compromised when the decision maker is further away from financial intermediates like banks, analysts and large institutional investors which are associated with reducing information asymmetries. Additionally, it may be the case that monitoring rural companies is more difficult due to their distance from a large base of analysts, banks and institutional investors.

Geography also has an influence on other financial policies such as dividends and cash holdings of firms. John, Knyazeva and Knyazeva (2008) find that location influences a firm's information environment and, as a consequence, its dividend and cash policies. If managers in rural firms find it easy to use free cash flow for empire building, investors would demand higher dividends to compensate. Thus, rural firms are going to issue more dividends to compensate for the asymmetric information costs for investors. Centrally located firms hold more cash, pay lower dividends, and replace regular dividends with share repurchases or special dividends. Similar results are obtained for changes in dividends and cash levels. They also control for debt, which can serve as a substitute for dividends.

Given a firm's information environment, the capital structure decision is a set of equity issuance and debt raising policies, and its realization and dynamic change is closely related to investor decisions and other financial policies of the firm. Existing evidence suggests that distance increases investors' information costs. Location as a direct geographic factor influences investors' portfolios, analysts' reporting and forecasting, firms' costs of external financing, and policies about cash and dividends. There is a lack of focus on the geographic impact on capital structure. We expect that location influences a firm's information environment and thus financing decisions, and, as a consequence, its capital structure. We are interested in examining the direct influence of firm's geographic location on capital structure.

Myers (1984) takes the existence of information asymmetries between managers and outside investors and develops a pecking order theory of capital structure. In this theory, capital structure is determined largely by the firms' ability to finance internally, because the high information asymmetry cost makes issuing new equity a last resort, right after debt. Following a pecking order is a theoretically optimal decision for firms when they determine their capital structure. However, how far they can move along the pecking order is limited by their information environment and thus their financing ability. Firms bearing an information disadvantage may have to stop in the "debt" step as they encounter too much difficulty moving toward equity issuance. Taking firm location as a measure of information environment, the more remotely a firm is located, the more informational disadvantage it will bear. Thus, we believe that when centrally located firms choose issuing equity to meet their new financial needs, ceteris paribus, remotely located firms with similar circumstances may choose issuing debt as they are at a more disadvantaged information environment. When centrally located firms choose issuing debt for coming financial needs for projects, ceteris paribus, remotely located firms may choose internal financing or just forego the investment opportunities. Therefore, remotely located firms are always behind centrally located firms on the pecking order road when they both face growth opportunities and high external financing costs. As debt will occupy a larger proportion in their total capital, it is reasonable to hypothesize that remotely located firms have a higher leverage ratio than do the centrally located ones. In this paper, we examine the differences in leverage ratios of centrally located firms and remotely located firms and the role of distance taken together with different analyst coverage and access to public debt markets.

Based on the prediction that the more distant a firm is located, the higher leverage ratio it will have, we hypothesize that leverage ratio has a positive correlation with location, which is represented by distance between each firm's headquarters and the ten largest U.S. metropolitan areas including their suburbs (Loughran and Schultz (2004, 2006)), controlling for other possible explanatory variables. We use the following model. The variables are defined below and are explained in the third part of this paper.

$$\text{Leverage}_{ij} = \beta_{0j} + \beta_{1j}\text{Location}_{ij} + \beta_{2j}\text{Size}_{ij} + \beta_{3j}\text{ROA}_{ij} + \beta_{4j}\text{Market to Book}_{ij} + \beta_{5j}\text{Dividends}_{ij} + \beta_{6j}\text{Fixed\_Assets} + \beta_{7j}\text{R and D} + \beta_{8j}\text{Industry}_{ij} + \beta_{9j}\text{Lag\_Leverage} + + \beta_{9j}\text{CR} + \beta_{10j}\text{Analysis}_{ij} + \varepsilon_{ij}$$

where the leverage ratio is calculated as the ratio of long term debt to total assets. Both book leverage (long term debt/total assets recorded in COMPUSTAT) and market leverage (long term debt/(book value of debt plus market value of equity)) are used in the model. Location is represented by distance, calculation of which will be explained in detail in section III. Alternatively, we use a central location dummy as another measure of location, which has a value of 1 when the firm is located in the 10 metropolitan areas or within 100km around them. Firm size (size) will be measured as the log of total assets. ROA, which reflects profitability, is calculated as the ratio of earnings before interest, tax, depreciation and amortization divided by total assets. Market-to-book ratio, which can reflect growth opportunities, is the end of the previous year's market value of equity scaled by the prior fiscal year's book value. The level of dividends can be defined as the ratio of annual cash dividends to total assets. Fixed-assets, calculated by the amount of fixed assets scaled by the firm's total assets, represents a firm's ability to raise debt through collateral and affects credit rating. R&D is the research and development expense which is used for growing the firm. Analysis here stands for analyst coverage which is defined as making forecasts of one year ahead earnings per share within a twelve-month period. We use the dummy of CR (credit rating) as a measure of access to public markets. If it is 1, the firm has a credit rating (S&P LT domestic issuer credit rating) and thus access to the public market. If it is 0, the firm has no credit rating and thus no access to the public market. Moreover, all regressions will have controls for industry dummies.

As firm location is one of the proxies for information environment, we should examine its power when taken together with different levels of other information environment measures. Analyst coverage has an impact on investment decisions and firm price performance. Studies use the number of analysts following each firm as the measure of analyst coverage. The more analysts analyzing and reporting on the firm, the more information advantage the firm will have. A firm will have to bear information disadvantage if it has few analysts following it. As investors would like to invest in firms for which they have more information, it is reasonable to expect that when centrally located firms choose issuing equity or debt to meet their new financial needs, non-centrally located firms with similar circumstances may choose issuing debt or give up the opportunity in that they are at a more disadvantaged information environment because of less analyst coverage. We would expect a negative relationship between analyst coverage and leverage ratio according to the same logic as we hypothesize about location and leverage ratio. To support the main hypothesis in this paper, we will examine the relationship between location and leverage ratios within subsamples subjected to different levels of analyst coverage. As both analysts following and location have important impacts on the information environment, their influence may counteract when they change in the opposite direction and may complement each other when they move towards the same direction. We expect that the less analyst coverage the firm has, the more important location is to capital structure. As reflected in statistics, the absolute value of the coefficient for location against leverage ratio should be larger in the subsample with lower analyst coverage than that in the subsample with higher analyst coverage.

Similarly, we can apply the logic to the relationship between credit rating and capital structure. When it comes to raising debt, we know that not all firms may be able to choose the source of their debt capital. If firms that do not have access to the public debt markets are constrained by lenders as to the amount of debt capital they may raise, then we should see this manifest itself in the form of lower debt ratios. Examining this intuition, Faulkender and Petersen (2005) find firms that have access to the public bond markets, as measured by having a debt rating, have significantly more leverage. Even after controlling for firm characteristics that determine observed capital structure, firms with a credit rating have 35% more debt. Since credit rating is another important factor for the leverage ratio, we may control for it when investigating the relationship between location and leverage, and test the importance of location on capital structure in different subsamples with or without credit rating. Since firms which have a credit rating, i.e. they have access to the public debt market, will feel it is easier to issue debt, we expect that firms with a credit rating will have higher leverage ratios. Another expectation that should be reasonable is that in subsamples with or without credit ratings, location of a firm may play a different role on capital structure. Following the same logic from the overlapping impact of analyst coverage and location, we expect that location will impact more on firms without a credit rating.

In summary, the hypotheses to be tested in this paper are:

Hypothesis 1: The more remotely a firm is located, the higher leverage ratios it will have.

Hypothesis 2: Location effect is more pronounced for firms with more severe information asymmetry.

4.3 Data and Variables

The sample includes Compustat Industrial firms from 1980-2006 with available state and county code data and excludes firms with total assets under $10 million as well as firms incorporated outside the US. Summary statistics for the main variables are presented in Table 4-1.

Table 4-1: Summary statistics of the main variables

The table reports summary statistics for the variables we use in the regressions of firm location and leverage ratios and control variables. *Market leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book leverage* is the amount of long debt divided by book value of total assets (represented by percentage). There lag values are the *t-1* value. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Distance* is distance in kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Fixed assets,* calculated by the amount of fixed assets scaled by the firm's total assets. *Dividends* is measured as common dividends over total assets. We measure *R&D* level by total R&D expenses divided by the total sales. *Analyst coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. Leverage measures are in percentage.

variable	Mean	Median	Std	5^{th} perpcentile	95^{th} perpcentile
Book leverage	20.630	15.023	21.426	0.000	63.847
Market leverage	15.118	9.439	16.585	0.000	49.442
distance	0.288	0.069	0.422	0.002	1.103
Lag book leverage	20.789	15.360	21.405	0.000	63.939
Lag market leverage	15.312	9.715	16.645	0.000	49.667
Market to book	2.350	1.562	3.329	0.035	7.727
ROA	-0.009	0.025	0.170	-0.335	0.143
Fixed assets	0.288	0.215	0.260	0.007	0.821
Dividends	0.010	0.000	0.022	0.000	0.048
Size	5.451	5.225	2.004	2.650	9.075
R&D level	0.014	0.000	0.068	0.000	0.069
Credit rating	0.102	0.000	0.303	0.000	1.000
Analyst coverage	0.120	0.000	0.787	0.000	0.000

As the dependent variable of the multivariable regression model, both market leverage and book leverage will be calculated and taken into the regression. Firm market leverage (Leverage) is calculated as the ratio of total debt to total assets (book value of debt plus market value of equity). Book leverage is the amount of long debt divided by book value of total assets. The ratios are calculated in terms of percentage.

Location is represented by a central location dummy or by a continuous variable, distance. To classify firms as central or non-central, we follow a number of authors, including Coval and Moskowitz (1999, 2001), Zhu (2002), Ivkovic and Weisbenner (2005), Loughran and Schultz (2004, 2006) and others, and use a company's headquarters as a proxy for its location. We obtain the headquarters locations for companies from Compustat, SDC and Hoover's. Following previous research, we classify firms as centrally located or non-centrally located. By the definition in Loughran and Schultz (2006), a company is defined as a centrally located firm if its headquarters is in one of the ten largest metropolitan areas of the United States according to the 2000 census. These include New York City, Los Angeles, Chicago, Washington-Baltimore, San Francisco, Philadelphia, Boston, Detroit, Dallas, and Houston. In this paper, we define Central Location as a dummy variable equal to 1 if the firm is located in one of the top ten metropolitan areas as identified by the 2000 Census or within 100 kms around them; 0 otherwise.

More directly, we can calculate distance as the measure of geography. Using latitude and longitude data, we can compute the distance between each firm's headquarters and the ten largest U.S. metropolitan areas including their suburbs as defined by the 2000 census. We can use the standard formula for computing the distance $d_{i,j}$ taken by

Coval and Moskowitz (1999):

$$d_{i,j} = arccos\{\cos(lat_i)\cos(lon_i)\cos(lat_j)\cos(lon_j) + \cos(lat_i)\sin(lon_i)\cos(lat_j)\cos(lon_j) + \sin(lat_i)\sin(lat_j)\}*\frac{2\pi r}{360}$$

where *lat* and *lon* are latitudes and longitudes (measured in degrees) of the headquarters locations and *r* is the radius of the earth. Distance is calculated as a main variable in thousand miles.

Firm size (size) is measured as the log of total assets. Firm size does affect the practical financial needs of firms. We expect the larger firms have higher leverage ratios since they are more mature in financing through the pecking order in which debt is chosen before equity.

Firm profitability can be represented by ROA, which is calculated as the ratio of earnings before interest, tax, depreciation and amortization divided by total assets. We control for this variable because profitability not only reflects the real financial need and reasons for issuing bonds or equity but also affects the ability of firms to finance externally.

Growth opportunities usually increase firms' funding needs. We use the market-to-book ratio to represent this explanatory variable. Following previous literature (Francis, Hasan, and Waisman, 2007), for the market-to-book ratio we use the end of the previous year's market value of equity (market price multiplied by common shares outstanding) scaled by the prior fiscal year's book value.

Dividends to some extent play a similar role as debt since they both ease the agency costs arising from free cash flow. The free cash flow theory offers the explanation that firms with high agency costs of free cash flow pay higher dividends to constrain managers from inefficient investment and subject them to monitoring from capital markets (Easterbrook, 1984; Lang and Litzenberger, 1989; Smith and Watts, 1992). Debt which engages the firm in payout obligations will also play a part in easing the agency problem. The level of dividends is defined as the ratio of annual cash dividends on common stock to total assets.

Fixed assets reflect the scale and the overall financing needs of a firm. R&D activities produce valuable, albeit intangible, assets such as patents, copyrights, and technological secrets, all of which require financing to operate.

Besides considering the determinants of its preferred leverage (the demand side) which are the characteristics of the firms, we should also consider the variables that measure the constraints on a firm's ability to increase its leverage (the supply side). Analyst coverage (Analysis) can mitigate information asymmetries faced by the firm. Existing work has shown that the information production role of analysts increases with analyst proximity to target firms (Malloy, 2005; Bae, Stulz, and Tan, 2005). Analyst coverage data is available from I/B/E/S and is defined as the number of one-year-ahead EPS analyst forecasts.

Moreover, we use the dummy of CR (credit rating) as a proxy for access to public markets. If it is 1, the firm has a credit rating and thus access to the public market. If it is 0, the firm has no credit rating and thus no access to the public market. If a firm is less likely to have a credit rating, it will be difficult to enter the public debt market and issue public debt. The credit rating data can be obtained from Compustat.

Industry affiliation (Industry) can have a significant effect both on the choice of location (e.g., geographic clusters of refining, auto making, financial services firms) and financing behavior (for instance, utilities have a much higher equity issuance than non-utilities.) In this paper, we take industry dummies classified by 3-digit SIC codes. All regressions will be controlled for industry dummies.

4.4 Empirical Results

Table 4-2 presents the correlation matrix for all the variables. We can see that distance has positive correlations with both book and market leverage. This is consistent with our arguments. We further find univariate results are consistent with the main prediction. Compared to remote firms, centrally located firms have lower levels of book and market leverage ratio. However, univariate tests (not reported) omit a number of determinants that can be correlated both with location and capital structure. We next turn to multivariate analysis.

Table 4-2: Correlation Matrix of Variables

The table reports the correlations among all the variables. *Market leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book leverage* is the amount of long debt divided by book value of total assets (represented by percentage). There lag values are the *t-1* value. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Distance* is distance in kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Fixed assets,* calculated by the amount of fixed assets scaled by the firm's total assets. *Dividends* is measured as common dividends over total assets. We measure *R&D* level by total R&D expenses divided by the total sales. *Analyst coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. Leverage measures are in percentage.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Book leverage	1.000												
Market leverage	0.905	1.000											
distance	0.055	0.057	1.000										
Lag book leverage	0.830	0.764	0.056	1.000									
Lag market leverage	0.755	0.828	0.057	0.904	1.000								
Market to book	-0.109	-0.217	-0.019	-0.113	-0.204	1.000							
ROA	-0.049	-0.017	0.013	-0.020	-0.014	0.024	1.000						
Fixed assets	0.330	0.344	0.117	0.333	0.346	-0.109	0.067	1.000					
Dividends	-0.058	-0.077	-0.021	-0.063	-0.076	0.053	0.235	0.088	1.000				
Size	0.198	0.175	-0.036	0.196	0.170	-0.001	0.226	0.178	0.151	1.000			
R&D level	-0.189	-0.249	-0.070	-0.209	-0.260	0.195	-0.472	-0.240	-0.140	-0.166	1.000		
Credit rating	0.156	0.120	0.004	0.158	0.126	0.008	0.146	0.167	0.133	0.576	-0.133	1.000	
Analyst coverage	-0.040	-0.061	-0.018	-0.043	-0.063	0.063	0.021	-0.027	0.013	0.154	0.080	0.075	1.000

In the multivariable panel regression model using distance and other control variables against leverage ratios, the statistical results (see Table 4-3) give a significantly positive coefficient for the continuous location measure-distance. The t-statistics are based on standard errors that are heteroskedasticity-consistent. It tells us that both market and book leverage ratios are increasing as distance to big cities increases. As we predicted, firms feel it is more difficult to finance through equity and rely more on debt as they are located further away from those metropolitan areas. Regressing the location dummy against leverage ratios and controlling for other variables, results give a significantly negative coefficient for the central location dummy (which has value of 1 when the firms locate in the 10 big cities or within 100km around them.) This result confirms the result from the distance regression and is consistent with the prediction from the univariate test even after controlling for firm characteristics on the capital demand side and factors on the supply side.

Table 4-3: The effect of geography on capital structure

The sample includes Compustat Industrial firms for 1980-2006 with available state and county code data and excludes firms with total assets under 10 mln, and firms incorporated outside the US. *Market Leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book Leverage* is the amount of long debt divided by book value of total assets (both in percentage). *Distance* is distance in kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Dividends* is the sum of cash dividends on common stock divided by the firm's total assets. *Fixed Assets,* calculated by the amount of fixed assets scaled by the firm's total assets. We measure *RandD* level by total R&D expenses divided by the total sales. *Analyst Coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. *Central Location* is the dummy variable equal to 1 if the firm is located in one of the top ten metropolitan areas as identified by the 2000 Census or within 100 kms around them; 0 otherwise.

Moreover, all regressions include year dummies, but we do not report their coefficient estimates. All regressions will have controls for industry dummies classified by 3-digit SIC codes, but we do not report their coefficients. The *t*-statistics in parentheses are based on standard errors that are heteroskedasticity-consistent.

$$\text{Leverage}_{ij} = \beta_{0j} + \beta_{1j}\text{Location}_{ij} + \beta_{2j}\text{Size}_{ij} + \beta_{3j}\text{ROA}_{ij} + \beta_{4j}\text{Market to Book}_{ij} + \beta_{5j}\text{Dividends}_{ij}$$

$$+\beta_{6j}\text{Fixed\_Assets}_{ij} + \beta_{7j}\text{R and D}_{ij} + \beta_{8j}\text{Industry}_{ij} + \beta_{9j}\text{Lag\_Leverage}_{ij}$$

$$+ +\beta_{9j}\text{CR}_{ij} + \beta_{10j}\text{Analyst\_Coverage}_{ij} + \varepsilon_{ij}$$

VARIABLES	*Market Leverage*		*Book Leverage*	
	(1)	*(2)*	*(3)*	*(4)*
Distance	.215***		.452***	
	(2.70)		(4.11)	
Central_location		-.179***		-.276***
		(-2.83)		(-3.18)
Size	.517***	.519***	.816***	.809***
	(23.90)	(23.76)	(27.25)	(26.81)
ROA	-2.680***	-.2.700***	-6.982***	-7.006***
	(-8.77)	(-8.83)	(-14.81)	(-14.86)
Market to Book	-.218 ***	-.218***	.230***	.229***
	(-20.08)	(-20.09)	(9.85)	(9.82)
Dividends	-.36.087 ***	-36.301***	-21.824 ***	-22.127***
	(-21.32)	(-21.43)	(-8.20)	(-8.31)
Fixed Assets	4.069 ***	4.061***	6.952 ***	6.960***
	(16.99)	(16.94)	(20.88)	(20.89)
R and D	-2.817 ***	-2.791***	-2.141 ***	-2.148***
	(-7.34)	(-7.26)	(-3.23)	(-3.24)
Lag Leverage	75.620 ***	75.625***	84.488***	84.508***
	(227.65)	(227.56)	(194.73)	(194.68)
Credit Rating	-.186 **	-.215 **	1.748 ***	1.720***
	(-2.15)	(-2.48)	(14.20)	(13.99)
Analyst Coverage	-.147***	-.092***	-.156 ***	-.066**
	(-8.30)	(-5.54)	(-5.70)	(-2.56)
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Obs	100912	100912	100915	100915
R2	0.7040	0.7039	0.6082	0.6081

*** significant at 1%; ** significant at 5%; * significant at 10%

Firm size is positively correlated with leverage ratios, whether we use distance or the location dummy in the regression. The positive coefficient is significant and consistent with our expectation that larger firms have higher leverage ratios since they feel easier to follow the pecking order theory in which debt is preferred to equity. Larger firms usually have more ability to raise debt through both public and private sources.

ROA, representing firm profitability, is negatively correlated with leverage ratios. Firms which have more profit usually go further to the next step in the pecking order. They are trying to make their firms public and financing through the broad equity market has the largest population of individual and institutional investors. Therefore, firms with higher ROA may have a higher equity ratio and lower leverage.

We use market-to-book ratio to represent growth opportunities, which usually increase firms' funding needs. Firms with high MTB will need more money to explore those opportunities which will increase their true value. Our results demonstrate that MTB is positively correlated with leverage ratios. Most literature has largely taken a negative relation between MTB and leverage as given (Myers, 1977; Baker and Wurgler, 2002; Welch, 2004.), and debate only about its economic interpretation. However, Chen and Zhao (2006) found that the relation between the market-to-book ratio and the leverage ratio is not monotonic and is positive for most firms (more than 88% of COMPUSTAT firms and more than 95% of total market capitalization). Debt financing increases when market-to-book ratio rises from low to medium and decreases when market-to-book ratio increases further from medium to high. The positive relation we found in our study may be driven by firms with low market-to-book ratios.

Dividends could substitute for the role of debt when easing agency problems arising from free cash flow. Thus, the level of dividends is expected to be negatively correlated with the debt level, which is confirmed in our regression results. Free cash flow theory could explain that firms with high agency costs of free cash flow pay higher dividends to constrain managers from inefficient investment and studies show that dividends payout could subject managers to monitoring from capital markets. Debt which engages the firm in payout obligations will also play a part in easing the agency problem. The more dividends a firm paid the less debt it has to raise to ease the FCF problem. Thus, firms paying a higher level of dividends will have less debt and thus lower leverage.

The fixed-assets variable has a significant positive coefficient, which means that firms with more fixed assets have higher leverage ratios. Fixed assets can be used as collateral, and they add confidence to both borrowers and lenders; hence, it is easier for firms which have considerable fixed assets to raise debt.

R&D expenses negatively correlate with leverage ratios in our evidence. R&D activities produce valuable, albeit intangible, assets such as patents, copyrights, and technological secrets, all of which require financing to operate. However, those activities aim at generating value for the firm in the future, which is considered as an asset by equity investors who focus on the firm's growing ability, but do not mean much to debt holders who prefer tangible and fixed guarantees. Thus, firms spending more R&D expenses may have lower leverage ratios.

After analyzing the determinants of a firm's preferred leverage (the demand side), we get the expected results about how the variables that measure the constraints on a firm's ability (the supply side) to get capital affect its leverage ratios. Consistent with our expectation, firms with fewer analysts following will have higher leverage ratios. Analyst coverage can mitigate information asymmetries between the firm and its shareholders. Firms with more analyst coverage are expected to have more equity thus lower leverage ratio. There is no doubt about the statistical result that the coefficient for analyst coverage against leverage ratios is significantly negative.

Credit rating, which has value of 1 if the firm has an S&P LT domestic issuer credit rating, is positively correlated with market leverage and negatively correlated with book leverage. For book leverage calculated as a ratio of book long debt to book total assets, firms with a credit rating will probably increase their long term debt which is usually issued in the public market. It is reasonable to conclude that firms with a credit rating will have higher book debt ratios. However, when it comes to market leverage, the coefficient may change its sign because the denominator of market leverage includes market equity which could also be influenced by the firm's credit rating. We ran regression of credit rating against market price multiplied by outstanding common shares; the coefficient is significantly positive and not reported in the paper. The credit rating will also improve the market performance of the firm's equity and this will lead a larger increase in the denominator than in the numerator, so the credit rating dummy could be negatively correlated with market leverage.

The analysis could be affected by the direction of causality. As discussed by Loughran (2008), we should notice that most of the studies about location and financing have assumed that the geographical location of firms was determined by proximity to natural resources, customers and suppliers and not by potential future needs to issue equity. Location of a firm could be endogenous, that is location is not taken as given and is not fixed forever. Firms may arrange their locations due to capital structure considerations. In order to exclude the endogeneity of the location variable, we have to find a valid instrumental variable which could be applied in a 2SLS regression. An instrumental variable is supposed to be related to the instrumented variable - location and not related to the dependent variable. Based on intuition that rent fees and administration fees (i.e. secretary fees, office maintenance fees, etc.) will be much higher in central places and they are not obviously related to a firm's capital structure, we choose rent and admin as IVs and test their validity through an over-identification test. The null hypothesis of the test is that the instrumental variables are valid. If the Sargan statistics do not reject the null, we can conclude that those IVs are valid. Results are shown in Table 4-4.

Table 4-4: Robustness checks: causality in location and capital structure

The sample includes Compustat Industrial firms for 1980-2006 with available state and county code data and excludes firms with total assets under 10 mln, and firms incorporated outside the US. *Market Leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book Leverage* is the amount of long debt divided by book value of total assets (both in percentage). *Distance* is distance in thousand kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Dividends* is the sum of cash dividends on common stock divided by the firm's total assets. *Fixed Assets,* calculated by the amount of fixed assets scaled by the firm's total assets. We measure *R&D* level by total R&D expenses divided by the total sales. *Analyst Coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. *Central Location* is the dummy variable equal to 1 if the firm is located in one of the top ten metropolitan areas as identified by the 2000 Census or within 100 kms around them; 0 otherwise.

Moreover, all regressions include year dummies, but we do not report their coefficient estimates. All regressions will have controls for industry dummies classified by 3-digit SIC codes, but we do not report their coefficients. The *t*-statistics in parentheses are based on standard errors that are heteroskedasticity-consistent.

$$\text{Leverage}_{ij} = \beta_{0j} + \beta_{1j}\text{Location}_{ij} + \beta_{2j}\text{Size}_{ij} + \beta_{3j}\text{ROA}_{ij} + \beta_{4j}\text{Market to Book}_{ij} + \beta_{5j}\text{Dividends}_{ij}$$

$$+\beta_{6j}\text{Fixed\_Assets}_{ij} + \beta_{7j}\text{R and D}_{ij} + \beta_{8j}\text{Industry}_{ij} + \beta_{9j}\text{Lag\_Leverage}_{ij}$$

$$+ +\beta_{9j}\text{CR}_{ij} + \beta_{10j}\text{Analyst\_Coverage}_{ij} + \varepsilon_{ij}$$

Columns II to V report two-stage least squares results. Over-identification tests give Sargan statistics and Chi-square P values. The null hypothesis is the instruments variables are valid. If the P value does not reject the null, we can conclude that those IVs are valid. First stage regressions predict Distance and Central Location with controls and rent or admin.

VARIABLES	*Market Leverage*	*Book Leverage*	*Market Leverage*	*Book Leverage*
	2SLS(1)	*2SLS(2)*	*2SLS(3)*	*2SLS(4)*
Distance	38.251***	64.052***		
	(6.01)	(6.32)		
Central Location			-16.861***	-28.820***
			(-8.69)	(-9.76)
Size	1.506***	2.502 ***	1.052***	1.759***
	(8.95)	(9.33)	(15.30)	(16.80)
ROA	-4.765***	-10.187***	-4.498***	-9.793***
	(-9.05)	(-12.15)	(-12.82)	(18.34)
Market to Book	-.231***	.203***	-.223***	.218***
	(-11.03)	(6.08)	(-15.09)	(9.73)
Dividends	-54.657***	-47.445***	-60.130***	-57.319***
	(-10.63)	(-5.79)	(15.28)	(-9.57)
Fixed Assets	-3.136**	-5.449***	-.070***	-.474
	(2.35)	(-2.57)	(-0.12)	(-0.51)
R and D	2.399*	7.523***	1.668**	6.468***
	(1.88)	(3.71)	(2.01)	(5.12)
Lag Leverage	72.516***	81.030***	72.507***	80.968***
	(136.24)	(95.60)	(194.44)	(142.67)
Credit Rating	-.640***	1.290***	-.617***	1.307***
	(-2.79)	(3.53)	(-3.87)	(5.39)
Analyst Coverage	-.136***	-.173**	-.233***	-.339***
	(-3.00)	(-2.40)	(-6.76)	(-6.47)
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Obs	72056	72058	72056	72058
Over identification Stats (rent and admin together as IVs)	1.037 P-val = 0.309	2.911 P-val = 0.088	0.127 P-val= 0.722	0.286 P-val= 0.592
First Stage	Central Location	Obs	Central Location	Obs
Rent	-14.685***	72120	.031***	72120
	(-8.95)		(12.60)	
Admin	-.682***	82862	.002***	82862
	(-4.84)		(9.62)	

*** significant at 1%; ** significant at 5%; * significant at 10%

No matter whether we use distance or the central location dummy, the chi-square p-values of rent and admin together as IVs for both book leverage and market leverage are more than 10%. The null hypothesis that those IVs are valid should not be rejected. As rent and admin passed the over-identification test, they are valid in testing the main hypothesis through 2SLS. The strength of the proposed instruments is supported by high first stage p-values. Location still affects capital structure significantly in that the more remote a firm is located, the higher leverage ratio it bears.

Even after these adjustments for the possible endogeneity of the location measure, our empirical results support the hypothesis that distance is positively related with the leverage ratio. Up to this step, we can conclude that geography does matter to capital structure.

However, will geography become more important when firms are less followed by analysts and face difficulty in accessing public markets? We test the relationship between geography and capital structure in subsamples with different analyst coverage and credit ratings.

We divided the total sample into three subsamples with different levels of analyst coverage. Results are reported in Table 4-5. High Analyst Coverage is a dummy variable equal to 1 if the firm has more than five analysts following it in that year. In the subsample with high analyst coverage, distance is not significantly correlated with leverage ratios, nor is the central location dummy. Since the strength of high analyst coverage could compensate for the weakness of remote location, location of a firm does not matter much to capital structure when there is considerable analyst coverage following the firm. In other words, if the firm is well exposed to the investors and people feel convenient enough to get necessary information about the firm, location could be ignored when choosing capital structure.

Table 4-5: Robustness checks: subsample results with different analyst coverage

The sample includes Compustat Industrial firms for 1980-2006 with available state and county code data and excludes firms with total assets under 10 mln, and firms incorporated outside the US. *Market Leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book Leverage* is the amount of long debt divided by book value of total assets (both in percentage). *Distance* is distance in kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Dividends* is the sum of cash dividends on common stock divided by the firm's total assets. *Fixed Assets,* calculated by the amount of fixed assets scaled by the firm's total assets. We measure *R&D* level by total R&D expenses divided by the total sales. *Analyst Coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. *Central Location* is the dummy variable equal to 1 if the firm is located in one of the top ten metropolitan areas as identified by the 2000 Census or within 100 kms around them; 0 otherwise.

High Analyst Coverage is a dummy variable equal to 1 if the firm more than 5 analysts following it in that year. *Low Analyst Coverage* is a dummy variable equal to 1 if the firm has 1to 5 analysts following it in that year. *Zero Analyst Coverage* is a dummy variable equal to 1 if the firm has no analyst following it in that year. Moreover, all regressions include year dummies, but we do not report their coefficient estimates. All regressions will have controls for industry dummies classified by 3-digit SIC codes, but we do not report their coefficients. The *t*-statistics in parentheses are based on standard errors that are heteroskedasticity-consistent.

$$\text{Leverage}_{ij} = \beta_{0j} + \beta_{1j}\text{Location}_{ij} + \beta_{2j}\text{Size}_{ij} + \beta_{3j}\text{ROA}_{ij} + \beta_{4j}\text{Market to Book}_{ij} + \beta_{5j}\text{Dividends}_{ij}$$

$$+\beta_{6j}\text{Fixed\_Assets}_{ij} + \beta_{7j}\text{R and D}_{ij} + \beta_{8j}\text{Industry}_{ij} + \beta_{9j}\text{Lag\_Leverage}_{ij}$$

$$+ +\beta_{9j}\text{CR}_{ij} + \beta_{10j}\text{Analyst\_Coverage}_{ij} + \varepsilon_{ij}$$

The main equation is applied in three subsamples with different analyst coverage.

Panel A: subsample results with different analyst coverage using distance

VARIABLES	*Market Leverage*			*Book Leverage*		
	High coverage	Low coverage	Zero coverage	High coverage	Low coverage	Zero coverage
Distance	-.247	.215***	.229***	-.387	.453***	.482 ***
	(-0.54)	(2.70)	(2.76)	(-0.43)	(4.11)	(4.20)
Size	.371 ***	.517***	.525***	.342*	.816 ***	.827***
	(2.96)	(23.90)	(23.20)	(1.75)	(27.25)	(26.43)
ROA	-6.682***	-2.680***	-2.566***	-9.712**	-6.982 ***	-6.951***
	(-3.24)	(-8.77)	(-8.08)	(-2.02)	(-14.81)	(-14.23)
Market to Book	-.255***	-.218***	-.219***	.161	.230***	.231 ***
	(-5.12)	(-20.08)	(-19.27)	(1.01)	(9.85)	(9.49)
Dividends	-39.003***	-36.087***	-37.083***	-64.827***	-21.824***	-21.499***
	(-3.90)	(-21.32)	(-21.12)	(-3.37)	(-8.20)	(-7.82)
Fixed Assets	4.398 **	4.069***	4.067 ***	7.535 ***	6.952 ***	6.999 ***
	(2.63)	(16.99)	(16.31)	(2.76)	(20.88)	(20.22)
R and D	-4.727 *	-2.817***	-2.822***	1.430	-2.141***	-2.353***
	(-1.79)	(-7.34)	(-7.01)	(-0.32)	(-3.23)	(-3.38)
Lag Leverage	70.518***	75.620 ***	75.456***	89.914 ***	84.488***	84.157 ***
	(20.63)	(227.65)	(220.27)	(19.93)	(194.73)	(187.90)
Credit Rating	-.483	-.186**	-.212**	.139	1.748 ***	1.754***
	(-0.96)	(-2.15)	(-2.30)	(0.18)	(14.20)	(13.43)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1939	100912	93749	1939	100915	93752
R2	0.817	0.704	0.701	0.690	0.608	0.605

*** significant at 1%; ** significant at 5%; * significant at 10%

Panel B subsample results with different analyst coverage using location dummy

VARIABLES	*Market Leverage*			*Book Leverage*		
	High coverage	Low coverage	Zero coverage	High coverage	Low coverage	Zero coverage
Central Location	-.224	-.179***	-.195***	-.233	-.278 ***	-.313***
	(-0.64)	(-2.84)	(-2.93)	(-0.37)	(-3.21)	(-3.44)
Size	.386***	.518***	.526***	.361*	.813***	.824***
	(3.07)	(23.92)	(23.22)	(1.84)	(27.15)	(26.34)
ROA	-6.768***	-2.688***	-2.575***	-.9.819**	-6.990***	-6.959***
	(-3.29)	(-8.79)	(-8.10)	(-2.05)	(-14.82)	(-14.25)
Market to Book	-.253***	-.217***	-.218***	.164	.230***	.2311***
	(-5.09)	(-20.06)	(-19.26)	(1.03)	(9.86)	(9.50)
Dividends	-38.652***	-36.211***	-37.214***	-64.431***	-22.037***	-21.738***
	(-3.85)	(-21.38)	(-21.19)	(-3.34)	(-8.28)	(-7.91)
Fixed Assets	4.368***	4.060***	4.057***	7.50***	6.962***	7.005***
	(2.61)	(16.94)	(16.26)	(2.74)	(20.90)	(20.22)
R and D	-4.602*	-2.806***	-2.812***	1.566	-2.141***	-2.354***
	(-1.74)	(-7.31)	(-6.99)	(0.35)	(-3.23)	(-3.38)
Lag Leverage	70.597***	75.616***	75.450***	90.013***	84.486***	84.151***
	(20.68)	(227.62)	(220.23)	(19.97)	(194.69)	(187.84)
Credit Rating	-.502	-.188**	-.214**	.114	1.748***	1.752***
	(-1.01)	(-2.16)	(0.020)	(0.15)	(14.20)	(13.42)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1939	100912	93749	1939	100915	93752
R2	0.817	0.704	0.701	0.690	0.608	0.605

*** significant at 1%; ** significant at 5%; * significant at 10%

As analyst coverage declines, the importance of location is increasing. Low Analyst Coverage is a dummy variable equal to 1 if the firm has five or fewer than five and more than zero analyst following it in that year. Zero Analyst Coverage is a dummy variable equal to 1 if the firm has no analyst following it in that year. The absolute value of the coefficient for location (distance and central location dummy) against the leverage ratio is larger in the subsample with zero analyst coverage than that in the subsample with low analyst coverage. This result further confirms our expectation about the changing impact of location on capital structure as other factors influencing information environment change. With no analyst following, centrally located firms have a significant advantage in terms of information environment relative to remotely located ones which are also under zero analyst coverage. However, when more analysts come to analyze and report differently located firms, the information disadvantage of remote firms will ease to a certain degree. Results remain robust if we choose four or more than four analysts forecasting as high analyst coverage in order to smooth the distribution of firms in the subsamples. Even when we look at the difference between firms with analyst coverage and without it, capital structure of the first group is significantly influenced by location while this relation does not hold for the latter group.

Credit rating could also influence how location affects capital structure. We use the dummy of CR (credit rating) as the indicator of access to public markets, and divide the total sample into two subsamples. If CR is 1, the firm has a credit rating (S&P LT domestic issuer credit rating) and thus access to the public market. As Table 4-6 shows, distance or the central location dummy is not significantly correlated to leverage ratios when the firms have a credit rating. We hypothesize that leverage of remote firms is higher because they rely more on debt, so if having a credit rating makes it easier for firms to raise money from public markets, it is not clear if the high leverage ratio is due to the constraints from location or the convenience of a credit rating. The location impact on capital structure will be masked when a credit rating is present. If CR is 0, the firm has no credit rating and thus no access to the public market. In this case, firm location really matters to leverage ratio. Rural firms without access to markets find it harder to obtain public financing and rely more on debt, which is easier to issue than equity. Therefore, the location impact appears significant for firms without a credit rating.

Table 4-6: Robustness checks: subsample results with credit rating

The sample includes Compustat Industrial firms for 1980-2006 with available state and county code data and excludes firms with total assets under 10 mln, and firms incorporated outside the US. *Market Leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book Leverage* is the amount of long debt divided by book value of total assets (both in percentage). *Distance* is distance in kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Dividends* is the sum of cash dividends on common stock divided by the firm's total assets. *Fixed Assets,* calculated by the amount of fixed assets scaled by the firm's total assets. We measure *R&D* level by total R&D expenses divided by the total sales. *Analyst Coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. *Central Location* is the dummy variable equal to 1 if the firm is located in one of the top ten metropolitan areas as identified by the 2000 Census or within 100 kms around them; 0 otherwise.
CR (credit rating) divides the whole sample into on subsample with credit rating and the other without it. Moreover, all regressions include year dummies, but we do not report their coefficient estimates. All regressions will have controls for industry dummies classified by 3-digit SIC codes, but we do not report their coefficients. The *t*-statistics in parentheses are based on standard errors that are heteroskedasticity-consistent.

$$\text{Leverage}_{ij} = \beta_{0j} + \beta_{1j}\text{Location}_{ij} + \beta_{2j}\text{Size}_{ij} + \beta_{3j}\text{ROA}_{ij} + \beta_{4j}\text{Market to Book}_{ij} + \beta_{5j}\text{Dividends}_{ij}$$

$$+\beta_{6j}\text{Fixed\_Assets}_{ij} + \beta_{7j}\text{R and D}_{ij} + \beta_{8j}\text{Industry}_{ij} + \beta_{9j}\text{Lag\_Leverage}_{ij}$$

$$+ +\beta_{9j}\text{CR}_{ij} + \beta_{10j}\text{Analyst\_Coverage}_{ij} + \varepsilon_{ij}$$

The main equation is applied in two subsamples with or without credit rating.

VARIABLES	*Market Leverage*				*Book Leverage*			
	Have credit rating		Have no credit rating		Have credit rating		Have no credit rating	
Distance	.239		.257***		.277		.408***	
	(1.08)		(2.59)		(0.88)		(3.01)	
Central Location		-.111		-.153**		-.217		-.171*
		(-0.87)		(-2.09)		(-1.19)		(-1.72)
Size	-.026	.041	.689***	.665***	-.374**	-.368***	1.227***	1.146***
	(-0.48)	(1.00)	(22.78)	(25.11)	(-4.57)	(-5.88)	(30.15)	(31.86)
ROA	-16.743***	-14.956***	-2.493***	-2.400***	-.13.936***	-12.156***	-.7.565***	-7.360***
	(-9.69)	(-9.01)	(-7.28)	(-7.67)	(-5.55)	(-5.00)	(-14.42)	(-15.27)
Market to Book	-.269***	-.263***	-.214***	-.204***	.155**	.170***	.223***	.225***
	(-8.69)	(-8.86)	(-16.31)	(-17.34)	(2.44)	(2.72)	(8.37)	(8.94)
Dividends	-14.949**	-20.295***	-37.401***	-37.611***	22.089**	11.398	-32.281***	-27.935***
	(-2.44)	(-4.01)	(-18.75)	(-20.55)	(1.95)	(1.28)	(-10.53)	(-10.23)
Fixed Assets	.901	1.069**	5.468***	4.726***	3.106***	4.249***	8.060***	7.660***
	(1.41)	(2.03)	(17.87)	(17.33)	(3.32)	(5.57)	(19.29)	(20.41)
R and D	-8.539***	-8.350	-2.650***	-2.289***	-8.541**	-6.501**	-1.982**	-1.812***
	(-3.54)	(-4.14)	(-5.70)	(-5.81)	(-2.42)	(-1.98)	(-2.39)	(-2.66)
Lag Leverage	74.214***	75.457***	73.016***	74.481***	85.857***	85.728***	81.051***	82.627***
	(92.32)	(108.57)	(169.61)	(194.73)	(76.35)	(89.44)	(146.35)	(167.30)
Analyst Coverage	-.067**	-.058**	-.116***	-.194***	-.093**	-.108***	-.136***	-.154***
	(-2.21)	(-2.34)	(-4.95)	(-7.54)	(-2.11)	(-2.89)	(-3.89)	(-3.89)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	14764	20428	68029	80484	14764	20428	80487	80487
R2	0.75	0.77	0.66	0.69	0.66	0.68	0.59	0.59

4.5 Additional tests

4.5.1 Financial constraints

Firm's financial status affects its decision on capital structure. Thus, we want to check whether rural firms have sufficient funds so that they will not relocate to urban areas, in other words, they will not care too much about external financing. We firstly control for cash flow ratios in our regressions of leverage measures against distance and location dummy, where cash flow ratio is defined as operating income before taxes and interests over total assets. Our results holds robust. We further compare the financial constraints between rural firms and urban firms. Following Almeida, Campello, and Weisbach (2004), we use the sensitivity of cash flow changes to internal funding as a measure of financial constraints. They show that if the correlation for cash flow changes over internal funding and a set of controls is greater than zero, then the firm is financially constrained. We run the cash flow regressions in rural firms and urban firms separately, and find that for rural firms the cash flow coefficient is significantly positive while for urban firms it is insignificant. Thus, we can see that rural firms are actually more financially constrained than urban firms. Rural firms have to face the difficulty of external financing.

4.5.2 Industry clustering effect

Almazan et al (2010) develop a model where being located within an industry cluster increases opportunities to make acquisitions, and, to facilitate those acquisitions, firms within clusters maintain more financial slack. Consistent with their model they find that firms located within industry clusters make more acquisitions, and have lower debt ratios and larger cash balances than their industry peers located outside clusters. They propose an industry clustering effect that is related to firm location but captures factor other than information cost of distance. Therefore, we control for this factor to show whether distances captures information that industry clustering effect can't explain.

Following Almazan et al (2010), we create a dummy variable that takes a value of one for firm-years in which a firm's headquarters is located within a financial center that has both 10 or more firms with the same three-digit SIC and at least 3% of the market value of the industry, and zero otherwise. We control this variable in our regressions of leverage measures against distance and location dummy, the negative relation between geographic proximity and leverage ratio still hold robust. Results are reported in Table 4-7. Thus, the industry clustering effect does not explain our distance measure as an information measure for capital structure.

Table 4-7: Robustness checks: Controlling for Industry Clustering Effect

The sample includes Compustat Industrial firms for 1980-2006 with available state and county code data and excludes firms with total assets under 10 mln, and firms incorporated outside the US. *Market Leverage* is the amount of long debt divided by market value of total assets (book value of debt plus market value of equity). *Book Leverage* is the amount of long debt divided by book value of total assets (both in percentage). *Distance* is distance in kms to the closest of the ten largest metropolitan statistical areas as identified by the 2000 Census. Firm *Size* is log of the firm's total assets. *ROA* is the ratio of EBITDA to total assets. *Market-to-Book* is the ratio of the firm's market value to the book value of total assets. *Dividends* is the sum of cash dividends on common stock divided by the firm's total assets. *Fixed Assets,* calculated by the amount of fixed assets scaled by the firm's total assets. We measure *R&D* level by total R&D expenses divided by the total sales. *Analyst Coverage* is the number of one-year-ahead EPS analyst forecasts (I/B/E/S). We use the dummy of *CR* (credit rating) as the access to public market. If it is 1, firm has a credit rating (S&P LT domestic issuer credit rating) and thus an access to the public market. If it is 0, firm has no credit rating and thus no access to the public market. *Central Location* is the dummy variable equal to 1 if the firm is located in one of the top ten metropolitan areas as identified by the 2000 Census or within 100 kms around them; 0 otherwise.
CR (credit rating) divides the whole sample into on subsample with credit rating and the other without it. We additionally control for industry clustering effect. *Cluster* is defined as a dummy variable that takes a value of one for firm-years in which a firm's headquarters is located within a financial center that has both 10 or more firms with the same three-digit SIC and at least 3% of the market value of the industry, and zero otherwise. Moreover, all regressions include year dummies, but we do not report their coefficient estimates. All regressions will have controls for industry dummies classified by 3-digit SIC codes, but we do not report their coefficients. The *t*-statistics in parentheses are based on standard errors that are heteroskedasticity-consistent.

$$\text{Leverage}_{ij} = \beta_{0j} + \beta_{1j}\text{Location}_{ij} + \beta_{2j}\text{Size}_{ij} + \beta_{3j}\text{ROA}_{ij} + \beta_{4j}\text{Market to Book}_{ij} + \beta_{5j}\text{Dividends}_{ij}$$

$$+\beta_{6j}\text{Fixed\_Assets}_{ij} + \beta_{7j}\text{R and D}_{ij} + \beta_{8j}\text{Industry}_{ij} + \beta_{9j}\text{Lag\_Leverage}_{ij}$$

$$+ +\beta_{9j}\text{CR}_{ij} + \beta_{10j}\text{Analyst\_Coverage}_{ij} + \beta_{11j}\text{Industry Cluster}_{ij} + \varepsilon_{ij}$$

VARIABLES	Book leverage		Market leverage	
	(1)	(2)	(3)	(4)
Distance	0.282***		0.200**	
	(2.69)		(2.30)	
Central location		-0.140		-0.188**
		(-1.47)		(-2.38)
Size	0.743***	0.741***	0.518***	0.518***
	(27.69)	(27.61)	(23.68)	(23.69)
ROA	-7.829***	-7.831***	-2.690***	-2.698***
	(-18.24)	(-18.23)	(-8.801)	(-8.823)
Market to book	-0.097***	-0.097***	-0.218***	-0.218***
	(-5.185)	(-5.176)	(-20.09)	(-20.08)
Devidends	-25.160***	-25.270***	-36.170***	-36.270***
	(-10.67)	(-10.73)	(-21.34)	(-21.41)
Fixed assets	5.835***	5.847***	4.072***	4.065***
	(19.88)	(19.91)	(16.98)	(16.96)
R&D level	-5.197***	-5.199***	-2.792***	-2.795***
	(-9.036)	(-9.038)	(-7.258)	(-7.265)
Lag market leverage			0.756***	0.756***
			(227.50)	(227.50)
Credit rating	0.458***	0.459***	-0.212**	-0.214**
	(4.31)	(4.32)	(-2.440)	(-2.469)
Analyst coverage	-0.047**	-0.047**	-0.091***	-0.092***
	(-2.119)	(-2.146)	(-5.483)	(-5.535)
Industry Cluster	-0.040	-0.060	-0.030	0.02
	(-0.432)	(-0.533)	(-0.359)	(0.26)
Lag book leverage	0.737***	0.737***		
	(205.80)	(205.80)		
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Observations	106363	106363	100874	100874
R-squared	0.68	0.68	0.70	0.70

4.6 Conclusion

As geography affects the ability and costs to raise money through public markets, firms must make tradeoffs between choosing high leverage and facing constraints of financing. When centrally located firms choose issuing equity or debt to meet their new financial needs, non-centrally located firms with similar circumstances may choose issuing debt or give up the opportunity since they are at a more disadvantaged information environment because of a more remote location. We could conclude that geography does matter to capital structure and leverage ratio does have a significantly positive correlation with distance; that is, non-centrally located firms usually have higher leverage ratios than centrally located ones.

As both analysts' following and location have important impacts on the information environment, their influence may counteract when they change in the opposite direction and may complement each other when they move in the same direction. Our study shows that the absolute value of the coefficient for location against the leverage ratio is larger in the subsample with lower analyst coverage than that in subsample with higher analyst coverage. Thus we conclude that the lower analyst coverage the firm has, the more important location is as to capital structure. Similarly, location of a firm may play a different role in capital structure in subsamples with or without credit rating. In statistical results, the absolute value of the coefficient for location against the leverage ratio is larger in the subsample without a credit rating than that in the subsample with it, which means that location will impact more on firms without a credit rating.

We further exclude the alternative explanations about the negative relation between firm geographic proximity and capital structure. We find that the financial constraint effect or industry clustering effect do not explain out results.

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Chapter 5: Conclusion

In this thesis, we explore the hidden risks in a firm's real operating process and the financial adjustments made to accommodate these risks. In the first two chapters, we investigate whether and how the specificity of a firm's suppliers and customers affects its risk, and what financial consequences these effects will bring. We firstly show strong evidence that a firm's cost of equity decreases as the supplier specificity translates into a decrease in the firm's operating leverage. Also, there is a decrease of the firm's systematic business risk associated with the negative impact from supplier specificity on the book-to-market beta in the Fama-French three factor pricing model. Next, the second essay shows that as the specificity of customers induces more cash flow instability, the firm's idiosyncratic risk increases with customer specificity. As a result, firms with more specific customers choose more conservative dividend payout policies to adjust for the risk changes. In the third chapter, we explore another hidden risk from a firm's geographic location. We find that remotely located firms face more severe adverse selection problems as their information environment is worse than that of the centrally located firms. This information risk will influence a firm's capital structure choice and we show that centrally located firms have lower leverage ratios than do remotely located ones.

Our results provide information for investors and management by suggesting that a firm's risks hidden in the real operating process matter to its financial strategies. For investors, as they care about the asset returns of a firm in which they invested, they need to observe and analyze changes in the firm's operating hidden risks. For management, they should pay attention to the firm's relationship with its specific suppliers and customers which could affect cost of equity and future operating cash flow performance. They should also notice that the geographic location of a firm will affect its capital structure choices. When managers realize these risks, their own management decisions will be adjusted too. In future research, we will explore how the risks from a firm's vertical chain and geographical location impact management decisions such as strategic investments associated with vertical channel changes, risk-taking strategies and merger and acquisition decisions.

Appendix A for Chapter 2
Variable Descriptions

Variables	Description	Definition
Implied cost of equity	Estimated cost of equity as in Gebhardt, Lee, and Swaminathan (2001)	We estimate the expected *ROE* using the analysts' earnings forecasts and book equity based on clean surplus accounting.
Supplier R&D intensity	Weighted average of R&D intensity of the firms in the supplier industries. Used as proxy for the relationship-specific investment as in Kale and Shahur (2007)	We measure supplier R&D intensity as the weighted average of the R&D intensities of all the firm's supplier industries. The weight is retrieved from the Use table of the benchmark input-output (IO) accounts for the US economy on the Bureau of Economic Analysis website. The supplier R&D intensity is given by the following equation: Supplier Industries R&D intensity $= \sum \text{Supplier industry R\&D intensity}_j$ * Industry Input Coefficient_{ji}, where Supplier Industry R&D intensity_j is the j^{th} supplier industry's R&D expenditures divided by its total assets, and Industry Input Coefficient_{ji} is the dollar amount of the j^{th} supplier industry's output used as an input to produce one dollar of the output of the i^{th} industry.
Strategic alliances (SA) / joint venture (JV) intensity	Intensity of SAs/JVs formed by firms and their suppliers	For each 4-digit SIC industry, we define SA/JV intensity as the number of SAs and JVs formed by firms in that industry with firms in a supplier (customer) industry divided by the number of firms in the industry.
Total assets	The natural logarithm of the book value of total assets	Compustat: log(AT)
R&D intensity	R&D expenses over the book value of total assets	Compustat: XRD/AT; set to zero if missing.
Leverage ratio	Book value of long term debt divided by total assets.	Compustat: DLTT/AT
Asset tangibility	Net fixed assets divided by book value of total assets.	Compustat: PPENT/AT
Firm age	Firm listing history in CRSP.	The natural logarithm of the number of years a firm has been listed in CRSP until calendar year *t*.
Sales growth rate	Sales growth rate from year t-1 to year t	Compustat: $\log(SALE_t/SALE_{t-1})$
Stock return volatility		The standard deviation of monthly stock returns during the calendar year.
Competition intensity	Herfindahl-Hirschman Index in the IO industry	The Herfindahl-Hirschman Index is calculated by squaring the market share of each firm in an IO industry, and then summing the resulting numbers.
Sales beta	Revenues cyclicality in the IO industry	The cyclicality of revenues in an IO industry is computed as the slope

		from a full-sample time-series regression of changes in log industry net sales over the one-year period on log GDP growth. The regressions are based on quarterly data.
Operating leverage	Operating cash flow sensitivity to sales	Calculated as the elasticity of a firm's operating income after depreciation with respect to its sales, using the 15 most recent quarterly observations. For firms with positive EBIT, we calculate this elasticity by estimating the time-series quarterly regression of log(EBIT) on log(SALES). For firms with at least one negative value of EBIT within a given series, we approximate the elasticity by estimating a similar regression of EBIT on SALES and then multiplying the coefficient on SALES by the ratio of average sales to average operating income calculated over the estimation period.
Cost-based Operating Leverage	Ratio of operating costs to total assets	Compustat: (COGS+XSGA)/AT
Market to Book ratio	Ratio of the market value of common equity to the book common equity.	Compustat: [(PRCC_F*CSHO)]/CEQ
Cash flow ratio	Operating cash flow over total assets	Compustat: OIBDP/AT
Interest Coverage Ratio	Earnings before interest and taxes divided by the interest expenses	Compustat: EBIT/XINT
Default probability	The likelihood of future financial distress.	We follow Campbell, Hilscher, and Szilagyi's (2010) model to calculate a firm's likelihood of future financial distress over 12-month period.
Market beta	The loading on the market factor	We estimate the Fama-French three factor time-series regression model using monthly data from year t + 1 to year t +3, and get the loading of the market factor for stock *j* in year *t*.
SMB beta	The loading on the SMB factor	We estimate the Fama-French three factor time-series regression model using monthly data from year t + 1 to year t +3, and get the loading of the SMB factor for stock *j* in year *t*.
HML beta	The loading on the HML factor	We estimate the Fama-French three factor time-series regression model using monthly data from year t + 1 to year t +3, and get the loading of the HML factor for stock *j* in year *t*.
Fama-French cost of equity	The annualized cost of equity projected from the Fama-French (1993) three-factor model from 1990 to 2010.	We estimate the Fama-French three factor time-series regression model using monthly data from year t + 1 to year t +3 to get all the factor loadings for stock *j* in year *t*. We then construct the Fama-French cost of equity in year t as follows: $\text{Fama-French cost of equity}_t = R_f + \text{Market bata}_{jt} * \overline{MKT} + \text{SMB beta}_{jt} * \overline{SMB} + \text{HML beta}_{jt} * \overline{HML}$ Where R_f, $\overline{MKT}$, $\overline{SMB}$, and $\overline{HML}$ are the average annualized returns of the risk-free asset and 3 Fama-French factors over the period 1926–2010.

Appendix B for Chapter 3
Variable Descriptions

This appendix provides a detailed description of the construction of all of the variables used in the tables.

Variables	Description
Customer R&D intensity	the weighted average R&D intensity of all customers; the weight is retrieved from the Use table of the benchmark input-output (IO) accounts for the US economy on the Bureau of Economic Analysis website: the weight is the percentage of the i^{th} industry's output that is sold to the j^{th} customer industry.
Size	the log value of total assets (at)
R&D level	firm's R&D expenses over its total assets (xrd/at)
MTB	firm market value divided by book value ((dltt)/(at+(prcc_f*csho)-ceq-txdb))
Profit	earnings before interest and taxation over total assets(ebit/at)
Asset growth	total assets value over its lag and also measures the growth of a firm
Current volatility	standard deviation of a firm's monthly returns during a year t
Leverage	long term debt level over firm market value
Idiosyncratic risk	standard deviation of the residuals after estimating the Fama-French 3 factor model using monthly excess returns over year t
ROA risk	the standard deviation of ROA (σ(ROA)) during year [t+1, t+5]
ROA performance	the mean of ROA during year [t+1, t+5]
CFROA risk	the standard deviation of CFROA (σ(CFROA)) during year [t+1, t+5]
CFROA performance	the mean of CFROA during year [t+1, t+5]
Dividend level	common dividend payout at year t divided by total assets at year t (dvc/at)