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Essays On The Financial Implications Of Economically Linked Firms

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Abstract

This dissertation consists of two topics on the financial implications of economically linked firms. The Chapter 1 examines the impact of supply chain concentration on purchasing firm's financing costs. I find that purchasing firms engaging in less concentrated supply chain structure are subject to higher risk and cost of equity. This effect is more pronounced when the supplier's financial performance deteriorates or when the purchasing firm's purchase demand is large. I also provide evidence that lower supply chain concentration increases purchasing firm's cost of debt. Lenders charge higher interests on the corporate loans as their compensation for the additional risk implied from less concentrated supply chain structure, in particular when the loan is unsecured. Finally, my results are robust to controlling the effect of supply chain diversification and endogenous issues. The Chapter 2 investigates the impact of customer horizontal mergers on supplier's cash holdings. I show that the suppliers strategically reduce their cash holdings after the merger to counteract the increased buying power from the merged customers. This effect is more pronounced when the supplier is sale reliant on the merging customers and less pronounced when the supplier operates in a concentrated industry. Further, consistent with the prediction of bargaining power hypothesis of cash holdings, I find that cash reducing suppliers experience higher post-merger cash flow margin than cash increasing suppliers. Finally, I show that to credibly reduce the liquidity, the suppliers are more likely to use cash reserves to finance their R&D investments, leading to a higher cash-R&D sensitivity after the merger.

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Chapter 1: Supply Chain Concentration and Cost of Capital

1.1 INTRODUCTION

The customer-supplier relationship is of great importance in determining a firm's business risk. While the financial risk imposed on suppliers by customer firms has been well documented by the prior researches (Cohen and Frazzini, 2008; Hertzel et al., 2008; Pandit, et al., 2011; Itzkowitz, 2013; Dhaliwal, et al., 2016; Lian, 2017; Costello, 2019), there is limited research on how the supply chain impacts the purchasing firm's business risk. Further, it seems unclear whether the risk stemming from the supply chain structure is priced by the market participants. I seek to fill this research gap by examining the impact of supply chain concentration on the purchasing firm's cost of capital. A complex (low concentration) supply chain may reduce the purchasing firm's risk due to multiple sourcing, while a concentrated supply chain may increase purchasing firm's risk. Alternatively, a low supply chain concentration may increase the purchasing firm's risk because of increased monitoring and coordinating requirements of the complex supply chain, while a concentrated supply chain may reduce risk because of simplicity supply chain management.

In my context the purchasing firm is the firm buying goods and services from the supply chain. Customer firms are firms the purchasing firm sells goods and services to. The supply chain concentration measures refer to the supply chain of the purchasing firm. I quantify supply chain concentration using two measures. First is the natural logarithm of the number of suppliers to the purchasing firm in a fiscal year. Second, following Chod et al (2019), I use the Herfindahl-Hirschman index (HHI) of supplier sales to the purchasing firm. The final sample consists of 12,187 firm year observations from 2003 to 2018.

Based on the prior studies (Dhaliwal et al., 2006; Hail and Leuz, 2006; Chen et al., 2009; Ghoul et al., 2011; Dhaliwal, et al., 2016), the cost of equity is measured as the average implied cost of equity among four individual equity premiums. I estimate these individual equity premiums based on the models developed by Gebhardt et al. (2001), Claus and Thomas (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004) respectively. After controlling for known determinants that affect the cost of equity, the results indicate that the supply chain concentration has a significantly negative effect on the cost of equity. Specifically the more complex the supply chain, as proxied by supply chain concentration, the higher cost of equity. In term of the economic significance, I show that one standard deviation increase in the log of the number of suppliers raises the cost of equity by 17 basis points. Given the sample median of $4,772 million for the market value of equity, this increase in the cost of equity translates into an additional financing cost of $8.11 million. For the Supplier HHI, my results indicate that one standard deviation decrease in the HHI leads to a 14 basis points rise in the implied cost of equity. This additional increase in the cost of equity implies an additional financing cost of $6.68 million.

Given my finding that a lower supply chain concentration increases the purchasing firm's cost of equity, I expect this effect to be more pronounced when suppliers' financial performance deteriorates or when the purchasing firm's purchase demand is large. Costello (2013) examines the supply contract and finds that the purchasing firms tend to incorporate profitability covenants in the supply agreement to timely detect any deterioration in supplier's financial performance. My results suggest that purchasing firms with lower supply chain concentration are subject to higher cost of equity if at least one of suppliers experience loss of earnings. This finding is robust across different measures to define suppliers' profitability. In addition, larger purchasing demand

exposes the buying firms to higher supply chain risk. I show that purchasing firms with lower supply chain concentration and larger purchasing demand experience higher equity financing cost.

While I find a negative relation between supply chain concentration and cost of equity, the relation should remain significant after controlling for the effect of supply chain diversification. If multiple sources are supplying the same or similar components to the purchasing firm, the diversified supply chain may reduce risk. Absent of the information about the goods and services each supplier sells to the purchasing firm, I identify the suppliers producing similar products based on the SIC 3-digit and 4-digit industry classification codes. It is possible that suppliers in the same industry are producing similar or the same goods and services to the purchasing firm. I recognize the potential error in identifying the suppliers producing similar goods and services based on SIC industry classification. Combining suppliers that actually sell materially different goods and services would make a more complex supply chain appear simpler than it actually is. This would bias my results against finding a relationship between the cost of equity and supply chain concentration. The results show that the negative relation between supply chain concentration and cost of equity remains significant after recalculating the measure of supply chain concentration by combining the number of suppliers and sales of suppliers within the same industry classification. This finding implies that any diversification effect that reduces risk is offset by an increase in risk based on supply chain management challenges.

The problem of potential omitted control variable and reverse causality could bias my estimates of the impact of supply chain concentration on the cost of equity. To address the omitted variable concern, I estimate a Two-Stage Least Squares (2SLS) regression using

instrumental variables for the endogenous variable of supply chain concentration. To mitigate the reverse causality issue, I include the implied cost of equity at fiscal year t-1 as an additional control variable and estimate a dynamic panel data regression under various GMM estimators. These estimators are developed by Blundell and Bond (1998), Anderson and Hsiao (1982), and Arellano and Bond (1991) respectively. The results of both IV and GMM models indicate that my findings about the relation between supply chain concentration and cost of equity are robust to the endogeneity concerns.

I also investigate whether lenders take into account of the risk implied from a lower supply chain concentration and impose higher cost of debt to the purchasing firms with complex supply chain. While the equity holders focus on the systematic risk in pricing the cost of equity, the debt holders consider both systematic risk and idiosyncratic risk implied in the lower supply chain concentration since the lending portfolio may not be well diversified. Acharya et al. (2012) identifies the problem of unobserved omitted variables and biased coefficients under the OLS estimator when using the cost of debt as the dependent variable.[1] To empirically test the impact of supply chain concentration on the cost of debt, I estimate a Two-Stage Least Squares (2SLS) regression following Acharya et al. (2012). In particular, I regress the natural logarithm of the All-in-Drawn spread of the loan on the supply chain concentration using instrumental variables while controlling for firm and loan characteristics. The robust results show that the supply chain concentration is significantly and negatively related to the cost of debt. In particular, I find that this effect is stronger for unsecured loans.

My study contributes to the literature in several ways. First, I provide evidence that a purchasing firm's supply chain structure affects its risk and financing cost. While prior research

[1] Acharya et al. (2012) show that OLS estimator leads to puzzling positive relation between cash holdings and loan spread.

investigates the impact of customers on supplier firm's bargaining power (Fee and Thomas, 2004; Shahrur, 2005), stock return (Cohen and Frazzini, 2008), wealth effect (Hertzel et al., 2008), information transfer (Pandit et al., 2011), operating efficiency (Patatoukas, 2012), cash holdings (Itzkowitz, 2013), supply covenant (Costello, 2013), cost of capital (Dhaliwal et al., 2016), financial distress (Lian, 2017), and leverage (Oliveira et al., 2017), limited research exists on the mechanism through which the supply chain structure could affect purchasing's cost of capital. Second, my study complements Dhaliwal et al. (2016), who find that customer concentration increases supplying firm's cost of capital. I show that lower supply chain concentration significantly raises the purchasing firm's cost of capital while controlling for the purchasing firm's customer concentration and other determinant variables. The empirical results also suggest that the customer concentration has slightly larger economic effect on the purchasing firm's cost of equity relative to the supply chain concentration, with one standard deviation increase in the customer Herfindahl index resulting in 19 basis points rise in the cost of equity. Third, Chod et al. (2019) find that supplier competition leads to less trade credit given to the purchasing firm due to the free-rider problem. I contribute to the research of supplier competition by showing that managing multiple supplier relationships correlates with higher financing cost when the purchasing firm raises fund from capital market.

Finally, my study adds to the literature of cost of capital by identifying an important variable, supply chain concentration, in determining the cost of capital. Prior studies focuses on the relation between cost of capital and firm's capital structure (Modigliani and Miller, 1958), corporate income taxes (Modigliani and Miller, 1963), information disclosure (Diamond and Verrecchia, 1991; Easley and O'Hara; 2004; Lambert et al., 2007; Francis et al., 2008; Amstrong et al., 2011), social and environment risk (Sharfman and Fernando, 2008; Ghoul et al., 2011;

Goss and Roberts, 2011; Oikonomou et al., 2014), corporate governance (Hail and Leuz, 2006; Chen et al., 2009), earnings transparency (Bath et al., 2013); accounting conservatism (Lara et al., 2011), and regulation (Gomes et al., 2007; Duarte et al., 2008). Given the importance of supply chain stability in controlling a company's operating risk, I fill the literature gap by showing that firms with a lower concentrated supply chain structure are subject to higher business risk and cost of capital.

The balance of the paper is structured as follows. Section 2 summarizes the previous literature and describes my hypothesis. Section 3 explains the methodology. The sample and data description are present in the section 4. Section 5 reports the empirical results. The conclusion is made in the section 6.

1.2 Literature Review and Hypothesis Development

1.2.1 Customer-Supplier Relationship

Existing studies show that supplier firm's financial and stock performance are significantly driven by their customer firms, since a majority of their operating income come from the customers. Cohen and Frazzini (2008) find that customer firm's stock return positively predicts its suppliers' subsequent stock performance. Pandit et al. (2011) confirm the information transfer along the supply chain structure by showing that supplier's stock price reacts to its customer's quarterly earnings announcement. Alldredge and Cicero (2015) investigate the insider trading at supplier firms and find that the managers earn positive abnormal returns by paying attention to the public information and unexpected earnings of their customer firms. In addition, suppliers selling on credit are subject to the credit risk of customers. Costello (2013) examines supply contracts and finds that suppliers incorporate capital covenants in the supply agreement to protect them from potential default on trade credit. Costello (2019) shows that the credit risk of customers is greatly mitigated when the suppliers have the rights to liquidate customer's collaterals. Finally, Fee and Thomas (2004) and Shahrur (2005) find that horizontal mergers between customer firms increases the buying power of customers, which adversely affects their suppliers, in particular when the suppliers are concentrated.

The influence of customers on suppliers is more pronounced in the case of financial distress. Hertzel et al. (2008) show that customer firm's financial distress has negative wealth effect on their suppliers. Lian (2017) find that supplier's probability of financial distress is positively associated with customer's financial distress status. Consistent with the bargaining theory of debt issue (Bronars and Deere, 1991), Oliveira et al. (2017) show that supplier firms

increase their leverage to strengthen their bargaining power over the period when their customers are in financial distress.

Prior studies also show that the supplier firm's level of risk is greatly raised when their customer base is concentrated. For instance, Itzkowitz (2013) find that suppliers whose customers are concentrated hold more cash as a protection against potential default from their major customers. Dhaliwal et al. (2016) show that customer concentration raises supplier firm's business risk and cost of capital. In contrast to the finding that customer concentration makes suppliers subject to greater risk, Patatoukas (2012) suggests that customer concentration improves suppliers' operating efficiency and results in better operating performance and market valuation.

1.2.2 Supply Chain Concentration and Cost of Capital

The nature of customer-supplier relationship indicates that the suppliers can equally impose significant risk and financial costs to the customers. For instance, Hertzel et al. (2008) examine the wealth effect of supplier's financial distress to the customer industries. They find that the customer industries suffer significantly negative abnormal returns when the suppliers are in financial distress. Further, Chod et al. (2019) show that supply chain composition imposes indirect cost to the customer firms by affecting the amount of trade credit. They find that supplier facing competition offer less trade credit to the customer as more trade credit let the customers to buy more goods and services from other suppliers. I complement this line of research by empirically investigating the purchasing firm's financing cost in term of the supply chain composition. A supply chain can be viewed in three basic compositions. First, a supply chain for a purchasing firm can be concentrated, where only a few suppliers provide needed goods and services to the purchasing firm. Second, a supply chain for the purchasing firm can be diversified, where many suppliers supply similar or the same goods and services to the purchasing firm. Finally, a supply chain can be complex, where many suppliers supply different goods and services.[2] The shared concern to purchasing firms is whether the suppliers are able to make timely delivers of quality goods and services to the purchasing firms.

A common way for purchasing firms to manage supply chain risk is to have a supplier screening ex ante and monitor the suppliers ex post. Costello (2013) investigates the supply contract and shows that purchasing firms incorporate profitability covenants in the supply

[2] An example of a complex supply chain would be the aircraft manufacturer's supply chain where multiple parts are sourced through many suppliers. This complex supply chain requires coordinated delivery of quality goods and services to meet production requirements of aircraft companies. In contrast, the supply chain for an airline can be concentrated, where the fleet of aircraft are supplied by only one or two manufacturers. While the purchase of maintenance and spare parts required to support the aircraft fleets may be substantial, they may be sourced through the aircraft manufacturer. A concentrated supply chain should not be interpreted as a supply chain providing only a few goods and services, but as a smaller number of source firms potentially supplying multiple goods and services.

agreement to mitigate their concerns on product quality when the supplier's financial performance deteriorates. Consequently, instead of increasing business risk, having a simple and concentrated supply chain reduces purchasing firm's monitoring complexity and exposure of supply risk. Alternatively, as the supply chain becomes less concentrated and more complex, firm's business risk increases.

Lower supply chain concentration creates several possible areas of risk. First, these complex supply chains will carry higher monitoring and coordination costs compared to a concentrated supply chain. If monitoring and coordination management becomes lax, it can significantly impact the operating efficiency of the purchasing firm. Second, purchasing firms with multiple supplier relationships are more likely to experience supplier acquisition by a downstream or competitive buyer leading to a potential disruption of the supply chain. Switching to a new or renegotiating an existing supply agreement could be costly in particular when the manager takes into account of the information asymmetries and hold up problems (Williamson, 1979; Costello, 2013). Given the positive relation between firm risk and cost of equity, my first hypothesis is:

H1: A lower supply chain concentration leads to higher cost of equity for the purchasing firm.

Riskier activities of purchasing firms can shift wealth from debt holders to equity holders (Jensen and Meckling, 1976).[3] By increasing the operating risk of the purchasing firm, a complex, less concentrated supply chain leads to higher default likelihood. As a result, lenders may require more compensation for the increased supply chain risk, resulting in a higher debt

[3] Equity holders have incentives to undertake riskier investment, which increases the value of equity claim. However, the risks are shared with debt holders.

financing cost to the purchasing firm. The above discussion leads to my second hypothesis as follows:

H2: A lower supply chain concentration leads to a higher cost of debt for the purchasing firm.

Although I expect the H2 to hold for the overall sample, the relation between supply chain concentration and cost of debt should be stronger and more pronounced when the debt issue is unsecured.

1.3 RESEARCH DESIGN

1.3.1 Measures of Supply Chain Concentration

In order to measure the extent to which a purchasing firm's suppliers are concentrated, I identify all the suppliers selling to the same purchasing firm using FactSet Revere Supply Chain Relationship database. The FactSet database starts to record the supply chain relationship, disclosed by either purchasing or supplying firms in 2003. After constructing the supply chain structure, I rely on two measures to proxy for the supply chain concentration. My first measure of supply chain concentration is the natural logarithm of the number of suppliers selling to the same purchasing firm in a fiscal year. The more suppliers the purchasing firm has, the lower the supply chain concentration. Following Chod et al. (2019), I use Supplier HHI as the second measure of supply chain concentration. The Supplier HHI is defined as the Herfindahl index of supplier sales shares, which is computed for purchasing firm j as:

$$Supplier\ HHI_j = \sum_{i=1}^{N_j} \left(\frac{Sales_{i,j}}{Purchase_j} \right)^2 \tag{1.1}$$

where $\mathrm{Sales}_{\mathrm{i,j}}$ represents the supplier i's sales to purchasing firm j's total purchase. Because of the undisclosed information regarding the sale of each supplier to the purchasing firm, Chod et al. (2019) suggest calculating the Supplier HHI as the total sales of supplier i scaled by the total sales of all $\mathrm{N_j}$ suppliers. The supplier HHI ranges from 0 to 1, with 1 indicating the highest concentrated supply chain for the purchasing firm. In addition to accounting for the number of suppliers selling to the purchasing firm, the Supplier HHI considers the relative importance of individual suppliers.

1.3.2 Estimates of Cost of Equity

Following prior studies (Dhaliwal et al., 2006; Hail and Leuz, 2006; Chen et al., 2009; Ghoul et al., 2011; Dhaliwal et al., 2016), I measure the cost of equity as the average implied cost of equity derived from four individual models. These four individual models are developed by Gebhardt et al. (2001), Claus and Thomas (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004) respectively. Estimating the cost of equity based on ex ante analyst forecast data not only overcomes the noise of using realized cash flows, but also avoids the survivorship bias in the process of estimation. The main dependent variable is computed as the average implied cost of equity in excess of the risk-free rate. The appendix provides the detailed descriptions and techniques to solve for each implied cost of equity.

1.3.3 Control Variables

Following (Ghoul et al., 2011; Dhaliwal, et al., 2016), I include stock beta, firm size, book-to-market ratio, leverage, analyst forecast dispersion, and long-term growth rate as the control variables. In the robustness analysis, I estimate a 2SLS regression using instrumental variables to mitigate omitted variable concerns. The beta is included to proxy for the market risk and is predicted to have a positive relation with the cost of equity. Large firms are generally considered as mature firms with relatively stable cash flows. Therefore, I expect large firms to have lower cost of equity. The book-to-market ratio can be used to proxy for either overpricing or growth opportunities. If the book-to-market ratio is used as a proxy for overpricing, I expect firms with lower book-to-market ratio to experience lower cost of equity, as the stock price tends to revert to the true value. If the book-to-market ratio is used as a proxy for growth opportunities, I predict that firms with lower book-to-market ratio will experience higher cost of equity. Modigliani and Miller (1958, 1963) posit a positive relation between leverage and cost of equity. The risk of equity increases when firms take more debt in their capital structure. The analyst forecast dispersion is used to control for the asymmetric information risk. The positive relation between information asymmetries and cost of equity is well documented by the prior research (Diamond and Verrecchia, 1991; Easley and O'Hara; 2004; Lambert et al., 2007; Francis et al., 2008; Amstrong et al., 2010). Finally, I control for the long-term growth rate in the regression. Firms with more growth opportunities are subject to higher cost of equity.

In addition to controlling for the common determinants of cost of equity, I also include the customer concentration as an additional control variable in the regression. Dhaliwal, et al. (2016) find that a higher concentrated customer base of purchasing firms increases purchasing firm's cost of capital. Using the Compustat Customer Segment Files, I am able to identify firm's

major customers and calculate the customer concentration as Customer HHI following Patatoukas (2012). In particular, I measure firm j's Customer HHI as:

$$Customer\ HHI_j = \sum_{i=1}^{N_j} \left(\frac{Sales_{i,j}}{Sales_j} \right)^2 \tag{1.2}$$

where $Sale_{i,j}$ is the sale of purchasing firm j to its major customer firm i in a fiscal year and $Sale_j$ is the total sale of purchasing firm j. By controlling for the customer concentration, I mitigate the concern that any effect of supply chain concentration on the cost of capital is driven by the impact of customer concentration of the purchasing firm.

1.3.4 Methodology

I predict that the supply chain concentration is negatively associated with the cost of equity. To empirically examine my hypothesis, I estimate the following regression:

$$Cost\ of\ Equity_{it} = \alpha + \beta Supplier\ Concentration_{it} + \gamma Controls_{it} + \varepsilon_{it} \quad (1.3)$$

The dependent variable is the average implied cost of equity in excess of the risk-free rate. I use 10-year Treasury bond yield to proxy for the risk-free rate. The main independent variable is the supply chain concentration, which is measured as the natural logarithm of the number of suppliers and Supplier HHI. Industry and year fixed effect are included in all regressions by including SIC 2-digit industry and year dummies in the estimation. The standard errors are robust to the presence of heteroscedasticity and are adjusted for clustering by purchasing firms.

I also expect a negative relation between supply chain concentration and cost of debt. The default risk on debt becomes higher when the purchasing firm has lower supply chain concentration. I examine this relation based on a sample of corporate loans obtained from DealScan. In particular, I estimate the following regression:

$$Cos\ of\ Debt_{it} = \alpha + \beta Supplier\ Concentration + \gamma_1 Firm\ Characteristics + \gamma_2 Loan\ Characteristics + \varepsilon_{it} \quad (1.4)$$

The cost of debt is measured as the natural logarithm of All-in-Drawn spread of the loan. I control the firm and loan characteristics that could affect the cost of debt. The firm characteristics include customer concentration, firm size, market-to-book ratio, leverage, return on asset, Altman's (1968) z-score, and asset tangibility. The loan characteristics include the natural logarithm of the loan maturity in months and the natural logarithm of the loan amount in

millions. In addition to accounting for the industry and year fixed effect, I control the loan types and purposes in all regressions.[4, 5]

[4] The common loan types in our sample include revolver/line>=1 year, term loan B, term loan, term loan A, 364-day facility, bridge loan, delay draw term loan, standby letter of credit, and revolver/line<1 year. All other types of loan are categorized into others.

[5] The common loan purposes in our sample include corporate purposes, working capital, takeover, acquisition line of credit, LBO, debt repayment, commercial paper backup, dividend recap, project finance, stock buyback, and capital expenditure. All other purposes of loan are categorized into others.

1.3.5 Endogeneity

A potential endogeneity issue could bias the estimates of coefficients under OLS estimator. For instance, for firms with no concerns on default, the managers, on behalf of the shareholders, are more likely to pursue growth opportunities by engaging in multiple supplier relationships in exchange for higher stock returns (Jensen and Meckling, 1976). For riskier firms, their priority is to survive. The precautionary motive (Acharya et al., 2012) causes these firms to reduce risk-taking activities and maintain a simple and concentrated supplier relationship. This endogeneity issue results in a positive relation between supply chain concentration and credit risk. As a consequence, firms with concentrated supply chain are observed to have higher cost of debt.

To mitigate the endogeneity concern, I estimate the regression using a Two-Stage Least Squares (2SLS) estimator. I introduce two instrumental variables for supply chain concentration. My first instrumental variable is an indicator variable, which is equal to one if firm has a foreign supplier in fiscal year t, and zero otherwise. I use the industry average supply chain concentration at fiscal year t-3 as the second instrumental variable. The instrumental variables need to meet both relevance and exclusion restrictions for being a valid instrument. I expect that firms having foreign suppliers are more likely to engage in multiple supplier relationships. In addition to increasing the number of suppliers, adding a foreign supplier to the supplier network will significantly increase purchasing firm's monitoring complexity due to higher information asymmetries between the purchaser and foreign suppliers. The industry average supply chain concentration should satisfy the relevance restriction and is expected to be positively associated with supply chain concentration at firm level. However, I do not expect the foreign supplier and industry average supply chain concentration to be correlated with any omitted firm

characteristics that could affect the cost of capital. To further test the exclusion restriction, I perform the Sargan test to examine the over-identification restriction that the instrumental variables are uncorrelated with the error term.

1.4 SAMPLE AND DATA

1.4.1 Sample Selection

I begin the sample by constructing a purchasing firm's supplier structure using FactSet Revere Supply Chain Relationship database. The FactSet starts to record the supply chain relationship disclosed by either purchasing or supplying firm since 2003. To examine the impact of supply chain concentration on the cost of equity, I follow Dhaliwal et al. (2006), Hail and Leuz (2006), Chen et al. (2009), Ghoul et al. (2011), and Dhaliwal et al. (2016) to estimate the implied cost of equity based on analyst forecast earnings, which requires earnings forecasts from Thomson Reuters I/B/E/S dataset. I identify the purchasing firm's major customers using the Compustat Customer Segment file. Financial and stock return data are obtained from Compustat and CRSP respectively. After merging the five databases, the final sample consists of 12,187 firm year observations representing 2,161 unique companies from 2003 to 2018.

1.4.2 Summary Statistics

Table 1.1 reports the descriptive statistics for the sample. On average, firms yield a 10% return for the equity holders. After subtracting the risk-free rate, the average equity premium for the entire sample is 7%. Consistent with prior studies, the Gebhardt et al. (2001) model yields the lowest estimate of implied cost of equity, whereas the Ohlson and Juettner-Nauroth (2005) and Easton (2004) model produce slightly higher implied cost of equity.[6] On average purchasing firms have 8 suppliers with a median of 3. While most of firms have simple and relatively concentrated supply chain structure, the upper quartile of the sample firms have a more complex supply chain, with the maximum number of suppliers top a purchasing firm of 197 firms. The mean supplier HHI is 0.63 and ranges from 0.04 to 1. 27% of the sample firms report at least a major customer, which accounts for at least 10% of the firm's total sales.[7] The average customer HHI is 0.03. The summary statistic for customer concentration is similar to Dhaliwal et al. (2016) who report a mean customer HHI of 0.02 with 26% of firms having major customers.

[6] See Ghoul et al. (2011) and Dhaliwal et al. (2016)

[7] Regulation SFAS No. 131 requires firms to report customers representing at least 10% of the total sales in their financial reports.

1.5 EMPIRICAL RESULTS

1.5.1 Supply Chain Concentration and Implied Cost of Equity

To examine the impact of supply chain concentration on the cost of equity, I estimate an OLS regression using the average implied equity premium as the dependent variable and the natural logarithm of number of suppliers and supplier HHI as the main independent variables respectively. Table 1.2 presents the results of multivariate regression with an inclusion of control variables. Overall, the results provide strong support to the H1 that lower supply chain concentration leads to higher cost of equity for purchasing firms. In column (1), the coefficient on the Log (# of Suppliers) is significant and positive, suggesting that firms with more complex supply chains are subject to higher equity financing costs. As an alternative measure of supply chain concentration, I use the supplier Herfindahl index. In column (2), the coefficient on the Supplier HHI is significantly negative, which indicates that firms with lower supply chain concentration experience higher cost of equity. In column (3) and (4), I include the customer concentration as an additional control variable in the regression, since Dhaliwal et al. (2016) find a positive relation between customer concentration and cost of equity. The coefficients on the Log (# of Suppliers) and Supplier HHI remain significant at 90% and 95% confidence level after controlling the customer concentration in the regression. The coefficient on the Customer HHI is significantly positive, which is consistent with the results of Dhaliwal et al. (2016). Table 1.2 also shows that the coefficients on other control variables are all significant and consistent with previous findings.

While the Table 1.2 documents a negative relation between supply chain concentration and cost of equity, it remains an open empirical question whether the effect of supply chain concentration on the cost of equity is economically significant. The result of column (3) in Table

1.2 implies that one standard deviation (1.12) increase in the Log (# of Suppliers) raises purchasing firm's excess cost of equity by 17 basis points (=0.154*1.12*100). Given the sample median of $4,772 million for the market value of equity, this increase in the cost of equity translates into an additional financing cost of $8.11 million (=0.17%*4,772). For Supplier HHI, the result in column (4) suggests that one standard deviation (0.30) decrease in the Supplier HHI increases the cost of equity by 14 basis points (=-0.453*-0.30*100), which is equivalent to an additional financing cost of $6.68 million (=0.14%*4,772). I compare the difference of economic significance between supply chain concentration and customer concentration. The results indicate that the customer concentration has slightly larger effect on the cost of equity, with one standard deviation (0.09) increase in the Customer HHI resulting in 19 basis points (=2.098*0.09*100) rise in the cost of equity or $9.07 million in additional financing cost. Overall, my results identify a significantly negative relation between supply chain concentration and cost of equity, which is not captured by existing studies.

In Table 1.3, I replace the dependent variable of average implied equity premium with individual equity premium, r_{GLS}, r_{CT}, r_{OJ}, and r_{ES}. The results show a strong significant relation between supply chain concentration and cost of equity when estimating the equity premium according to Ohlson and Juettner-Nauroth (2005) and Easton (2004). I do not find significant relation between supply chain concentration and cost of equity estimated based on Gebhardt et al. (2001) and Claus and Thomas (2001). By using individual equity premium as the dependent variable, I show that the effect of supply chain concentration on the cost of equity is not driven by a particular individual measure of cost of equity.

1.5.2 Supply Chain Concentration and Firm Risk

The total risk of a firm can be divided into systematic risk, which is priced by the market, and idiosyncratic risk specific to a firm. I examine how supply chain concentration risk is viewed by the market participants. I use three measures of risk; the firm beta, idiosyncratic risk of the firm, and total risk of the firm. The firm beta is estimated as the coefficient of market model by regressing the daily stock return on the value-weighted return of all firms in CRSP in a fiscal year. I adjust the beta for non-synchronous trading following Scholes and Williams (1977). The idiosyncratic risk is measured as the annualized standard deviation of the residuals from the market model using daily stock returns. Total firm risk is measured as the annual return volatility for the firm. The results are shown in Table 1.4.

Columns (1) and (2) show the results for firm betas. I find that supply chain concentration is priced by the market. Both the log of the number of suppliers and Supplier HHI are statistically significant. The sign of the log of the number of suppliers is negative and the sign of Supplier HHI is positive in the beta regression indicating the systematic risk is decreasing as the supply chain concentration decreases. As previously stated supply chains can be complex, diversified, or concentrated. The signs of the supply chain concentration measures may reflect decreasing systematic risk due to the risk reducing diversification effects in the supply chain composition. I specifically address this issue in section 1.5.4 of the paper. However, my main finding indicates that supply chain concentration is priced by the market as a systematic risk.

In columns (3) and (4) I show the results for annualized idiosyncratic risk. The sign of the log of the number of suppliers is positive and significant while the sign of Supplier HHI is negative and significant. Both measures indicate that lower supply chain concentration result in higher firm specific risk. The total firm risk results are shown in columns (5) and (6).

Consistent with idiosyncratic risk, the coefficients on the log of the number of suppliers and Supplier HHI are significant. The sign of log of the number of suppliers is positive and the sign of Supplier HHI is negative. Overall, these findings indicate that as supply chain complexity increases, firm risk, both idiosyncratic and total, increase.

1.5.3 Supply Chain Cross-Sectional Analysis

Given my finding that lower supply chain concentration increases the purchasing firm's cost of equity, I expect this effect to be more pronounced when the supplier's financial performance deteriorates. Costello (2013) examined the supply contract and find that the purchasing firms tend to incorporate profitability covenants to mitigate their concerns on the product quality when the supplier's financial performance deteriorates. A deterioration in supplying firm's financial performance may reflect supplier's poor operating efficiency and raise purchasing firms' concerns on whether the suppliers are able to timely deliver quality goods and services. A delivery delays or with low quality goods and services would adversely affect purchasing firms and raise financial risk to the purchasing firms. To measure the deterioration in supplier's financial performance, I create an indicator variable, which is equal to one if the purchasing firm has at least one supplier experiencing loss of earnings in a given fiscal year, and zero otherwise. I interact this indicator variable with low supply chain concentration, which is set to one if the purchasing firm's supplier HHI is in the lower tercile of the sample in a given fiscal year, and zero otherwise. I conduct the analysis by regressing the average implied equity premium on the indicator variable of negative earnings, low supply chain concentration, and interaction variable.

I define supplier's financial performance based on different accounting measures. From column (1) to (3), I measure the loss of earnings according to earnings before interest and tax (EBIT), earnings before interest, tax, depreciation and amortization (EBITDA), and income before extraordinary items (IB) respectively. The results of Table 1.5 show that the coefficients on the interaction term are significant and positive, suggesting that the firms having lower supply chain concentration are subject to higher equity financing cost if at least one of suppliers

experiences loss in earnings. The results also show that this finding is robust to different measures to define suppliers' financial performance.

The supply chain risk also depends on the purchasing firm's purchase demand. Larger purchasing demand exposes the buying firms to higher risk of supply shortage and price increase. Therefore, I expect the relation between supply chain concentration and cost of equity to be stronger when the purchasing firm has larger purchase demand. I measure the purchasing firm's purchase demand as the ratio of purchasing firm's cost of goods sold to the total cost of goods sold of all firms in the same industry. Large purchasing demand is defined as an indicator variable, which is equal to one if the purchasing firm's demand is above the sample median in a given fiscal year, and zero otherwise. I interact the indicator variable of large purchasing demand with low supply chain concentration and regress the average implied cost of equity on them. The results of my analysis are shown in Table 1.6. In column (1), I measure the purchasing firm's purchase demand according to SIC 3-digit code. To better capture the purchasing firm's purchase share within the industry, I compute the purchasing demand ratio based on SIC 4-digit code in column (2). The results in both column (1) and column (2) show a positive and significant coefficient on the interaction term, suggesting that purchasing firms with lower supply chain concentration and larger purchase demand are subject to higher cost of equity.

1.5.4 Supply Chain Complexity or Supply Chain Diversification

A Supply chain can be concentrated, diversified, or complex. In a diversified supply chain, multiple suppliers supply the same or similar goods and services to the purchasing firm. A diversified supply chain may appear to be complex, but carry lower risks because of the diversification effect. While my finding suggests that the complexity of monitoring multiple supplier relationships overweighs the effect of supply chain diversification in explaining the relation between supply chain concentration and cost of equity, the result should remain significant after controlling for the effect of supplier diversification.

Absent of the information about the goods and services each supplier sells to the purchasing firm, I identify suppliers producing similar goods and services based on SIC 3-digit and 4-digit industry classification codes. It is possible that suppliers in the same industry are supplying similar goods and services to the purchasing firm. I recalculate the supply chain concentration by combining the number of suppliers and supplier sales within the same industry classification. For example, if three firms are in the same industry, I sum their sales for the Herfindahl index calculation and treat them as a single firm for the count of suppliers. Table 1.7 reports the results of the baseline regression after combining the number and sales of the supplies in the same industry. In column (1) and (2), I present the results based on 3-digit SIC code consolidation. I find that the coefficient on the Log (# of Suppliers) becomes insignificant but the coefficient on the Supplier HHI remains significant at 90% confidence level. In column (3) and (4), I show the results based on 4-digit SIC code consolidation. I find the coefficient on the Log (# of Suppliers) is positive and significant at 90% confidence level and the coefficient on the Supplier HHI remains significantly negative at 95% confidence level. Since the SIC 4-digit code

better categorizes the firms undertaking similar business activities, I believe it presents a closer model of supply chain diversification.

Just as my original measure of supply chain concentration might underestimate the supply chain diversification aspect, consolidating supplier information based on industry classification can underestimate supply chain complexity. It is possible that two firms in the same industry are supplying materially different goods or services. The consolidated measure of supply chain concentration based on industry classification creates a downward bias on the coefficients with respect to my hypothesis. By consolidating at the industry level I force supply chains to become more concentrated. My findings in Table 1.7 indicate that supply chain complexity is more important than supply chain diversification in determining the cost of equity for the purchasing firm. The findings are robust to differing ways of supply chain consolidation for supplier HHI, and at the 4-digit SIC level, for the number of suppliers. I next address potential endogeneity issues.

1.5.5 Endogeneity Issues

My results could suffer from an endogenous bias due to the unobserved omitted variables that are correlated with both supply chain concentration and cost of equity. To mitigate the endogeneity concern, I estimate a 2SLS regression using two instrumental variables for the endogenous variable of supply chain concentration. My first instrumental variable is an indicator variable, which is equal to one if the purchasing firm has a foreign supplier in fiscal year t, and zero otherwise. The second instrumental variable for the number of suppliers is the 3-digit SIC industry average number of suppliers in year t-3. When estimating the regression based on supplier HHI, I use the 3-digit SIC industry average supplier HHI at fiscal year t-3 as the instrumental variable.

Table 1.8 presents the results of 2SLS regressions. In column (1), I estimate the first stage regression by regressing the natural logarithm of the number of suppliers on the indicator variable of Foreign Supplier and the industry average number of suppliers at fiscal year t-3. The result confirms the relevance of the instrumental variables. First, firms having supply agreements with foreign companies are more likely to engage in multiple supplier relationships. Second, the industry average number of suppliers is positively associated with the number of suppliers at firm level. Column (2) presents the result of the second stage regression by regressing the average implied equity premium on the fitted value for the natural logarithm of the number of suppliers derived from the first stage regression. The coefficient on the Log (# of suppliers) is significantly positive at 99% confidence level, which is consistent with the H1 hypothesis. I also perform an over-identification test to examine whether the instrumental variables meet the exclusion restriction. The result of Sargan test suggests that we are not able to reject the null hypothesis that instrumental variables are uncorrelated with the error term. The column (3) and

(4) report the result of 2SLS regression using instrumental variables for Supplier HHI. The result confirms the validity of my instrumental variables and shows that firms with lower supplier HHI are subject to higher cost of equity. In sum, Table 1.8 shows that my findings are not influenced by the omitted variable concern.

To mitigate the reverse causality issue, I include the implied cost of equity at fiscal year t-1 as an additional variable and estimate a dynamic panel data regression under GMM. I estimate the regression following Blundell and Bond (1998), Anderson and Hsiao (1982), and Arellano and Bond (1991) respectively.[8] In Table 1.9, the column (1), (3), and (5) show that the coefficient on the Log (# of Suppliers) is significant and positive, suggesting that firms engaging in multiple supplier relationships are subject to higher equity financing costs. In column (2), (4), and (6), the coefficient on the Supplier HHI is significantly negative, which indicates that firms with lower supplier HHI experience higher cost of equity. The coefficients on the lagged implied equity premium are positive and significant using instrumental variables following Blundell and Bond (1998) and Arellano and Bond (1991) but become insignificant according to Anderson and Hsiao (1982). The positive coefficient on the lagged implied equity premium suggests that firms experiencing higher cost of equity in the past year are likely to suffer from higher financing cost in the following year. Finally, the result of Hansen over-identification test shows that the instrumental variables are valid and meet the exclusion restriction.

[8] Although it is desirable from an efficiency perspective to include as many moment conditions as possible, it may be infeasible to do so in many cases. To avoid the use of too many moment conditions, I use the collapsed instrument set.

1.5.6 Supply Chain Concentration and Cost of Debt

I next investigate whether lenders take into account of the risk stemming from the supply chain concentration and charge higher interest rate to purchasing firms engaging in multiple supplier relationships. I collect a sample of corporate loans in DealScan from 2003 to 2018. To empirically test the H2, I estimate a 2SLS regression by regressing the natural logarithm of the All-in-Drawn spread of the loan on the supply chain concentration using instrumental variables while controlling for firm and loan characteristics. The All-in-Drawn spread measures the amount the borrowing firms pay in basis points over LIBOR for each dollar drawn down, including the annual fee paid to the bank. Table 1.10 reports the results of the regressions. The results in column (2) and (4) are consistent with my hypothesis that firms with lower supply chain concentration have higher debt financing cost. The results in column (1) and (3) confirm the relevance of the instrumental variables. Firms having foreign suppliers are likely to have a lower concentrated supply chain composition. And also the extent to which the supplier base is concentrated at firm level is significantly driven by the industry average. Using Sargan test, I examine the over-identification restrictions of the instrumental variables. The result of Sargan test suggests that I am not able to reject the null hypothesis that the instrumental variables are uncorrelated with residuals. In sum, my findings in Table 1.10 provide evidence that lenders have concern on the risk implied from complex supply chain composition and charge higher interest rate on the loan as their compensation.

Although the results show a significant and negative relation between supply chain concentration and cost of debt for the overall sample, I expect the relation to be more pronounced when the lender's position is unsecured. Prior empirical evidence has shown that the borrowing firm's credit risk is greatly mitigated when lenders have rights to dispose the

collaterals imposed in the loan contract. To test this prediction, I split the sample into two subsamples. The first subsample consists of loans that are not secured by any collaterals, whereas the second subsample consists of secured loans. The Table 1.11 presents the results of 2SLS regressions by regressing the natural logarithm of the all-in-drawn spread of the loan on the supply chain concentration for the subsample of unsecured loans and secured loans respectively. The results of first stage regressions are not reported. In column (1) and (2), I show that firms having lower supply chain concentration pay higher interest, when there is no protective collaterals in the loan contract. The results of column (3) and (4) suggest that lenders are indifferent to the supply chain risk when the loan is secured.

1.6 CONCLUSION

While the prior research has identified the impact of customer firm's characteristics and structure on the suppliers' extent of risk taking, the mechanism through which the suppliers can affect a purchasing firm's business risk is overlooked by the literature. Further, whether the risk transmitted from supply chain composition to the purchasing firm is priced in the cost of capital is an empirically open question. To fill this research gap, I show that firms with lower supply chain concentration are subject to higher business risk due to increased monitoring and coordination complexity from managing multiple supplier relationships. Consistent with lower supply chain concentration resulting in higher firm risk, my results indicate that supply chain concentration is significantly and negatively associated with the purchasing firm's cost of equity. I also show that the impact of supply chain concentration on the cost of equity becomes more pronounced when the supplier's financial performance deteriorates or when the purchasing firm's purchase demand is large. In addition, I provide evidence that lower supply chain concentration increases the purchasing firm's cost of debt by examining a sample of corporate loans obtained from DealScan. Lenders have more concerns on the risk arising from lower supply chain concentration when the loan is unsecured. Finally, I conduct robustness analysis showing that my findings are not affected by potential endogenous concerns and remain significant while controlling for the effect of supply chain diversification.

Table 1.1: Descriptive Statistics

The sample consists of 2,161 unique firms from 2003 to 2018. r_{avg} is the average implied cost of equity among four individual costs of equity: r_{GLS}, r_{CT}, r_{OJ}, and r_{OJ}. These four individual implied costs of equity are estimated based on model developed by Gebhardt et al. (2001), Claus and Thomas (2001), Ohlson and Juettner-Nauroth (2005), and Easton (2004) respectively. r_f is the risk-free rate, proxied by the yield on 10-years Treasury bond. The # of Suppliers indicates the number of suppliers selling to a purchasing firm in a fiscal year. Following Chod et al. (2019), the supply chain composition is measured as the supplier Herfindahl index (Supplier HHI). Customer HHI is the customer Herfindahl index estimated following Patatoukas (2012). Beta is the coefficient of market model by regressing the daily stock return on the value-weighted return of all firms in CRSP in a fiscal year, adjusting for nonsynchronous trading following Scholes and Williams (1977). Idiosyncratic risk is the annualized standard deviation of residuals of the market model. Volatility is the annual stock volatility using daily stock returns in a fiscal year. Firm size is measured as the natural logarithm of total assets. BTM is the book-to-market ratio, obtained as the book value of equity divided by the market value of equity. Lev is firm's leverage ratio, measured as the short-term debt plus the long-term debt scaled by the total assets. DISP is the analysts' earnings forecast dispersion and LTG is the long-term growth rate. All the variables are winsorized at 1 and 99 percent, except for the # of Suppliers, Supplier HHI, and Customer HHI.

Variable	N	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
r_{avg}	12,187	0.10	0.05	0.04	0.08	0.09	0.11	0.43
r_{GLS}	12,187	0.09	0.04	0.02	0.06	0.08	0.10	0.31
r_{CT}	12,187	0.10	0.07	0.02	0.07	0.09	0.11	0.55
r_{OJ}	12,187	0.11	0.05	0.04	0.08	0.10	0.12	0.40
r_{ES}	12,187	0.11	0.06	0.03	0.08	0.10	0.13	0.46
r_f	12,187	0.03	0.01	0.01	0.02	0.03	0.04	0.05
# of Suppliers	12,187	7.97	13.33	1.00	2.00	3.00	8.00	197.00
Supplier HHI	12,187	0.63	0.30	0.04	0.36	0.61	1.00	1.00
Customer HHI	12,187	0.03	0.09	0.00	0.00	0.00	0.03	1.00
Beta	12,187	1.18	0.53	0.17	0.81	1.11	1.47	2.90
Idiosyncratic Risk	12,187	0.29	0.14	0.11	0.18	0.25	0.35	0.83
Volatility	12,187	0.34	0.16	0.13	0.23	0.30	0.41	0.98
Size	12,187	8.57	1.69	4.96	7.41	8.48	9.68	13.26
BTM	12,187	0.48	0.34	0.03	0.24	0.39	0.62	1.89
Lev	12,187	0.48	0.34	0.03	0.24	0.39	0.62	1.89
DISP	12,187	0.24	0.18	0.00	0.10	0.23	0.36	0.70
LTG	12,187	0.10	0.24	0.00	0.01	0.03	0.07	1.85

Table 1.2: Supply Chain Concentration and Implied Cost of Equity

The table shows the result of OLS regression on a sample consisting of 12,187 firm year observations from 2003 to 2018. The dependent variable is the excess implied cost of equity, measured as the difference between average implied cost of equity, r_{avg} and the risk-free rate, r_f. The main independent variables are the Log (# of Suppliers) and Supplier HHI. All other variables are defined in Table I. The industry and year fixed effects are controlled by including SIC 2-digit industry and year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity and clustered at the purchasing firm level. T- Statistics are reported in the parentheses.

	Implied Cost of Equity			
	(1)	(2)	(3)	(4)
Log (# of Suppliers)	0.163*		0.154*	
	(1.94)		(1.84)	
Supplier HHI		-0.463**		-0.453**
		(-2.08)		(-2.03)
Customer HHI			2.062***	2.098***
			(2.60)	(2.65)
Beta	1.220***	1.209***	1.219***	1.209***
	(7.14)	(7.06)	(7.14)	(7.07)
Size	-0.162**	-0.131*	-0.140*	-0.112*
	(-2.17)	(-1.95)	(-1.87)	(-1.66)
BTM	4.106***	4.090***	4.074***	4.059***
	(16.39)	(16.39)	(16.23)	(16.24)
Lev	4.731***	4.680***	4.722***	4.676***
	(8.99)	(8.83)	(8.98)	(8.83)
DISP	2.379***	2.397***	2.374***	2.391***
	(5.38)	(5.40)	(5.37)	(5.39)
LTG	9.634***	9.626***	9.536***	9.526***
	(9.46)	(9.45)	(9.36)	(9.35)
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	12,187	12,187	12,187	12,187
Adj. R^2	0.26	0.26	0.26	0.26

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.3: Supply Chain Concentration and Individual Implied Cost of Equity

The table shows the result of OLS regression on a sample consisting of 12,187 firm year observations from 2003 to 2018. The dependent variable is the excess individual implied cost of equity, measured as the difference between individual implied cost of equity (r_{GLS}, r_{CT}, r_{OJ}, and r_{ES}) and the risk-free rate, r_f. The main independent variables are the Log (# of Suppliers) and Supplier HHI. All other variables are defined in Table I. The industry and year fixed effects are controlled by including SIC 2-digit industry and year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity and clustered at the purchasing firm level. T- Statistics are reported in the parentheses.

	r_{GLS}		r_{CT}		r_{OJ}		r_{ES}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (# of Suppliers)	-0.009		0.131		0.198***		0.283***	
	(-0.14)		(1.13)		(2.59)		(3.12)	
Supplier HHI		-0.151		-0.491		-0.487**		-0.672***
		(-0.93)		(-1.62)		(-2.33)		(-2.70)
Customer HHI	1.856***	1.846***	2.820***	2.846***	1.748**	1.800**	1.911*	1.985**
	(3.29)	(3.27)	(2.78)	(2.80)	(2.26)	(2.33)	(1.95)	(2.02)
Beta	0.783***	0.787***	1.231***	1.224***	1.105***	1.090***	1.705***	1.684***
	(6.81)	(6.82)	(5.34)	(5.29)	(7.12)	(7.01)	(9.19)	(9.05)
Size	0.034	0.015	0.061	0.075	-0.200***	-0.154**	-0.415***	-0.347***
	(0.68)	(0.33)	(0.61)	(0.82)	(-2.80)	(-2.40)	(-4.88)	(-4.56)
BTM	4.509***	4.520***	4.968***	4.961***	3.304***	3.279***	3.480***	3.443***
	(25.18)	(25.43)	(14.80)	(14.86)	(14.01)	(13.90)	(12.16)	(12.04)
Lev	2.378***	2.407***	5.431***	5.408***	5.096***	5.022***	5.325***	5.216***
	(6.10)	(6.12)	(7.64)	(7.55)	(10.72)	(10.56)	(9.64)	(9.42)
DISP	0.431	0.425	0.035	0.046	2.968***	2.992***	5.957***	5.992***
	(1.58)	(1.56)	(0.06)	(0.08)	(6.70)	(6.72)	(11.10)	(11.10)
LTG	2.877***	2.875***	19.247***	19.237***	12.780***	12.769***	3.188***	3.173***
	(3.99)	(3.99)	(13.05)	(13.05)	(13.47)	(13.45)	(3.03)	(3.02)
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	12,187	12,187	12,187	12,187	12,187	12,187	12,187	12,187
Adj. R^2	0.34	0.34	0.22	0.22	0.28	0.28	0.27	0.27

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.4: Supply Chain Concentration and Firm Risk

The table shows the result of OLS regression on a sample consisting of 12,187 firm year observations from 2003 to 2018. The dependent variable in column (1) and (2) is the stock Beta, measured as the coefficient of market model by regressing the daily stock return on the value-weighted return of all firms in CRSP in a fiscal year. The dependent variable in column (3) and (4) is the Idiosyncratic Risk, measured as the standard deviation of residuals of the market model, multiplied by the squared root of 252. The dependent variable in column (5) and (6) is the annual stock Volatility in a fiscal year. The main independent variables are the Log (# of Suppliers) and Supplier HHI. All other variables are defined in Table I. The industry and year fixed effects are controlled by including SIC 2-digit industry and year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity and clustered at the purchasing firm level. T-Statistics are reported in the parentheses.

	Beta		Idiosyncratic Risk		Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Log (# of Suppliers)	-0.039***		0.009***		0.005***	
	(-4.77)		(4.90)		(2.72)	
Supplier HHI		0.049**		-0.014***		-0.009*
		(2.24)		(-2.84)		(-1.70)
Customer HHI	0.019	0.006	0.089***	0.091***	0.073***	0.075***
	(0.25)	(0.08)	(4.42)	(4.56)	(3.51)	(3.59)
Size	-0.011	-0.025***	-0.038***	-0.035***	-0.033***	-0.031***
	(-1.63)	(-4.47)	(-25.48)	(-28.94)	(-20.16)	(-23.72)
BTM	0.276***	0.285***	0.107***	0.105***	0.112***	0.111***
	(12.13)	(12.45)	(19.95)	(19.65)	(18.93)	(18.86)
Lev	0.270***	0.293***	0.087***	0.082***	0.088***	0.085***
	(6.14)	(6.62)	(7.91)	(7.47)	(7.40)	(7.19)
DISP	0.229***	0.223***	0.099***	0.100***	0.102***	0.103***
	(7.14)	(6.98)	(14.49)	(14.64)	(14.21)	(14.32)
LTG	0.836***	0.841***	0.256***	0.255***	0.271***	0.270***
	(11.85)	(11.84)	(15.39)	(15.38)	(15.31)	(15.30)
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	12,187	12,187	12,187	12,187	12,187	12,187
Adj. R^2	0.28	0.28	0.56	0.56	0.61	0.61

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.5: The Effect of Supplier's Financial Performance on Cost of Equity

The table shows the result of OLS regression on a sample consisting of 12,187 firm year observations from 2003 to 2018. The dependent variable is the excess implied cost of equity, measured as the difference between average implied cost of equity, r_{avg} and the risk-free rate, r_f. Low supply chain concentration is defined as an indicator variable, which equals to one if Supplier HHI is in the bottom tercile of the sample in a given firm year and zero otherwise. Negative Earnings is an indicator variable, which equals to one if at least one of suppliers experience loss of earnings in a fiscal year and zero otherwise. Earnings are defined based on EBIT in column (1), EBITDA in column (2), and Income before Extraordinary Items (IB) in column (3) respectively. All other variables are defined in Table I. The industry and year fixed effects are controlled by including SIC 2-digit industry and year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity and clustered at the purchasing firm level. T-Statistics are reported in the parentheses.

	Implied Cost of Equity		
	(1)	(2)	(3)
Low Supplier Concentration	-0.165	-0.205	-0.324
	(-0.98)	(-1.17)	(-1.63)
Negative Earnings	-0.167	-0.231	-0.274*
	(-1.11)	(-1.44)	(-1.80)
Low Supplier Concentration × Negative Earnings	0.541***	0.629***	0.685***
	(2.71)	(2.80)	(3.13)
Customer HHI	2.150***	2.128***	2.138***
	(2.72)	(2.69)	(2.70)
Size	1.213***	1.210***	1.211***
	(7.12)	(7.11)	(7.09)
BTM	-0.095	-0.093	-0.084
	(-1.44)	(-1.33)	(-1.26)
Lev	4.038***	4.035***	4.034***
	(16.23)	(16.18)	(16.23)
DISP	4.651***	4.653***	4.638***
	(8.75)	(8.78)	(8.75)
LTG	2.386***	2.386***	2.395***
	(5.38)	(5.38)	(5.40)
Industry Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
# of Obs.	12,187	12,187	12,187
Adj. R^2	0.26	0.26	0.26

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.6: The Effect of Purchasing Firm's Purchase Demand on Cost of Equity

The table shows the result of OLS regression on a sample consisting of 12,187 firm year observations from 2003 to 2018. The dependent variable is the implied individual cost of equity in excess of the risk-free rate. Low supply chain concentration is defined as an indicator variable, which equals to one if Supplier HHI is in the bottom tercile of the sample in a given fiscal year and zero otherwise. Purchasing share is the ratio of purchasing firm's cost of goods sold to the total cost of goods sold of all firms in the same industry. We categorize firms into industry based on SIC 3-digit code in column (1) and SIC 4-digit code in column (2) respectively. High purchasing demand is defined as an indicator variable, which equals to one if a purchasing firm's purchasing share is above the sample median in a given fiscal year and zero otherwise. All other variables are defined in Table I. The industry and year fixed effects are controlled by including SIC 2-digit industry and year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity and clustered at the purchasing firm level. T-Statistics are reported in the parentheses.

	SIC 3-digit	SIC 4-digit
	(1)	(2)
Low Supplier Concentration	-0.166	-0.124
	(-0.97)	(-0.77)
High Purchasing Demand	0.116	0.142
	(0.56)	(0.79)
Low Supplier Concentration × High Purchasing Demand	0.583**	0.509**
	(2.50)	(2.29)
Customer HHI	2.181***	2.118***
	(2.75)	(2.66)
Size	1.203***	1.207***
	(7.05)	(7.06)
BTM	-0.132*	-0.126*
	(-1.85)	(-1.83)
Lev	4.075***	4.074***
	(16.30)	(16.41)
DISP	4.663***	4.649***
	(8.78)	(8.73)
LTG	2.394***	2.398***
	(5.40)	(5.41)
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
# of Obs.	12,187	12,187
Adj. R^2	0.26	0.26

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.7: The Effect of Combining Suppliers in the Same Industry

The table shows the result of OLS regression on a sample consisting of 12,187 firm year observations from 2003 to 2018. The dependent variable is the excess implied cost of equity, measured as the difference between average implied cost of equity, r_{avg} and the risk-free rate, r_f. The number and sales of suppliers in the same industry are combined together based on SIC 3-digit and 4-digit industry classification respectively. The main independent variables are the Log (Combined # of Suppliers) and Combined Supplier HHI. All other variables are defined in Table I. The industry and year fixed effects are controlled by including SIC 2-digit industry and year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity. T-Statistics are reported in the parentheses.

	SIC 3-digit		SIC 4-digit	
	(1)	(2)	(3)	(4)
Log (Combined # of Suppliers)	0.089		0.114*	
	(1.36)		(1.84)	
Combined Supplier HHI		-0.315*		-0.380**
		(-1.79)		(-2.24)
Customer HHI	2.123***	2.137***	2.107***	2.125***
	(3.90)	(3.92)	(3.87)	(3.90)
Beta	1.209***	1.205***	1.212***	1.206***
	(9.41)	(9.39)	(9.43)	(9.40)
Size	-0.098**	-0.094**	-0.112**	-0.102***
	(-2.21)	(-2.42)	(-2.48)	(-2.62)
BTM	4.051***	4.047***	4.059***	4.053***
	(21.02)	(21.15)	(21.05)	(21.17)
Lev	4.649***	4.643***	4.674***	4.664***
	(14.04)	(14.01)	(14.08)	(14.03)
DISP	2.390***	2.393***	2.386***	2.392***
	(6.89)	(6.90)	(6.88)	(6.89)
LTG	9.541***	9.538***	9.542***	9.540***
	(12.49)	(12.48)	(12.49)	(12.49)
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	12,187	12,187	12,187	12,187
Adj. R^2	0.26	0.26	0.26	0.26

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.8: Instrumental Variables and Implied Cost of Equity

The table shows the result of 2SLS regression. The instrumental variables are the Foreign Supplier,Industry Supplier Number$_{t-3}$, and Industry Supplier HHI$_{t-3}$. The Foreign Supplier is defined as an indicator variable, which equals to one if customer firm has a foreign supplier in a fiscal year t and zero otherwise. The Industry Supplier Number$_{t-3}$ is the average number of suppliers among all firms in the same industry at fiscal year t-3. The Industry Supplier HHI$_{t-3}$ is the average Supplier HHI among all firms in the same industry at fiscal year t-3. The industries are categorized based on SIC 3-digit code. T-Statistics are reported in the parentheses.

	2SLS		2SLS	
	1st Stage	2nd Stage	1st Stage	2nd Stage
	(1)	(2)	(3)	(4)
Foreign Supplier	0.531***		-0.102***	
	(29.20)		(-15.97)	
Industry Supplier Number	0.041***			
	(17.27)			
Industry Supplier HHI			0.324***	
			(13.65)	
Log (# of Suppliers)		0.546***		
		(3.68)		
Supplier HHI				-2.171***
				(-3.15)
Customer HHI	0.230**	1.608***	-0.025	1.728***
	(2.32)	(3.03)	(-0.73)	(3.26)
Beta	-0.113***	1.403***	0.014**	1.366***
	(-6.30)	(14.30)	(2.18)	(14.09)
Size	0.406***	-0.260***	-0.083***	-0.205***
	(65.00)	(-3.26)	(-38.16)	(-2.73)
BTM	-0.225***	3.766***	0.048***	3.748***
	(-8.63)	(26.09)	(5.29)	(25.85)
Lev	-0.507***	4.415***	0.105***	4.347***
	(-9.46)	(14.54)	(5.60)	(14.34)
DISP	0.140***	2.461***	-0.008	2.530***
	(3.82)	(12.46)	(-0.64)	(12.89)
LTG	0.095	8.594***	-0.078**	8.486***
	(0.96)	(16.21)	(-2.24)	(15.88)
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	8,297	8,297	8,297	8,297
Adj. R^2	0.63	0.33	0.37	0.33
Test of Over-identification Restrictions				
p-value for Sargan Test		0.816		0.170

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.9: Dynamic Panel Data Regression

The table shows the result of dynamic GMM regression by regressing the excess implied cost of equity on supplier composition. The Lag (Implied cost of equity) is the excess average implied cost of equity at fiscal year t-1. All other variables are defined in the Table I. The regressions are estimated following Blundell and Bond (1998), Anderson and Hsiao (1982), and Arellano and Bond (1991) respectively. The year fixed effect is controlled by including year dummies in the regression. The standard errors are robust to the presence of heteroskedasticity. T-Statistics are reported in the parentheses.

	Blundell and Bond (1998)		Anderson and Hsiao (1982)		Arellano and Bond (1991)	
	(1)	(2)	(3)	(4)	(5)	(6)
Lag (implied cost of equity)	0.341***	0.337***	0.058	0.057	0.372***	0.370***
	(5.49)	(5.44)	(1.16)	(1.14)	(4.89)	(4.91)
Log (# of Suppliers)	0.135***		0.243***		0.253***	
	(3.01)		(3.07)		(2.58)	
Supplier HHI		-0.420***		-0.416***		-0.439**
		(-2.97)		(-3.11)		(-2.52)
Customer HHI	1.053*	1.082*	0.125	0.108	-0.379	-0.398
	(1.68)	(1.73)	(0.09)	(0.08)	(-0.25)	(-0.26)
Beta	0.699***	0.698***	0.576***	0.575***	0.415***	0.423***
	(5.90)	(5.89)	(4.99)	(4.97)	(3.20)	(3.25)
Size	0.002	0.022	-0.183	-0.160	-0.284	-0.265
	(0.04)	(0.49)	(-0.84)	(-0.73)	(-1.22)	(-1.14)
BTM	3.090***	3.077***	2.014***	2.015***	2.429***	2.418***
	(11.29)	(11.36)	(6.22)	(6.20)	(5.88)	(5.87)
Lev	2.323***	2.292***	3.422***	3.453***	3.823***	3.852***
	(6.44)	(6.34)	(5.08)	(5.14)	(5.16)	(5.24)
DISP	1.424***	1.441***	1.144***	1.142***	0.920**	0.907**
	(4.10)	(4.14)	(3.29)	(3.27)	(2.40)	(2.37)
LTG	9.460***	9.425***	10.367***	10.318***	11.509***	11.409***
	(12.92)	(12.88)	(12.73)	(12.66)	(10.38)	(10.33)
Industry Fixed Effect	No	No	No	No	No	No
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	8,420	8,420	6,388	6,388	6,388	6,388
Test of Over-identification Restrictions						
p-value for Hansen Test	0.100	0.109	0.505	0.488	0.269	0.301

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.10: Supply Chain Concentration and Cost of Debt

The table shows the result of 2SLS regression. The dependent variable is the natural logarithm of All-in-Drawn spread of the loan. The instrumental variables are defined in Table VIII. MTB is the market-to-book ratio. ROA is the income before extraordinary items divided by total assets. Z Score is the Altman (1968)'s Z Score. Tangibility is the ratio of fixed assets to total assets. Loan Maturity is the time to maturity of the loan in months. Loan Amount is the amount of the loan issued in millions. All other variables are defined in Table I. The loan type and purpose are controlled in all regressions. T-Statistics are reported in the parentheses.

	Loan Spread			
	2SLS		2SLS	
	1st Stage	2nd Stage	1st Stage	2nd Stage
	(1)	(2)	(3)	(4)
Foreign Supplier	0.616***		-0.131***	
	(25.91)		(-15.36)	
Industry Supplier Number	0.042***			
	(12.84)			
Industry Supplier HHI			0.360***	
			(11.98)	
Log (# of Suppliers)		0.054**		
		(2.42)		
Supplier HHI				-0.169*
				(-1.82)
Customer HHI	0.157	0.175*	0.006	0.190**
	(1.18)	(1.94)	(0.12)	(2.11)
Size	0.388***	-0.084***	-0.073***	-0.073***
	(41.53)	(-6.72)	(-21.83)	(-6.97)
MTB	0.053***	-0.065***	0.008	-0.060***
	(2.88)	(-5.19)	(1.20)	(-4.83)
Lev	-0.881***	0.532***	0.065**	0.492***
	(-10.54)	(8.65)	(2.15)	(8.56)
ROA	-1.146***	-1.322***	0.125**	-1.368***
	(-6.76)	(-11.22)	(2.04)	(-11.84)
Z Score	-0.009	-0.007	-0.004	-0.008
	(-1.12)	(-1.19)	(-1.48)	(-1.49)
Tangibility	-0.080	0.143***	0.054**	0.146***
	(-1.09)	(2.88)	(2.03)	(2.93)
Log (Loan Maturity)	-0.015	0.111***	-0.007	0.109***
	(-0.53)	(5.68)	(-0.66)	(5.57)
Log (Loan Amount)	-0.005	-0.127***	-0.001	-0.127***
	(-0.62)	(-21.68)	(-0.20)	(-21.73)
Loan Type and Purpose	Yes	Yes	Yes	Yes
Industry and Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	5,206	5,206	5,206	5,206
Adj. R^2	0.63	0.57	0.36	0.57
Test of Over-identification Restrictions				
p-value for Sargan Test	0.802		0.322	

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 1.11: Loan Security and Cost of Debt

The table shows the result of 2SLS regression by regressing the loan spread on supply chain composition for a subsample of unsecured loans and secured loans respectively. The secured loan is a loan secured by a collateral, whereas the unsecured loan is a loan not secured by any collaterals. The results of 1st stage regression are not reported. All the variables are defined in the previous tables. The standard errors are robust to the presence of heteroskedasticity. T-Statistics are reported in the parentheses.

	2nd Stage			
	Unsecured		Secured	
	(1)	(2)	(3)	(4)
Log (# of Suppliers)	0.081***		0.027	
	(2.58)		(0.94)	
Supplier HHI		-0.342**		-0.081
		(-2.20)		(-0.83)
Customer HHI	0.475***	0.497***	-0.119	-0.115
	(3.48)	(3.61)	(-1.28)	(-1.23)
Size	-0.112***	-0.102***	0.007	0.011
	(-5.83)	(-5.76)	(0.47)	(1.02)
MTB	-0.069***	-0.064***	-0.015	-0.012
	(-3.64)	(-3.38)	(-1.07)	(-0.82)
Lev	0.577***	0.545***	0.186***	0.169***
	(5.79)	(5.57)	(2.98)	(2.77)
ROA	-1.156***	-1.217***	-1.059***	-1.077***
	(-5.93)	(-6.24)	(-9.07)	(-9.45)
Z Score	-0.013	-0.016*	-0.004	-0.004
	(-1.56)	(-1.82)	(-0.63)	(-0.74)
Tangibility	0.091	0.109	0.161***	0.160***
	(1.25)	(1.48)	(3.01)	(2.99)
Log (Loan Maturity)	0.100***	0.101***	0.031	0.027
	(3.91)	(3.90)	(1.27)	(1.13)
Log (Loan Amount)	-0.115***	-0.117***	-0.096***	-0.096***
	(-14.28)	(-14.26)	(-13.15)	(-13.12)
Loan Type and Purpose	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	3,019	3,019	2,187	2,187
Adj. R^2	0.56	0.55	0.50	0.50

* indicates p-value<0.1; ** indicates p-value<0.05; *** indicates p-value<0.01

Chapter 2: The Impact of Customer Horizontal Mergers on Supplier's Cash Holdings

2.1 INTRODUCTION

Prior studies (Snyder 1996; Fee and Thomas, 2004; Shahrur, 2005; Bhattacharyya and Nain, 2011) find evidence that horizontal merger increases the buying power of merging firms, which adversely affects their suppliers. Given that the bargaining power between customer and supplier is significantly imbalanced through the customer horizontal merger, it remains an empirical open question how the suppliers react to balance their bargaining positions. This research question is suggested by Fee and Thomas (2004) showing that the effect of horizontal merger on suppliers appears to be temporary.[9] They interpret this impermanent effect as those suppliers strategically adapt financial policies and plans to counteract the increased buying power from their customers. I seek to fill this research gap by examining one of the mechanisms that suppliers use to rebalance their bargaining positions with the merged customers. Specifically, I investigate whether the suppliers strategically adjust their cash holdings in response to the customer's horizontal mergers and acquisitions.

The bargaining power theory introduced by Bronars and Deere (1991) indicates that firms could strengthen their bargaining powers against the stakeholders by reducing the amount of surplus to share in a negotiation. Further, Klasa et al. (2009) show that firms facing strong labor unions tend to hold less cash to gain bargaining advantages over the unions. In the context of this paper, I hypothesize that the suppliers strategically reduce their cash holdings for the purpose of counteracting the increased buying power from their customers in the post-merger period. After the horizontal mergers, the merged customer firms may pressure the suppliers to provide better

[9] Fee and Thomas (2004) find that the supplier's operating performance deteriorates only in the first year after the merger.

price discount or more trade credit. By adopting a policy of less cash holdings, the suppliers can argue during the negotiation that they do not have the capacity to meet the customer's request since they need to maintain the liquidity. A threat of liquidity deficiency not only affects the supplier's likelihood of survivability in the presence of a potential economic hardship, but also raises customer's concern on whether the suppliers are able to commit to the supply agreement if keeping pressuring them.[10] Therefore, by maintaining less cash holdings the suppliers can significantly improve their bargaining positions against the merged customers.

I examine the supplier's cash holdings change between pre-merger and post-merger period. The sample is constructed based on 1,512 completed horizontal mergers and acquisitions in the Securities Data Company (SDC) platinum from 2003 to 2018. The merger is considered as horizontal if acquiring and target firm share the same four-digit SIC code.[11] I identify the merging firm's suppliers by using the FactSet Revere Supply Chain Relationship database and include supplier data in the sample starting from 2 years before and up to 2 years after the merger announcement date. My findings suggest that the suppliers who retain the supply relationship with the merged customer firms strategically reduce their cash holdings in the post-merger period. In addition, I show that the suppliers who terminate the supply relationship with the merged customer firms do not adjust their cash holdings in the post-merger period, since they have no incentives to hold less cash for the purpose of improving bargaining positions.

Given my finding that the customer horizontal merger results in a decrease in the supplier's cash holdings, I expect this effect to be more pronounced when the supplier's revenue relies on the merged customer's purchase. The suppliers are considered as sale reliant to the

[10] The economic hardship such as coronavirus pandemic makes firms with low liquidity vulnerable to the shutdown of economics. Some of these firms are forced to file for bankruptcy due to the declining revenues and large operating expenses.

[11] I follow Fee and Thomas (2004) and Shahrur (2005) to define horizontal merger.

merged customers if more than 10% of their total sales are from either acquiring or target firms. The empirical result shows that the customer horizontal merger leads to lower post-merger cash holdings by the suppliers when the merging firm (either bidder or target) is a major customer to the suppliers. In addition, I find that the impact of customer horizontal mergers and acquisitions on supplier's cash holdings is less pronounced when the supplier operates in a concentrated industry or when the supplier is a market leader within the industry. Oliveira et al. (2017) show that the suppliers in a concentrated industry or being as a market leader within the industry already own enough bargaining power to their customers. Therefore, they should have less incentive to adjust their cash holdings.

I provide further analysis to examine the supplier's bargaining power gain related to cash holdings reduction. Following prior studies (Fee and Thomas, 2004; Bhattacharyya and Nain, 2011), I use the cash flow-to-sales as a proxy for the bargaining power. If cash holdings decline improves bargaining power, as my hypothesis suggests, suppliers who reduce their cash holdings after the merger should experience higher cash flow margin. The empirical result confirms my prediction and shows that in comparison to suppliers experiencing an increase in cash holdings, the cash reducing suppliers have higher post-merger cash flow margin. This finding is robust to controlling for firm level cash flow determinants and year and industry fixed effect.

I also investigate the action suppliers take to credibly hide their cash surplus from the merged customers. Prior studies find that increasing payout to shareholders or expanding capital expenditures may not be an effective way to shelter liquidity from the strong stakeholders. For instance, Chen et al. (2015) and Chino (2016) suggest that increasing payout to the shareholders via dividends or share repurchase conveys less credible signal to the labor unions that the firms are in shortage of liquidity. Further, Bronars and Deere (1993) show that firms facing strong

labor unions are associated with lower capital expenditures, since a large proportion of future investment profits would be captured by the unions.[12] I find that the suppliers tend to use cash reserves to finance their R&D investments after the customer merger. Prior studies (Brown and Peterson, 2011; Guney et al., 2017) show that firms use both internal and external sources to support their R&D activities. Because of the high adjustment cost, the R&D investments appear to be smooth and are unlikely to be cut off by the firms. By using more internal cash reserves to finance the R&D activities, the suppliers can first conceal their cash surplus from the merged customers. Second, R&D investment is different from the regular capital expenditures (plant and equipment) in that the R&D will benefit the supplier shareholders in a relatively longer term and avoid any economic profits being captured by the customers.

My findings could suffer from a potential model misspecification. Further, any sample selection bias could possibly drive the significant decreases in the supplier's cash holdings after the merger. To mitigate these concerns, I construct a matched sample of control firms who do not experience a customer horizontal merger using propensity score matching approach. Each supplier in my sample is matched to a control firm based on the pre-merger cash holdings, firm size, market-to-book ratio, leverage, capital expenditures, R&D expenses, operating cash flows, dividend payments, acquisitions, net working capital, industry and year. I then examine the difference of post-merger cash holdings between sample of suppliers and control firms. The result shows that the suppliers in the sample hold significantly less cash than the control firms in the post-merger period. This finding suggests that the significantly less cash holdings by the suppliers are not driven by the potential model misspecification or sample selection bias.

[12] Bronars and Deere (1993) find that unionized firms reduce their investments as a response to the potential expropriation of rents by the labor union.

There are several alternative explanations for a decrease in the cash holdings by suppliers. For instance, a scale-increasing merger increases the customer's demand for the upstream inputs for production. Therefore, suppliers may use the cash reserves to finance their operations in the presence of larger sales. To distinguish which explanation, bargaining power or increased purchase demand, is driving the decline in the cash holdings by suppliers, I split the sample into two subsamples based on whether a merger generates a positive or negative abnormal return around the merger announcement date to the suppliers. A subsample of suppliers with positive abnormal returns may indicate that a merger results in greater purchasing quantity from these suppliers, whereas a subsample of suppliers with negative abnormal returns is consistent with the buying power hypothesis that the customers pressure their suppliers for better trade conditions. I find that the suppliers reduce their cash holdings after the merger for both subsamples. While an increase in the purchasing demand could potentially explain a decrease in the cash holdings by the suppliers with positive abnormal returns, it is unlikely to explain any changes in the cash holdings for the suppliers with negative abnormal returns. Therefore, a decline in the cash holdings by the suppliers experiencing negative abnormal returns is mainly attributable to the bargaining power hypothesis that those suppliers strategically hold less cash to improve their bargaining positions against the customers.

To provide more convincing evidence on the bargaining power hypothesis, I conduct several robustness tests to rule out other alternative explanations. First, a decrease in the supplier's cash holdings after the merger could be due to a potential increase in the capital expenditures if a merger forces the suppliers to improve their production efficiencies to compete with the lower cost rivals. Second, the suppliers may strategically issue more debt after the merger to increase their bargaining power (Kale and Shahrur, 2007; Brown et al., 2009;

Hennessy and Livdan, 2009; Chu, 2012; Oliveira et al., 2017), which causes less cash holdings due to larger interest expenses. To test these alternative explanations, I investigate whether the suppliers have higher cash sensitivity on the capital expenditures and interest expenses after the merger. The results do not support any of these alternative explanations. Finally, Bhattacharyya and Nain (2011) find that suppliers are likely to consolidate following their customer mergers. Therefore, the reduced cash holdings and improved bargaining positions could be concurrently driven by the supplier's cash financed consolidation activities. To mitigate the effect of supplier's horizontal merger, I remove the suppliers who consolidate following their customer mergers from the initial sample and reexamine the cash holdings change and bargaining power of suppliers in the remaining sample. The results are consistent with my hypothesis that the nonconsolidated suppliers strategically hold less cash after the merger to improve their bargaining power against the merged customers.

This study adds to the literature in several dimensions. First, I complement prior studies (Snyder 1996; Fee and Thomas, 2004; Shahrur, 2005; Bhattacharyya and Nain, 2011) on the buying power hypothesis of horizontal merger by empirically investigating a reason for the temporary merger effect on suppliers. I show that the upstream suppliers counteract the increased buying power from their customer firms by holding less cash in two years after the merger. Second, while a large part of existing literature (Klasa et al., 2009; Chen and Chen, 2013; Chen et al., 2018) has focused on the bargaining power of cash holdings against labor unions, little studies exist examining the strategic use of cash holdings in the context of other stakeholders. My paper adds to this line of research by investigating the cash holdings change in response to an important stakeholder event: customer horizontal merger. Finally, my study sheds lights on the literature by showing that the customer-supplier relationship can determine a firm's liquidity.

Different from Itzkowitz (2013) showing that suppliers engaging in a concentrated customer relationship hold more cash as a precautionary motive, I find that the suppliers hold less cash for the purpose of improving their bargaining power against the merged customers.

The rest of the paper is stated as follows. Section 2 summarizes the related literature and describes my hypothesis. Section 3 explains the methodology. The sample and data description are present in the section 4. Section 5 reports the empirical results. The conclusion is made in the section 6.

2.2 Literature Review and Hypothesis Development

2.2.1 Buying Power Hypothesis of Horizontal Merger

The finance literature has recognized the increased buying power for the merging firms as one of the synergies to horizontal mergers. For instance, Snyder (1996) show that horizontal mergers increase customer firm's profit at the expense of suppliers. Fee and Thomas (2004) find that horizontal mergers result in a negative abnormal return and a decline in the post-merger operating performance for the suppliers. Shahrur (2005) also find evidence that the merging firms increase their buying power through horizontal merger, which adversely affect the suppliers when the takeover is large or when the supplier industry is highly concentrated. These studies interpret the results as the customer firms pressure their suppliers to offer lower upstream price after the merger. Consistent with the prediction of buying power hypothesis, Bhattacharyya and Nain (2011) find that the suppliers experience negative changes in cash flow margins and selling price in the post-merger period.

2.2.2 Bargaining Power Hypothesis of Cash Holdings

Firms choose their optimal cash holdings by trading off the benefits and costs of cash reserves. On the one hand, sufficient cash holdings protect the firms against potential operating losses or liquidity shortages (Opler et al., 1999; Mikkelson and Partch, 2003; Bates et al., 2009). On the other hand, large cash holdings earn minimal returns for the shareholders and allow the managers to pursue their own interests at the expenses of shareholders (Jensen and Meckling, 1976; Jensen, 1986; Pinkowitz et al., 2006; Dittmar and Mahrt-Smith, 2007; Harford et al., 2008). Recent studies identify another important cost of large cash reserve, which lowers the firm's bargaining power in front of a strong stakeholder. Klasa et al. (2009) show that large cash reserves induce the labor union to request more benefits at the expenses of shareholders. To protect the wealth of shareholders from expropriation by the labor union, they find that unionized firms strategically reduce their cash holdings prior to the negotiation with the union. Consistent with the bargaining power hypothesis of lower cash holdings, Chen and Chen (2013) find that firms facing strong labor unions tend to reduce their liquidity by increasing capital expenditures. In the context of merger and acquisitions, Chen et al. (2018) find that bidders with strong unions are more likely to use cash rather than stock to complete the transactions.

2.2.3 Hypothesis Development

I investigate whether the suppliers strategically reduce their cash holdings in response to the stronger customers after the merger. Specifically, the merged customers can combine their purchasing activities and pressure the supplies to provide lower selling prices and more trade credit. Further, the horizontal mergers result in more intensive competitions among the suppliers. All these impacts of horizontal mergers on suppliers suggest that the suppliers have a strong need to improve their bargaining positions in a negotiation with the merged customers.[13] Bhattacharyya and Nain (2011) suggest an external mechanism that the suppliers can use to counteract the increased buying power from the customers. They find that the suppliers are more likely to consolidate following their customer's horizontal merger. My paper focuses on the internal mechanism, which is to reduce the liquidity. By adopting a policy of less cash holdings, the suppliers can credibly argue during the negotiation that they do not have the capacity to meet the customer's request of better trade conditions because of liquidity shortages. The threat of liquidity deficiency affects the supplier firm's likelihood of survivability in the presence of an economic hardship, which is exacerbated by providing more concessions to the customers (Klasa et al., 2009).

From a customer's point of view, maintaining supply chain stability is equally important to requesting better trade terms from the suppliers. When the supplier is at risk of financial distress, the customer firms are concurrently subject to the risk of supply shortages or even disruption.[14] Switching to a new supply agreement could be costly when the managers take into account of the information asymmetries and hold up problems (Williamson, 1979; Costello, 2013). Therefore, a threat of liquidity shortages at suppliers raises customer's concerns on

[13] The merger causes the supply contract to be renegotiated between the suppliers and the new merged customer.

[14] Hertzel et al. (2008) show that financial distress at suppliers is associated with negative stock performance for the customers.

whether the suppliers can commit to the supply agreement if continuing pressuring the suppliers. The above discussion leads to my first hypothesis that:

H1: The suppliers strategically reduce their cash holdings after the customer horizontal merger to improve their bargaining power against merged customers.

Fee and Thomas (2004) and Bhattacharyya and Nain (2011) show that the customer horizontal merger leads to lower cash flow-to-sales for the suppliers after the merger. If cash holdings reduction improves the supplier's bargaining power against the customer's request of better trade conditions, I should expect suppliers who reduce their cash holdings to experience higher post-merger cash flow margin relative to cash increasing suppliers. Therefore, I posit the second hypothesis as follows:

H2: The suppliers who reduce their cash holdings after the customer merger have higher post-merger cash flow-to-sales than suppliers experiencing an increase in cash holdings.

How do suppliers successfully conceal liquidity from the customer? Prior studies (Chen et al., 2015; Chino, 2016) suggest that distributing cash reserves to shareholders via dividends or shares repurchase convey a positive signal to the customers. Consequently, it induces the merged customers to extract more rents from the suppliers. Further, Bronars and Deere (1993) indicate that firms facing strong stakeholders (union) will cut investments to prevent the future earnings from being expropriated by the stakeholders (union). In this paper, I hypothesize that the suppliers tend to use cash reserves to finance their R&D expenditures after the customer horizontal merger. Prior studies have shown that firms use mixed financing sources to support their R&D activities. For instance, Guney et al. (2017) show that firms use credit lines to finance their R&D investments. Brown and Peterson (2011) examine the link between cash reserve and R&D expenditures. They show that R&D has high adjustment costs and is unlikely to be cut off

by the firms.[15] When facing external financing frictions, firms tend to use internal cash holdings to smooth their R&D expenditures. I argue that suppliers having stronger incentives to reduce their liquidity after the merger are more likely to use cash reserves to finance their R&D expenditures. Further, the R&D investments will benefit the supplier firms in relatively longer horizon and avoid any generated economic rents being captured by the customers. In sum, I make my third hypothesis as:

H3: The suppliers are more likely to use cash reserves to finance their R&D expenditures, leading to a higher cash-R&D sensitivity after the customer horizontal merger.

[15] Brown and Peterson (2001) argue that cutting R&D will involve releasing talented workers and bring additional hiring and training costs when new employment needs occur in the future.

2.3 RESEARCH DESIGN

2.3.1 The Impact of Customer Horizontal Merger on Supplier's Cash Holdings

To empirically examine the hypothesis 1 that the suppliers hold less cash after the customer horizontal mergers, I estimate the following regression:

$$Cash_{it} = \alpha + \beta_1 After + \beta_2 Size_{it} + \beta_3 MTB_{it} + \beta_4 Lev_{it} + \beta_5 CAPX_{it} + \beta_6 R\&D_{it} + \beta_7 CF_{it} + \beta_8 DIV_{it} + \beta_9 ACQ_{it} + \beta_{10} NWC_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (2.1)$$

where the dependent variable is the supplier's cash holdings, measured as the ratio of cash and marketable securities to total non-cash assets. Since I am interested in examining the supplier's cash holding change between pre-merger and post-merger period, I include supplier data in the sample starting from 2 years before and up to 2 years after the merger announcement date. My main explanatory variable (After) is defined as an indicator variable that is equal to one in the two fiscal years (Year 1 and Year 2) after the mergers and acquisitions, and zero otherwise. To support the hypothesis, I expect the coefficient on the indicator variable After to be significantly negative. The firm and year fixed effects are controlled in all regressions by including the firm and year dummies in the equation.

Following prior studies (e.g., Opler et al., 1999; Bates et al., 2009; Itzkowitz, 2013), I include the following firm characteristics of suppliers in the regression as control variables. Firm size is measured as the natural logarithm of total assets and is predicted to be negatively related to the cash holdings. Larger firms have economic of scale to hold less cash to total assets. The market-to-book ratio (MTB) is defined as the book value of total assets minus the book value of equity plus the market value of equity scaled by total assets. The market-to-book ratio is proxy for the growth opportunities. Firms with higher market-to-book ratio hold more cash as a precaution against passing valuable investment opportunities. Leverage (Lev) is measured as the short-term debt plus long-term debt divided by total assets. Firms may use the cash to retire debt

to save for debt capacity, which results in a negative relation between leverage and cash holdings. The capital expenditures (CAPX) and Acquisitions (ACQ) are examples of larges cash outflows and are expected to be negatively associated with cash holdings. The effect of R&D expense (R&D) on cash holdings is unpredictable. Brown and Peterson (2011) show that firms use their cash reserves to smooth the R&D expenditures, suggesting a negative relation between R&D expense and cash holdings. Alternatively, firms may hold more cash as a capital buffer to better support their intensive R&D activities (Mikkelson and Partch, 2003). The cash flow (CF) is defined as the ratio of operating income before depreciation minus interest expenses, taxes, and dividend payments to total assets. Firm with larger cash flows is predicted to accumulate more cash. The dividend payment (DIV) is an indicator variable, which is equal to one if the firm pays common dividends and, zero otherwise. The dividend paying firms are usually cash rich firms who need to distribute dividends to mitigate agency problems. Finally, I include the net working capital (NWC) to total assets to control for the non-cash substitute of liquidity.

2.3.2 The Effect of Cash Holdings Reduction on Supplier's Cash Flow Margin

To test the hypothesis 2 that cash reducing suppliers have higher post-merger cash flow margin than cash increasing suppliers, I estimate the regression model as:

$$CF/Sales_{it} = \alpha + \beta_1 After + \beta_2 Negative\ \Delta Cash_{it} + \beta_3 After \times Negative\ \Delta Cash_{it} + \beta_4 Size_{it} + \beta_5 MTB_{it} + \beta_6 Lev_{it} + \beta_7 CAPX_{it} + \beta_8 R\&D_{it} + \beta_9 DIV_{it} + \beta_{10} ACQ_{it} + \varepsilon_{it} \quad (2.2)$$

where CF/Sales is defined as the ratio of supplier's cash flow to sales. After is an indicator variable set equal to one in years after the customer mergers, and zero otherwise. Negative ΔCash is an indicator variable, which is equal to one if supplier's cash holdings change after the merger is negative, and zero otherwise. Change in cash holdings after the merger is measured as the post-merger cash holdings at Year 1 minus the pre-merger cash holdings at Year -1. I control for firm characteristics that could affect the cash flow margin. The control variables include firm size, market-to-book ratio, leverage, capital expenditures, R&D expenses, dividend, and acquisitions. The year and industry fixed effect are also controlled in the regression to mitigate any effects of industry and time trend on the supplier's cash flows. To support hypothesis 2, I expect a positive coefficient β_3 suggesting that the cash reducing suppliers have higher cash flow-to-sales than the cash increasing suppliers.

2.3.3 Supplier's Cash-R&D Sensitivity after the Customer Horizontal Merger

I estimate the following regression to examine the effect of customer horizontal merger on supplier's cash-R&D sensitivity:

$$R\&D_{it} = \alpha + \beta_1 After + \beta_2 \Delta Cash_{it} + \beta_3 After \times \Delta Cash_{it} + \beta_4 CF_{it} + \beta_5 NF_{it} + \beta_6 AP_{it} + \beta_7 Recv_{it} + \beta_8 Size_{it} + \beta_9 MTB_{it} + \mu_i + \eta_t + \varepsilon_{it} \quad (2.3)$$

where R&D is supplier's R&D expenditures divided by total assets. ΔCash is the change in cash holdings from year t-1 to year t. I control for other internal and external financing sources in addition to cash reserves. CF is operating cash flows to total assets. NF is net external financing, measured as the net equity issuance plus net debt issuance scaled by total assets. ΔAP and ΔRecv are changes in account payables and account receivables respectively. The coefficient β_3 measures the supplier's cash-R&D sensitivity after the merger. A negative β_3 indicates that the suppliers use more cash to support their R&D activities, leading to a higher cash-R&D sensitivity.

2.4 SAMPLE AND DATA

2.4.1 Sample Construction

I began the sample from collecting 1,512 completed horizontal mergers and acquisitions in the Securities Data Company platinum from 2003 to 2018. The merger and acquisition is considered as horizontal if the bidder and target share the same four digit SIC code. I use the FactSet Revere Supply Chain Relationship database to identify the merging firm's suppliers. The FactSet starts to record the data of customer-supplier relationship disclosed by either customer or supply firm since 2003. I include the supplier data in the sample starting from 2 years before and up to 2 years after the merger announcement date. The Year 0 is defined as the fiscal year when the customer firms make the merger announcement. I retain all the suppliers in the sample who still maintain the supply relationship with the merged customer firms after one year of the merger effective date. The financial data is collected from the Compustat dataset. The stock return is from the CRSP. Conditional on merging these four datasets, I further restrict the sample by excluding suppliers in the industry of utilities (4900-4999), finance (6000-6999), and public administration (9000-9999). The suppliers with asset value less than 1 million or missing values on any regression variables are also deleted from the sample. The final sample consists of 27,353 firm-year observations around the mergers and acquisitions.

2.4.2 Summary Statistics

Table 2.1 reports the distribution of customer horizontal mergers and acquisitions by industry and year. Consistent with the prior evidence (Harford, 2005) on merger waves, the merger transactions in the sample are mainly clustered during the period from 2005 to 2006 and from 2014 to 2016. The table also shows a shape of industry clustering in mergers. 35% of the mergers are from the manufacturing industry. 25% and 14% of the merges come from the industry of service and transportation and communications, respectively.

In panel A of Table 2.2, I present the descriptive statistics for the suppliers in my sample. All variables are winsorized at 1 and 99 percent. On average, the ratio of cash holdings to non-cash assets is 0.62. The suppliers in the sample hold a median cash ratio of 0.17. In term of the control variables, the suppliers in the sample has a mean (median) firm size of 7.03 (6.83), market-to-book ratio of 2.22 (1.71), leverage of 0.23 (0.20), capital expenditures of 0.04 (0.03), R&D expenses of 0.07 (0.02), cash flows of 0.02 (0.07), acquisitions of 0.03 (0.00), and net working capital of 0.02 (-0.05). 36% of the sample firms are paying common dividends to the shareholders. The Panel B of Table 2.2 shows the Pearson correlation coefficients among the regression variables. The coefficients are generally consistent with the predicted sign. I do not identify multicollinearity issues from the table.

2.5 EMPIRICAL RESULTS

2.5.1 Univariate Analysis

To examine the supplier's cash holdings change in response to the customer horizontal mergers and acquisitions, I compare the supplier's cash holdings before and after the merger. In panel A of Table 2.3, I present the univariate results for the retained suppliers. The average cash holdings of retained suppliers increase slightly from 0.635 to 0.638 before the merger and then decrease to 0.595 after one year of the merger. Further, the median cash holdings for retained suppliers decrease monotonically from 0.178 in Year -2 to 0.170 in Year 2. A mean (median) difference t-test (Wilcoxon rank test) suggests that the retained suppliers significantly reduce their cash holdings after the customer horizontal merger. Specially, the retained suppliers maintain an average (median) cash holdings ratio of 0.637 (0.176) before the merger and reduce it to 0.600 (0.171) in the post-merger period. The difference is significant at 90% confidence level.

The Panel B of Table 2.3 reports the cash holdings change before and after the merger for the terminated suppliers. The terminated suppliers are those suppliers who do not disclose a supply relationship with the merged customers after one year of the merger effective date. Since the terminated suppliers discontinue the supply contract with the customers after the merger, they have no incentives to alter their cash holdings for the purpose of improving the bargaining positions. Consistent with this prediction, I do not find evidence from the univariate analysis showing that the terminated suppliers hold less cash in response to the customer horizontal merger. The mean cash holdings remain approximately flat from Year -2 to Year 2. Further, a mean difference t-test shows no significant difference of cash holdings between pre-merger and

post-merger period. Although the median cash holdings show a decreasing pattern from 0.184 to 0.172, the difference is not significant either based on the Wilcoxon rank sum test.

2.5.2 Multivariate Analysis

To ensure that the results are not driven by other factors related to cash holdings or time trend, I estimate a multivariate regression examining the supplier's cash holdings change while controlling for the common determinants of cash reserves and unobserved firm and year fixed effect. Table 2.4 reports the results of my regression model. Overall, I find strong support to the hypothesis 1 that the suppliers strategically hold less cash after the merger to improve their bargaining positions against the merged customers. In column (1), the coefficient on the indicator variable After is significantly negative at 99% confidence level. In term of the economic significance, the results suggest that on average, the retained suppliers reduce their cash holdings ratios by 0.0259 after the merger. Given the sample median non-cash assets of $757 million, this reduction is equivalent to a dollar decrease of $20 million (=757*0.0259) in the cash reserves. In column (2), I replace the main explanatory variable After with two dummy variables, After1 and After2. After1 (After2) is set equal to one for Year 1 (Year 2) after the merger, and zero otherwise. The coefficient on After1 is significantly negative at 95% confidence level, showing that the retained suppliers reduce their cash holdings in the first year right after the merger is completed. Conditional on a decrease in the cash holdings at Year 1, the negative coefficient on After2 suggests that these retained suppliers hold further less cash in Year 2 after the merger. In sum, after controlling for the cash-related factors and time trend, the significant reduction in the cash holdings by retained suppliers indicates that these suppliers use cash as a bargaining tool in a negotiation with the merged customers.

In column (3) and (4) of Table 2.4, I report the multivariate test results for the terminated suppliers. Consistent with the prediction that the terminated suppliers have no incentives to adjust their cash holdings because of the discontinued supply relationship, I do not find evidence

that the terminated supplier's cash holdings are altered. In column (3), the coefficient and t-statistic for the indicator variable After is negative, but close to zero. In column (4), when the two dummy variables, After1 and After2, are used to replace the main explanatory variable (After), both coefficients are insignificant and round to zero.

2.5.3 Cross-Sectional Analysis

In this section, I conduct analysis on whether the supplier's cash holdings change depends on the importance of customer-supplier relationship and the industry competition. In particular, I examine if the customer horizontal mergers lead to more or less change in the supplier's cash holdings in the presence of (1) supplier sale reliance and (2) industry competition.

2.5.3.1 The Effect of Sale Reliance on Supplier's Cash Holdings Change

The prior studies (e.g., Cohen and Frazzini, 2008; Hertzel et al., 2008; Patatoukas, 2012; Itzkowitz, 2013; Dhaliwal, et al., 2016; Lian, 2017) have well documented the impact of a major customer on the supplier's financial and stock performance. Since a majority of the operating income comes from the major customer, the supplier whose revenue is depending on the merged customers should be more adversely affected by the horizontal merger. Specially, if the merged customers utilize their increased buying power to request for lower price per unit, this effect could be exacerbated in the presence of larger purchasing quantity. To prevent from loss of profit, I expect these sale reliant suppliers to hold further less cash to improve their bargaining power against the customers. Following the prior literature, I identify the suppliers who are sale reliant on the merging customer firms if at least 10% of their total sales come from either the acquiring or target firm. Alternatively, the non-sale reliant suppliers are considered as those suppliers with either undisclosed sale amount or percentage of sale less than 10%.[16]

Table 2.5 presents the results of the effect of sale reliance on supplier's cash holdings change in response to the merger. To test my prediction that the sale reliant suppliers are more likely to hold less cash after the merger, I interact the main explanatory variable After with an

[16] Prior studies identify suppliers by inversing the Compustat Customer Segment files. The Compustat Customer Segment files record firm's major customers in a fiscal year. By using Factset Customer and Supplier Relationship dataset, I am able to identify the customers accounting for less than 10% of supplier's total sales.

indicator variable set equal to one if the merging customer firm (either acquirer or target) is a major customer for the supplier, and zero otherwise. The results in Table 2.5 show that the suppliers who are sale reliant on the merged customers hold less cash than the non-sale reliant suppliers. The coefficient on the interactive variable is significantly negative at 90% confidence level. On average, the sale reliant suppliers reduce their cash holding by 0.0798 (=0.0193+0.0605). In addition, the coefficient of indicator variable After remains significant and negative at 95% confidence level, suggesting the average non-sale reliant suppliers reduce their cash holding ratio by 0.0193. Overall, the results are consistent with my hypothesis that the suppliers hold less cash to raise their bargaining power in the context of customer horizontal merger. The effect is more pronounced for the suppliers who are sale reliant on the merging customers.

2.5.3.2 The Effect of Industry Competition on Supplier's Cash Holdings Change

I next investigate whether the supplier's cash holdings change depends on the extent to which competition prevails in the upstream industry. The effect of supplier industry competition on the change in cash holdings appears to be unclear. First, Fee and Thomas (2004) and Shahrur (2005) show that the negative impact of horizontal merger on suppliers is stronger when the supplier is in a concentrated industry. Specially, they show that the suppliers in more concentrated industries experience lower abnormal returns and larger declines in the post-merger operating performance. Their findings are consistent with the implication of buying power hypothesis that the horizontal merger intensifies competition in the upstream industry, which benefits the customers at the expense of suppliers. In order to counteract the increased buying power, the suppliers in concentrated industries should have more incentives to reduce their cash holdings. Therefore, I should expect the impact of customer horizontal merger on the supplier's cash holdings change to be more pronounced when the suppliers operate in more concentrated industries. On the other hand, Oliveira et al. (2017) show that the suppliers in a concentrated industry already own enough bargaining power against their customers.[17] Consequently, they should have less incentive to use cash as the bargaining tool. Therefore, I should expect the customer horizontal mergers to cause less change in the cash holdings for suppliers in a concentrated industry.

I measure the extent of supplier industry competition using the Herfindahl-Hirschman index. The Herfindahl-Hirschman index is calculated as the sum of the squared market shares of all firms operating in the same industry. I classify the industry according to the four-digit SIC code. To examine the effect of industry competition on the supplier's cash holdings change, I

[17] Oliveira et al. (2017) show that suppliers in concentrated industry do not increase leverage as much as suppliers in competitive industry to improve their bargaining power against financial distressed customers.

interact the main explanatory variable (After) with an indicator variable set equal to one if the Herfindahl-Hirschman index is above the sample median in a given firm year, and zero otherwise. The results in the column (1) of Table 2.6 show that the suppliers in concentrated industries reduce less cash holdings than the suppliers in competitive industries. The coefficient on the explanatory variable After remains significantly negative at 99% confidence level, suggesting that on average, the suppliers in competitive industries reduce their cash holdings ratio by 0.0415. The coefficient on the interaction term is significantly positive at 95% confidence level, indicating that the suppliers in concentrated industries reduce their cash holdings ratio by 0.008 (=0.0415-0.0335). In sum, the results are consistent with the Oliveira et al. (2017) showing that the suppliers in a concentrated industry already own enough bargaining power against their customers, and therefore have less incentives to reduce the cash holdings for the purpose of improving bargaining positions.

In column (2) of Table 2.6, I use the supplier's industry market shares as an alternative proxy for the existing bargaining power. I expect that the suppliers should have less incentive to reduce their cash holdings if they act a market leader in a particular industry. To test my prediction, I interact the explanatory variable (After) with an indicator variable set equal to one if the supplier's industry market share is above the sample median in a given firm year, and zero otherwise. The results are consistent with my prediction. Specially, the coefficient on the explanatory variable After is significantly negative at 99% confidence level, suggesting that the supplier who is not a market leader reduces the cash holdings by 0.0762. In addition, the coefficient on the interactive variable is significantly positive at 99% confidence level, indicating that the suppliers being as a market leader do not use cash as a bargaining tool against their customers. Overall, I find that the impact of customer horizontal mergers on the supplier's cash

holdings change is less pronounced if suppliers operate in a concentrated industry or stand as a market leader within the industry.

2.5.4 Supplier's Cash Holdings Reduction and Cash Flow Margin

Table 2.7 reports the results of regression analysis examining the effect of supplier's cash holdings reduction on their post-merger cash flow-to-sales. The results are consistent with hypothesis 2 that those suppliers who reduce cash holdings experience higher cash flow margin than suppliers having an increase in cash reserves. Specially, the coefficient on the indicator variable After is significantly negative, confirming the findings of prior studies that horizontal mergers benefit the merged customers at the expense of suppliers. Further, the coefficient on the interactive variable between After and Negative ΔCash is significantly positive at 99% confidence level, indicating higher cash flow margin for those cash reducing suppliers. Overall, this finding gives support to the hypothesis 2 that cash holdings reduction improves the supplier's bargaining positions with the merged customers, which leads to better post-merger operating performance.

2.5.5 Supplier's Cash-R&D Sensitivity after the Merger

In Table 2.8, I present the results of sensitivity analysis investigating whether the suppliers use more cash reserves to support their R&D expenditures after the merger. Consistent with the prediction of hypothesis 3, I find that the suppliers have higher cash-R&D sensitivity after the customer horizontal merger. In column (1), the coefficient on the interactive variable between After and ΔCash is significantly negative, indicating more cash spending on the R&D activities in the post-merger period. On average, these suppliers increase their cash and R&D sensitivity by 28% (0.0067/0.0242) after their customers are merged. This result shows that the R&D investment is an important channel in which the suppliers use to credibly reduce the liquidity to improve their bargaining positions against the customers.

2.5.6 Matched Sample Analysis

One concern related to my findings is that a decrease in the supplier's cash holdings after the merger could be driven by the endogeneity issue or sample selection bias. For instance, my results could be endogenously biased if the main explanatory variable (After) is correlated with an omitted variable. In addition, since firms voluntarily disclose the customer-supplier relationship, the results could be distorted by the sample selection bias if I exclude a subset of suppliers from the sample. To mitigate these concerns, I use a propensity score matching procedure to construct a matched sample of control firms who do not experience a customer horizontal merger. Specifically, each supplier in the sample is matched to a control firm with the closest propensity score estimated according to a logistic regression. The variables used in the logistic regression include the pre-merger (Year -1) cash holdings, firm size, market-to-book ratio, leverage, capital expenditures, R&D expenses, cash flows, dividend payments, acquisitions, net working capital, industry (2-digit SIC code) and year dummies. I then compare the post-merger cash holdings between the sample of suppliers and the control firms. My matching procedure results in 4,338 suppliers being matched to a control group.

I test the successfulness of my matching procedure by investigating whether the mean difference of the propensity score and pre-merger firm characteristics are significantly different between the sample of suppliers and control firms. In Panel A of Table 2.9, the results show that the propensity score is identical between sample of suppliers and control firms. The mean difference is minor and round to zero. Additionally, the mean differences for all the explanatory variables used in the logistic regression are insignificant. I do not find any variations between sample of suppliers and control firms in term of the pre-merger (Year -1) cash holdings, firm

size, market-to-book ratio, leverage, capital expenditures, R&D expenses, cash flows, dividend payments, acquisitions, and net working capital.

Panel A of Table 2.9 reports the results of univariate test regarding the post-merger cash holdings difference. I compare the post-merger cash holdings between the sample of suppliers and control firms. The results suggest that the suppliers facing a horizontal customer merger hold significantly less cash in the first year after the merger compared to the control firms. On average, these suppliers hold less cash reserves by 0.093. In addition, I find that compared to the control firms, the suppliers hold less cash by 0.046 in the second year after the merger. However, the difference is insignificant.

In Panel B of Table 2.9, I conduct a multivariate analysis by estimating the baseline regression on the combined sample consisting of sample of suppliers and control firms. Consistent with the findings in Panel A, I find that the suppliers experiencing customer horizontal merger hold significantly less cash than the control firms in the first year following the merger, but not after that. The coefficient on the interactive variable is significantly negative at 95% confidence level, suggesting that these suppliers hold less cash by 0.1235 in comparison to the control firms. Overall, the results suggest that a decrease in the post-merger cash holdings by the suppliers is unlikely to be driven by the endogeneity issue or sample selection bias.

2.5.7 Bargaining Power or Increased Purchase Demand

The upstream effect of horizontal merger could be either positive or negative. For instance, Fee and Thomas (2004) find that horizontal merger results in negative abnormal returns for the suppliers, whereas Shahrur (2005) document a positive abnormal return to the suppliers around the merger announcement date. A negative abnormal return is mainly consistent with the buying power hypothesis that the merged customers pressure their suppliers for better trade conditions, which benefits themselves at the expense of suppliers. A positive abnormal return could be interpreted as the scale-increasing merger brings greater purchasing quantity to the suppliers, although at lower price. In this paper, an alternative explanation about a significant decrease in supplier's cash holdings after the merger could be that these suppliers use the cash to financially support their operations in the presence of larger post-merger sales. Specifically, the suppliers may need to purchase new equipment to improve their production efficiencies or build up inventories in order to meet the larger downstream order. All these activities cause cash outlay to the suppliers.

To distinguish which explanation, bargaining power or increased purchase demand, drives the decline in supplier's cash holdings in the post-merger period, I split the sample into two subsamples according to the supplier's cumulative abnormal returns around the merger announcement date. The abnormal returns are calculated based on the market model estimated from -250 to -11 trading days prior to the merger announcement date. I use the CRSP value-weighted return as the market return. The cumulative abnormal returns are calculated over a three-day window from day -1 to day 1. A subsample of suppliers with positive abnormal returns may indicate that a merger generates greater purchasing quantity to the suppliers, whereas a subsample of suppliers with negative abnormal returns is consistent with the buying power

hypothesis that the customers pressure their suppliers for better trade conditions. I estimate the baseline regression on these two subsamples. While an increase in the purchasing demand could potentially explain the decrease in the cash holdings by the suppliers with positive abnormal returns, it is unlikely to explain any changes in the cash holdings for the suppliers with negative abnormal returns.

Table 2.10 reports the results of the baseline regression for the two subsamples. For the subsample with negative abnormal returns, the coefficient on the explanatory variable After is significantly negative at 99% confidence level. On average, these suppliers reduce their cash holdings by 0.0345 after the merger. When the explanatory variable After is replaced with two dummy variables, After1 and After2, the coefficients remain significant and negative for both two variables. Conditional on a decrease in the cash holdings by the suppliers in the first year after the merger, these suppliers further reduce their cash holdings in the second year. In Column (3) and (4), I present the results for the subsample of suppliers experiencing positive abnormal returns. I find similar pattern for the coefficients on the explanatory variable After, After1, and After2. On average, the suppliers who benefit from the customer horizontal merger also reduce their cash holdings by 0.0361 in the post-merger period. While I find some evidence that supports the explanation of increased purchasing demand, the results for the subsample of negative abnormal returns are mainly consistent with my hypothesis that suppliers facing stronger customers strategically reduce the cash holdings to improve their bargaining position.

2.5.8 Robustness Test of Alternative Explanations

To check the robustness of my results, I conduct several additional tests to rule out other alternative explanations. First, a decrease in the post-merger cash holdings by the suppliers could be due to a potential increase in the capital expenditures if a merger forces the suppliers to improve their production efficiencies to compete with the lower cost rivals. This interpretation suggests that suppliers will experience higher cash-capital expenditure sensitivity after the merger. To test this alternative explanation, I regress the supplier's capital expenditures on the indicator variable After, cash holdings change (ΔCash), and the interaction term (After × ΔCash). In column (1) of Table 2.11, I find that the coefficient on interaction term between After and ΔCash is insignificant, indicating no incremental sensitivity of cash reserves to capital expenditures. This result suggests that the less cash holdings by the supplier in the post-merger period is unlikely to be driven by the motive of improving the production efficiencies to compete with lower cost rivals through capital investments.

Second, prior studies (Kale and Shahrur, 2007; Brown et al., 2009; Hennessy and Livdan, 2009; Chu, 2012; Oliveira et al., 2017) posit that the suppliers can use debt as a bargaining tool against the customers. By issuing more debt, the suppliers reduce their cash surplus being captured by the customers due to larger interest expense. I investigate whether the interest expenses could be the alternative reason of lower cash holdings by the suppliers. Specifically, I examine whether the suppliers have higher cash and interest expenses sensitivity after the merger. In column (2) of Table 2.11, I find that the coefficient on the interaction term between After and ΔCash is insignificant, ruling out larger interest expenses as a reason for the lower cash holdings by suppliers after the merger.

Finally, Bhattacharyya and Nain (2011) show that the suppliers are likely to engage in a consolidation following their customer mergers and acquisitions. Andrade et al. (2001) investigate the takeover transactions from 1973 to 1998. They find that more than 35% of the takeover deals are entirely cash financed. Therefore, the reduced cash holdings and improved bargaining power could possibly be due to the supplier's cash financed consolidation activities. To mitigate the effect of supplier's horizontal merger, I remove the suppliers who consolidate following their customer mergers from the initial sample and reexamine the cash holdings change and bargaining powers of suppliers in the remaining sample. Table 2.12 reports the results of regression analysis on the remaining sample. In column (1), the coefficient on the indicator variable After is significantly negative at 99% confidence level, indicating that the nonconsolidated suppliers reduce their cash holdings in response to the customer horizontal mergers. In column (2), I examine the effect of cash holdings reduction on the post-merger cash flow margin for nonconsolidated suppliers. The results are consistent with my hypothesis that cash holdings work an effective internal mechanism that the nonconsolidated suppliers use to improve their bargaining positions against the merged customers.

2.6 CONCLUSION

Building on the prior studies documenting that horizontal merger increases the buying power of merged customers, this paper investigates how the suppliers react to balance their bargaining positions. I find evidence that the suppliers strategically reduce their cash holdings to improve their bargaining power against the merged customers. My study adds to the literature by empirically examining a reason for the temporary merger effect on suppliers. Fee and Thomas (2004) find that the horizontal merger effect on suppliers is strongest in the first year but becomes trivial after that. I show that the temporary merger effect on suppliers could be due to the improved bargaining power of suppliers through adopting a policy of less cash holdings. Given that the horizontal merger results in less cash holdings by suppliers, I find that this effect is more pronounced when the supplier is sale reliant on the merging customers and less pronounced when the supplier is in a concentrated industry.

I use cash flow-to-sales as a proxy for the supplier's bargaining power. Consistent with my prediction that lower cash holdings improve bargaining positions, I find that the cash reducing suppliers experience higher cash flow margin compared to suppliers having an increase in cash holdings after the merger. I also investigate the actions suppliers take to credibly hide their liquidity from the merged customers. Specifically, I show that the suppliers tend to use cash reserves to finance their R&D expenditures after the merger.

Finally, I conduct several robustness tests for my findings. By implementing a propensity score matching procedure, I show that the results are not driven by the endogeneity issue or sample selection bias. Additionally, I rule out the alternative explanations that a significant decrease in the supplier's cash holdings is caused by a potential increase in the capital expenditures, larger interest expenses, or cash financed supplier consolidations. Lastly, while I

find some evidence that the suppliers may use the cash to finance their operations in the presence of larger post-merger sale, the results for the suppliers with negative abnormal returns around the merger announcement date are mainly consistent with the bargaining power hypothesis of cash holdings.

Table 2.1: Sample Distribution of Customer Horizontal Mergers and Acquisitions

The sample consists of 1,512 completed horizontal mergers and acquisitions in the Securities Data Company (SDC) platinum from 2003 to 2018. The merger and acquisition is considered as horizontal if acquiring firm and target firm share the same four-digit SIC code. The table reports the sample distribution of horizontal mergers and acquisitions by year the industry classification.

Year	Agriculture, Forestry and Fishing	Mining and Construction	Manufacturing	Transportation and Communications	Wholesale and Retail Trade	Finance, Insurance and Real Estate	Service	Total
2003	0	2	17	8	9	3	14	53
2004	1	4	27	9	6	7	18	72
2005	0	13	26	15	14	10	26	104
2006	0	16	29	17	17	6	27	112
2007	1	10	24	11	11	5	27	89
2008	0	6	32	6	7	9	29	89
2009	0	3	33	11	5	4	18	74
2010	1	12	20	12	4	0	19	68
2011	1	6	35	11	9	4	19	85
2012	0	9	33	12	11	4	26	95
2013	1	13	34	16	8	1	23	96
2014	0	9	53	26	14	4	30	136
2015	1	9	47	19	11	4	22	113
2016	0	23	43	16	5	5	29	121
2017	0	9	41	13	10	3	18	94
2018	0	14	37	14	9	4	33	111
Total	6	158	531	216	150	73	378	1,512

Table 2.2: Descriptive Statistics of Suppliers

This table reports the firm characteristics of suppliers whose customers are engaged in a horizontal merger and acquisition from 2003 to 2018. Panel A presents the summary statistics for suppliers. Cash is the ratio of cash and marketable securities to total assets minus cash and marketable securities. Size is the natural logarithm of total assets. MTB is the market-to-book ratio, measured as the book value of assets minus book value of equity plus market value of equity scaled by total assets. Lev is the short-term debt plus long-term debt divided by total assets. CAPX is the capital expenditure scaled by total assets. R&D is the R&D expense divided by total assets. CF is the operating cash flows, measured as the ratio of operating income before depreciation minus interest, tax, and dividend to total assets. DIV is an indicator variable set equal to one if the firm pays a common dividend, and zero otherwise. ACQ is the acquisition expenditure divided by total assets. NWC is the net working capital minus cash and marketable securities divided by total assets. Panel B presents the Pearson correlation coefficients among the firm characteristics. All the variables are winsorized at 1% and 99%.

Panel A: Summary Statistics

	N	Mean	Std. Dev.	Q1	Median	Q3
Cash	27,535	0.62	1.43	0.05	0.17	0.53
Size	27,535	7.03	2.40	5.31	6.83	8.67
MTB	27,535	2.22	1.57	1.28	1.71	2.50
Lev	27,535	0.23	0.21	0.03	0.20	0.34
CAPX	27,535	0.04	0.05	0.01	0.03	0.05
R&D	27,535	0.07	0.12	0.00	0.02	0.10
CF	27,535	0.02	0.19	0.01	0.07	0.11
DIV	27,535	0.36	0.48	0.00	0.00	1.00
ACQ	27,535	0.03	0.07	0.00	0.00	0.00
NWC	27,535	0.02	0.15	-0.51	-0.05	0.01

Panel B: Correlation Matrix

Cash	1.00									
Size	-0.28	1.00								
MTB	0.31	-0.17	1.00							
Lev	-0.14	0.21	-0.08	1.00						
CAPX	-0.17	0.13	-0.07	0.11	1.00					
R&D	0.49	-0.36	0.43	-0.09	-0.17	1.00				
CF	-0.43	0.43	-0.25	-0.08	0.13	-0.62	1.00			
DIV	-0.20	0.53	-0.14	0.06	0.06	-0.28	0.21	1.00		
ACQ	-0.13	0.05	-0.06	0.07	-0.11	-0.11	0.10	0.00	1.00	
NWC	-0.24	0.00	-0.30	-0.15	-0.03	-0.34	0.36	0.09	0.05	1.00

Table 2.3: Univariate Test of Supplier's Cash Holdings Change

This table reports the univariate test result of supplier's cash holdings change in response to the customer mergers and acquisitions. Panel A presents the mean and median cash holdings of retained suppliers around the year (Year 0) when the customers make the merger and acquisition announcement. Panel B presents the mean and median cash holdings of terminated suppliers around the year (Year 0) when the customers make the merger and acquisition announcement. The mean (median) difference of cash holdings between pre-merger and post-merger period is examined based on t-test (Wilcoxon rank sum test).

Panel A: Retained Suppliers

Year	-2	-1	0	1	2
Mean	0.635	0.638	0.618	0.595	0.606
Median	0.178	0.176	0.175	0.172	0.170

	Before (-2 to -1)	After (1 to 2)	Diff (After - Before)	
Mean	0.637	0.600	-0.036*	(-1.88)
Median	0.176	0.171	-0.006*	(-1.92)

Panel B: Terminated Suppliers

Year	-2	-1	0	1	2
Mean	0.656	0.645	0.667	0.646	0.658
Median	0.184	0.190	0.180	0.176	0.172

	Before (-2 to -1)	After (1 to 2)	Diff (After - Before)	
Mean	0.651	0.652	0.001	(0.02)
Median	0.186	0.175	-0.011	(-1.14)

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.4: Multivariate Analysis of Supplier's Cash Holdings Change

This table reports the multivariate test result of supplier's cash holdings change in response to the customer mergers and acquisitions. In all models, the dependent variable is the supplier's cash holdings. After is an indicator variable, which is equal to one in year 1 and 2 after the customer mergers and acquisitions, and zero otherwise. After1 (After2) is an indicator variable, which is equal to one in year 1 (year 2), and zero otherwise. The retained suppliers are identified as those suppliers who maintain the supply relationship with the customers after one year of the merger effective date. The terminated suppliers are those suppliers who had supply relationship with the customers prior to and at the year of the mergers and acquisitions but not after. The firm and year fixed effects are controlled in all regressions. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	Retained		Terminated	
	(1)	(2)	(3)	(4)
After	-0.0259***		-0.0005	
	(-2.81)		(-0.03)	
After1		-0.0252**		-0.0006
		(-2.28)		(-0.03)
After2		-0.0268**		-0.0005
		(-2.24)		(-0.02)
Size	-0.0826***	-0.0826***	-0.1843***	-0.1843***
	(-3.37)	(-3.37)	(-3.58)	(-3.58)
MTB	0.0605***	0.0605***	0.0641***	0.0641***
	(5.79)	(5.79)	(3.79)	(3.79)
Lev	-0.4714***	-0.4713***	-0.6977***	-0.6977***
	(-6.20)	(-6.20)	(-5.18)	(-5.18)
CAPX	-2.6083***	-2.6083***	-2.9208***	-2.9208***
	(-14.38)	(-14.38)	(-8.94)	(-8.94)
R&D	-2.4658***	-2.4658***	-4.4776***	-4.4776***
	(-8.14)	(-8.14)	(-7.80)	(-7.80)
CF	-0.2319**	-0.2319**	-0.1974	-0.1974
	(-2.20)	(-2.20)	(-1.03)	(-1.03)
DIV	0.1173***	0.1173***	0.0811	0.0811
	(4.37)	(4.37)	(1.24)	(1.24)
ACQ	-1.0085***	-1.0085***	-1.1970***	-1.1970***
	(-20.16)	(-20.16)	(-9.76)	(-9.76)
NWC	-1.0118***	-1.0117***	-0.8116***	-0.8116***
	(-8.85)	(-8.85)	(-4.47)	(-4.47)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	27,535	27,535	11,373	11,373
Adj. R^2	0.77	0.77	0.73	0.73

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.5: The effect of Sale Reliance on Supplier's Cash Holdings Change

This table examines the effect of sale reliance on the supplier's cash holdings change in response to the customer mergers and acquisitions. The dependent variable is the supplier's cash holdings. After is an indicator variable, which is equal to one in year 1 and 2 after the customer mergers and acquisitions, and zero otherwise. Major Customer is an indicator variable that is set equal to one if more than 10% of the supplier's total sales are from the merging customers, and zero otherwise. The firm and year fixed effects are controlled in all regressions. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	(1)
After	-0.0193**
	(-2.07)
Major Customer	0.0420
	(1.49)
After × Major Customer	-0.0605*
	(-1.75)
Size	-0.0821***
	(-3.35)
MTB	0.0603***
	(5.78)
Lev	-0.4686***
	(-6.17)
CAPX	-2.6116***
	(-14.40)
R&D	-2.4639***
	(-8.13)
CF	-0.2318**
	(-2.20)
DIV	0.1165***
	(4.34)
ACQ	-1.0083***
	(-20.16)
NWC	-1.0118***
	(-8.85)
Firm Fixed Effect	Yes
Year Fixed Effect	Yes
# of Obs.	27,535
Adj. R^2	0.77

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.6: The effect of Industry Competition on Supplier's Cash Holdings Change

This table examines the effect of supplier's industry competition on their cash holdings change in response to the customer mergers and acquisitions. In all models, the dependent variable is the supplier's cash holdings. After is an indicator variable, which is equal to one in year 1 and 2 after the customer's mergers and acquisitions, and zero otherwise. Concentrated Industry is an indicator variable that is equal to one if the supplier's industry Herfindahl index is above the sample median in a given firm year, and zero otherwise. Market Leader is an indicator variable that is equal to one if the supplier's market share within the industry is above the sample median in a given firm year, and zero otherwise. The industry is classified based on 4-digit SIC code. The firm and year fixed effects are controlled in all regressions. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	(1)	(2)
After	-0.0415***	-0.0762***
	(-2.68)	(-4.38)
Concentrated Industry	0.0075	
	(0.42)	
After × Concentrated Industry	0.0335**	
	(1.99)	
Market Leader		-0.1919***
		(-6.02)
After × Market Leader		0.0993***
		(5.62)
Size	-0.0823***	-0.0685***
	(-3.36)	(-2.85)
MTB	0.0604***	0.0602***
	(5.78)	(5.77)
Lev	-0.4693***	-0.4650***
	(-6.17)	(-6.12)
CAPX	-2.6166***	-2.6208***
	(-14.43)	(-14.48)
R&D	-2.4686***	-2.4328***
	(-8.14)	(-8.04)
CF	-0.2330**	-0.2339**
	(-2.21)	(-2.22)
DIV	0.1170***	0.1093***
	(4.36)	(4.04)
ACQ	-1.0139***	-1.0291***
	(-20.20)	(-20.51)
NWC	-1.0094***	-0.9993***
	(-8.82)	(-8.74)
Firm Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
# of Obs.	27535	27535
Adj. R^2	0.77	0.77

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.7: The Effect of Supplier's Cash Holdings Reduction on Cash Flow Margin

This table examines the effect of supplier's cash holdings reduction on their bargaining power against customers in the post-merger period. The bargaining power is measured as the cash flows to sales. After is an indicator variable set equal to one in years after the customer's horizontal merger, and zero otherwise. Negative ΔCash is an indicator variable, which is equal to one if the supplier's cash holdings at Year 1 after the merger is less than that at Year -1 before the merger, and zero otherwise. All other variables are defined in table II. The year and industry fixed effects are controlled in all regressions. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	(1)
	CF to Sales
After	-0.0252*
	(-1.93)
Negative ΔCash	-0.0228**
	(-2.15)
After × Negative ΔCash	0.0638***
	(3.66)
Size	0.0676***
	(28.10)
MTB	-0.0085
	(-1.37)
Lev	-0.2344***
	(-6.20)
CAPX	0.6509***
	(5.30)
R&D	-3.0683***
	(-27.60)
DIV	-0.0663***
	(-8.41)
ACQ	0.4230***
	(11.52)
Year Fixed Effect	Yes
Industry Fixed Effect	Yes
# of Obs.	23,924
Adj. R^2	0.34

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.8: Supplier's Cash-R&D Sensitivity after the Merger

This table investigates the supplier's cash-R&D sensitivity in response to the customer horizontal mergers. The dependent variable is the supplier's R&D expenditures scaled by total assets. After is an indicator variable, which is equal to one in year 1 and 2 after the customer's mergers and acquisitions, and zero otherwise. ΔCash is the annual cash holdings change divided by total assets. CF is the ratio of operating cash flows to total assets. Net Financing is measured as the net equity issuance plus net debt issuance divided by total assets. ΔAP is the change in account payables scaled by total assets. ΔRecv is the change in account receivables scaled by total assets. Size is the natural logarithm of total assets. MTB is the market-to-book ratio. The firm and year fixed effects are controlled in all regressions. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	(1)
	R&D
After	0.0004
	(0.67)
ΔCash	-0.0242***
	(-15.30)
After × ΔCash	-0.0067**
	(-2.33)
CF	-0.1299***
	(-17.79)
NF	-0.0059
	(-1.35)
ΔAP	0.0031
	(0.18)
ΔRecv	-0.0302***
	(-2.72)
Size	-0.0213***
	(-18.24)
MTB	0.0055***
	(8.68)
Firm Fixed Effect	Yes
Year Fixed Effect	Yes
# of Obs.	26,699
Adj. R^2	0.90

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.9: Matched Sample Analysis of Supplier's Post-Merger Cash Holdings

This table compares the supplier's post-merger cash holdings with that of a matched firm. Using propensity score matching approach, each supplier in our sample is matched to a control firm in the Compustat who doesn't experience a customer merger and acquisition. The variables used in the matching procedures include pre-merger cash holdings, firm size, market-to-book ratio, leverage, capital expenditures, R&D expenses, operating cash flows, dividend payment, acquisitions, net working capital, industry (two-digit SIC code) and year. In Panel A, we test the difference in cash holdings between suppliers and control firms in the post-merger period. Cash1 (Cash2) is defined as the cash holdings one year (two years) after the merger and acquisition. Panel B reports the results of multivariate regressions on a combined sample of suppliers and control firms. In all panels, t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

Panel A: Propensity Score Matching

	Treated (Obs.=4,338)	Controls (Obs.=4,338)	Mean Diff	t-statistic
Post-Merger Period				
Cash1	0.665	0.758	-0.093*	(-1.87)
Cash2	0.658	0.704	-0.046	(-0.98)
Pre-Merger Period				
Propensity Score	0.264	0.264	0.000	(0.04)
Cash	0.758	0.728	0.030	(0.58)
Size	7.021	6.952	0.069	(1.34)
MTB	2.257	2.190	0.067	(1.62)
Lev	0.218	0.214	0.004	(0.82)
CAPX	0.045	0.045	0.001	(0.47)
R&D	0.071	0.070	0.001	(0.38)
CF	0.021	0.014	0.007	(1.36)
DIV	0.358	0.353	0.005	(0.49)
ACQ	0.032	0.031	0.001	(0.49)
NWC	0.025	0.024	0.001	(0.20)

Panel B: Multivariate Analysis

	Cash1	Cash2
After	0.0115	-0.0496
	(0.24)	(-1.07)
Treated	0.0389	0.0418
	(0.84)	(0.90)
After × Treated	-0.1235**	-0.0331
	(-1.96)	(-0.53)
Controls	Yes	Yes
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
# of Obs.	17,352	17,352
Adj. R^2	0.23	0.21

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.10: Bargaining Power or Increased Purchase Demand

This table investigates whether the reduced cash holdings by suppliers are driven by the bargaining power hypothesis or the increased demand for the supplier input. Panel A reports the results of supplier's cash holdings change in response to the customer mergers and acquisitions for a subsample of suppliers experiencing negative abnormal returns around the merger announcement date. Panel B reports the results of supplier's cash holdings change in response to the customer mergers and acquisitions for a subsample of suppliers experiencing positive abnormal returns around the merger announcement date. The abnormal returns are calculated based on the market model estimated from -250 to -11 trading days prior to the merger announcement date. The CRSP value-weighted return is used as a proxy for the market return.

	CARs (-1,1) < 0		CARs (-1,1) > 0	
	(1)	(2)	(3)	(4)
After	-0.0345***		-0.0361***	
	(-2.92)		(-2.74)	
After1		-0.0315**		-0.0334**
		(-2.24)		(-2.08)
After2		-0.0383**		-0.0395**
		(-2.43)		(-2.32)
Size	-0.0592*	-0.0593*	-0.1165***	-0.1165***
	(-1.76)	(-1.76)	(-2.75)	(-2.75)
MTB	0.0477***	0.0477***	0.0641***	0.0641***
	(3.42)	(3.42)	(3.72)	(3.72)
Lev	-0.6184***	-0.6181***	-0.2380**	-0.2375**
	(-5.34)	(-5.33)	(-2.01)	(-2.01)
CAPX	-2.8354***	-2.8350***	-2.5428***	-2.5432***
	(-10.12)	(-10.12)	(-9.25)	(-9.25)
R&D	-2.9724***	-2.9726***	-1.9115***	-1.9111***
	(-6.26)	(-6.26)	(-4.19)	(-4.19)
CF	-0.4701***	-0.4699***	-0.2086	-0.2085
	(-2.81)	(-2.81)	(-1.29)	(-1.29)
DIV	0.0912**	0.0913**	0.1713***	0.1713***
	(2.44)	(2.44)	(3.63)	(3.63)
ACQ	-0.8964***	-0.8961***	-1.0308***	-1.0308***
	(-12.89)	(-12.89)	(-13.52)	(-13.52)
NWC	-1.1944***	-1.1946***	-0.8951***	-0.8951***
	(-7.72)	(-7.72)	(-4.98)	(-4.98)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
# of Obs.	13,207	13,207	11,825	11,825
Adj. R^2	0.78	0.78	0.78	0.78

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.11: Robust Tests of Alternative Explanations

This table examines the alternative explanations for the reduced cash holdings by suppliers in the post-merger period. In column (1), the dependent variable is supplier's capital expenditures scaled by total assets. In Column (2), the dependent variable is supplier's interest expenses divided by total assets. The independent variables used in the regressions include After, annual cash holdings change (ΔCash), operating cash flows (CF), net external financing (NF), change in account payables (ΔAP), change in account receivables (ΔRecv), Size and market-to-book ratio (MTB). The firm and year fixed effects are controlled in all regressions. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	(1)	(2)
	CAPX	INT
After	0.0001	0.0001
	(0.36)	(0.88)
ΔCash	-0.0056***	0.0003
	(-13.36)	(0.81)
After × ΔCash	-0.0005	-0.0004
	(-0.78)	(-0.67)
CF	0.0115***	-0.0341***
	(4.81)	(-16.36)
NF	0.0208***	-0.0135***
	(9.32)	(-8.99)
ΔAP	0.0322***	-0.0238***
	(3.56)	(-4.13)
ΔRecv	-0.0145***	-0.0090**
	(-2.96)	(-2.51)
Size	0.0001	-0.0021***
	(0.21)	(-6.01)
MTB	0.0025***	0.0002
	(11.30)	(1.08)
Firm Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
# of Obs.	26,699	26,699
Adj. R^2	0.76	0.73

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

Table 2.12: Removing Consolidated Suppliers

In this table, we remove the suppliers who consolidate following their customer's merger from the initial sample. Column (1) reexamines the supplier's cash holdings change in response to the customer' horizontal mergers after taking out the consolidated suppliers. Column (2) investigates the effect of supplier's cash holdings reduction on their bargaining power against the merged customers after removing the consolidated suppliers. All the variables are defined in previous tables. The t-statistics are reported in the parentheses adjusting for the presence of Heteroskedasticity of standard errors.

	(1)	(2)
	Cash	CF to Sales
After	-0.0286***	-0.0216
	(-2.64)	(-1.45)
Negative ΔCash		-0.0342***
		(-2.76)
After × Negative ΔCash		0.0685***
		(3.37)
Size	-0.0597**	0.0658***
	(-2.36)	(23.64)
MTB	0.0591***	-0.0072
	(4.97)	(-1.01)
Lev	-0.4974***	-0.1941***
	(-5.68)	(-4.47)
CAPX	-2.9231***	0.8665***
	(-13.96)	(6.14)
RD	-2.5036***	-3.1813***
	(-7.34)	(-26.01)
CF	-0.1359	
	(-1.15)	
DIV	0.1473***	-0.0669***
	(5.70)	(-7.55)
ACQ	-0.9483***	0.4191***
	(-17.69)	(10.00)
NWC	-1.1205***	
	(-8.42)	
Firm Fixed Effect	Yes	No
Year Fixed Effect	Yes	Yes
Industry Fixed Effect	No	Yes
# of Obs.	24,447	21,130
Adj. R^2	0.77	0.34

* indicates p-value<0.10; ** indicates p-value<0.05; *** indicates p-value<0.01

References

Acharya, V., Davydenko, S.A., Strebulaev, I.A., 2012. Cash holdings and credit risk. Review of Financial Studies 25, 3572-3609.

Alldredge, D.M., Cicero, D.C., 2015. Attentive insider trading. Journal of Financial Economics 115, 84-101.

Altman, E.I., 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. Journal of Finance 23, 589-609.

Anderson, T.W., Hsiao, C., 1982. Formulation and estimation of dynamic models using panel data. Journal of Econometrics 18, 47-82.

Andrade, G., Mitchell, M., Stafford, E., 2001. New evidence and perspectives on mergers. Journal of Economic Perspectives 15, 103-120.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The Review of Economic Studies 58, 277-297.

Armstrong, C.S., Core, J.E., Taylor, D.J., Verrecchia, R.E., 2011. When does information asymmetry affect the cost of capital? Journal of Accounting Research 49, 1-40.

Bates, T.W., Kahle, K.M., Stulz, R.M., 2009. Why do U.S. firms hold so much more cash than they used to? The Journal of Finance 64, 1985-2021.

Barth, M.E., Konchitchki, Y., Landsman, W.R., 2013. Cost of capital and earnings transparency. Journal of Accounting and Economics 55, 206-224.

Bhattacharyya, S., Nain, A., 2011. Horizontal acquisitions and buying power: a product market analysis. Journal of Financial Economics 99, 97-115.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87, 115-143.

Brown, D.T., Fee, C.E., Thomas, S.E., 2009. Financial leverage and bargaining power with suppliers: evidence from leveraged buyouts. Journal of Corporate Finance 15, 196-211.

Brown, J.R., Petersen, B.C., 2011. Cash holdings and R&D smoothing. Journal of Corporate Finance 17, 694-709.

Bronars, S.G., Deere, D.R., 1991. The threat of unionization, the use of debt, and the preservation of shareholder wealth. The Quarterly Journal of Economics 106, 231-254.

Bronars, S.G., Deere, D.R., 1993. Unionization, Incomplete Contracting, and Capital Investment. The Journal of Business 66, 117-132.

Chen, I.J., Chen, Y.S., Chen, S.S., 2018. The strategic choice of payment method in corporate acquisitions: the role of collective bargaining against unionized workers. Journal of Banking & Finance 88, 408-422.

Chen, K., Chen, Z., Wei, K., 2009. Legal protection, of investors, corporate governance, and the cost of equity capital. Journal of Corporate Finance 15, 273-289.

Chen, S., Chen, Y., Wang, Y., 2015. Does labor power affect the likelihood of a share repurchase. Financial Management 44, 623-653.

Chen, Y.S., Chen, I.J., 2013. The impact of labor unions on investment-cash flow sensitivity. Journal of Banking & Finance 37, 2408-2418.

Chen, Z., Dhaliwal, D.S., Xie, H., 2010. Regulation fair disclosure and the cost of equity capital. Review of Accounting Studies 15, 106-144.

Chino, A., 2016. Do labor unions affect firm payout policy? Operating leverage and rent extraction effects. Journal of Corporate Finance 41, 156-178.

Chod, J., Lyandres, E., Yang, A., 2019. Trade credit and supplier competition. Journal of Financial Economics 131, 484-505.

Chu, Y., 2012. Optimal capital structure, bargaining, and the supplier market structure. Journal of Financial Economics 106, 411-426.

Claus, J., Thomas, J., 2001. Equity premia as low as three percent? Evidence from analysts' earnings forecasts for domestic and international stock markets. Journal of Finance 56, 1629-1666.

Cohen, L., Frazzini, A., 2008. Economic links and predictable returns. Journal of Finance 63, 1977-2011.

Costello, A.M, 2013. Mitigating incentive conflicts in inter-firm relationships: Evidence from long-term supply contracts. Journal of Accounting and Economics 56, 19-39.

Costello, A.M., 2019. The value of collateral in trade finance. Journal of Financial Economics 134, 70-90.

Easley, D., O'hara, M., 2004. Information and the cost of capital. Journal of Finance 59, 1553-1583.

Easton, P.D., 2004. PE ratios, PEG ratios, and estimating the implied expected rate of return on equity capital. The Accounting Review 79, 73-95.

Dhaliwal, D., Heitzman, S., Li, O.Z., 2006. Taxes, leverage, and the cost of equity capital. Journal of Accounting Research 44, 691-723.

Dhaliwal, D., Judd, J.S., Serfling, M., Shaikh, S., 2016. Customer concentration risk and the cost of equity capital. Journal of Accounting and Economics 61, 23-48.

Diamond, D.W., Verrecchia, R.E., 1991. Disclosure, liquidity, and the cost of capital. Journal of Finance 46, 1325-1359.

Dittmar, A., Mahrt-Smith, J., 2007. Corporate governance and the value of cash holdings. Journal of Financial Economics 83, 599-634.

Duarte, J., Han, X., Harford, J., Young, L., 2008. Information asymmetry, information dissemination and the effect of regulation FD on the cost of capital. Journal of Financial Economics 87, 24-44.

Fama, E.F., French, K.R., 1997. Industry costs of equity. Journal of Financial Economics 43, 153-193.

Fee, C.E., Thomas, S., 2004. Sources of gains in horizontal mergers: evidence from customer, supplier, and rival firms. Journal of Financial Economics 74, 423-460.

Francis, J., Nanda, D., Olsson, P., 2008. Voluntary disclosure, earnings quality, and cost of capital 46, 53-99.

Gebhardt, W.R., Lee, C.M.C., Swaminathan, B., 2001. Toward an implied cost of capital. Journal of Accounting Research 39, 135-176.

Ghoul, S.E., Guedhami, O., Kwok, C.C.Y., Mishra, D.R., 2011. Does corporate social responsibility affect the cost of capital? Journal of Banking and Finance 35, 2388-2406.

Gomes, A., Gorton, G., Madureira, L., 2007. SEC regulation fair disclosure, information, and the cost of capital. Journal of Corporate Finance 13, 300-334.

Goss, A., Roberts, G.S., 2011. The impact of corporate social responsibility on the cost of bank loans. Journal of Banking & Finance 35, 1794-1810.

Guney, Y., Karpuz, A., Ozhan, N., 2017. R&D investment and credit lines. Journal of Corporate Finance 46, 261-283.

Hail, L., Leuz, C., 2006. International differences in cost of equity capital: Do legal institutions and securities regulations matter? Journal of Accounting Research 44, 485-531.

Harford, J., 2005. What drives the merger waves? Journal of Financial Economics 77, 529-560.

Harford, J., Mansi, S.A., Maxwell, W.F., 2008. Corporate governance and firm cash holdings in the US. Journal of Financial Economics 87, 535-555.

Hennessy, C.A., Livdan, D., 2009. Debt, bargaining, and credibility in firm-supplier relationships. Journal of Financial Economics 93, 382-399.

Hertzel, M.G., Li, Z., Officer, M.S., Rodgers, K.J., 2008. Inter-firm linkages and the wealth effects of financial distress along the supply chain. Journal of Financial Economics 87, 374-387.

Itzkowitz, J., 2013. Customers and cash: How relationships affect suppliers' cash holdings. Journal of Corporate Finance 19, 159-180.

Jensen, M.C., 1986. Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. The American Economic Review 76, 323-329.

Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305-360.

Kale, J.R., Shahrur, H., 2007. Corporate capital structure and the characteristics of suppliers and customers. Journal of Financial Economics 83, 321-365.

Klasa, S., Maxwell, W.F., Ortiz-Molina, H., 2009. The strategic use of corporate cash holdings in collective bargaining with labor unions. Journal of Financial Economics 92, 421-442.

Lambert, R., Leuz, C., Verrecchia, R.E., 2007. Accounting information, disclosure, and the cost of capital. Journal of Accounting Research 45, 385-420.

Lara, J.M.G., Osma, B.G., Penalva, F., 2011. Conditional conservatism and cost of capital. Review of Accounting Studies 16, 247-271.

Lian, Y., 2017. Financial distress and customer-supplier relationships. Journal of Corporate Finance 43, 397-406.

Mikkelson, W.H., Partch, M.M., 2003. Do persistent large cash reserves hinder performance? The Journal of Financial and Quantitative Analysis 38, 275-294.

Modigliani, F., Miller, M., 1958. The cost of capital, corporation finance, and the theory of investment. American Economic Review 48, 261-297.

Modigliani, F., Miller, M., 1963. Corporate income taxes and the cost of capital: A correlation. American Economic Review 53, 433-443.

Ohlson, J.A., Juettner-Nauroth, B.E., 2005. Expected EPS and EPS Growth as Determinants of Value. Review of Accounting Studies 10, 349-365.

Oikonomou, I., Brooks, C., Pavelin, S., 2014. The effects of corporate social performance on the cost of corporate debt and credit ratings. The Financial Review 49, 49-75.

Oliveira, M., Kadapakkam, P., Beyhaghi, M., 2017. Effect of customer financial distress on supplier capital structure. Journal of Corporate Finance 42, 131-149.

Opler, T., Pinkowitz, L., Stulz, R., Williamson, R., 1999. The determinants and implications of corporate cash holdings. Journal of Financial Economics 52, 3-46.

Pandit, S., Wasley, C.E., Zach, T., 2011. Information externalities along the supply chain: The economic determinants of suppliers' stock price reaction to their customers' earnings announcements. Contemporary Accounting Research 28, 1304-1343.

Patatoukas, P.N., 2012. Customer-base concentration: implications for firm performance and capital markets. The Accounting Review 87, 363-392.

Pinkowitz, L., Stulz, R., Williamson, R., 2006. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. The Journal of Finance 61, 2725-2751.

Scholes, M., and Williams, J., 1977. Estimating betas from non-synchronous data, Journal of Financial Economics 5, 309 – 327.

Shahrur, H., 2005. Industry structure and horizontal takeovers: Analysis of wealth effects on rivals, suppliers, and corporate customers. Journal of Financial Economics 76, 61-98.

Snyder, C.M., 1996. A dynamic theory of countervailing power. The Rand Journal of Economics 27, 747-769.

Sharfman, M.P., Fernando, C.S., 2008. Environmental risk management and the cost of capital. Strategic Management Journal 29, 569-592.

Williamson, O., 1979. Transaction-cost economics: the governance of contractual relations. Journal of Law and Economics 22, 233-261.

Appendix

In the appendix, I describe the models and techniques to estimate the implied cost of equity developed by prior studies. I first declare the common variables used in the following models.

P_t = stock price in June of year t.

B_t = most recent book value of equity before June of year t.

$FEPS_{t+i}$ = analyst's consensus forecasted earnings per share at year t+i.

D_{t-1} = dividend per share at year t-1.

r_f = risk free rate, measured as the yield on 10-years Treasury bond in June of year t.

A.1 Gebhardt et al. (2001)

$$P_t = B_t + \sum_{i=1}^{11} \frac{FROE_{t+i} - r_{GLS}}{(1+r_{GLS})^i} B_{t+i-1} + \frac{FROE_{t+12} - r_{GLS}}{r_{GLS}(1+r_{GLS})^{11}} B_{t+11}$$

$FROE_{t+i}$ is the analyst's forecasted return on equity at year t+i. The forecast horizon is set to be 12 years. I set $FROE_{t+i}$ equal to $FEPS_{t+i}/B_{t+i-1}$ for the first three years. I/B/E/S provides the one-year-ahead ($FEPS_{t+1}$) and two-year-ahead ($FEPS_{t+2}$) analyst's forecasted earnings per share (FEPS) as well as a long-term growth rate (LTG). I use the long-term growth rate to calculate the three-year-ahead earnings forecast ($FEPS_{t+3}$), which is equal to $FEPS_{t+2}(1 + LTG)$. The $FROE_{t+i}$ from 4th year to 12th year are estimated by declining linearly to the industry median ROE. Firms are categorized into 48 industries based Fama and French (1997) classifications. The industry median ROE is a moving median of all firms' ROEs excluding loss firms in the same industry over the past 10 years. I estimate the book value (B_{t+i}) at year t+i as $B_{t+i} = B_{t+i-1} + FEPS_{t+i}(1 - DPR_{t+i})$. DPR_{t+i} is the dividend payout ratio at year t+i. I set DPR_{t+i} equal to the dividend payout ratio at year t-1 (i.e., $DPR_{t+i} = D_{t-1}/EPS_{t-1}$)). If the EPS_{t-1} is negative, I replace the value using a 6% return on asset. The dividend payout ratio (DPR) is winsorized to be between 0 and 1. The implied cost of equity, r_{GLS}, is solved using numerical method.

A.2 Claus and Thomas (2001)

$$P_t = B_t + \sum_{i=1}^{5} \frac{ae_{t+i}}{(1+r_{CT})^i} + \frac{ae_{t+5}(1+g)}{(r_{CT}-g)(1+r_{CT})^5}$$

ae_{t+i} is the abnormal earnings at year t+i, which is defined as $FEPS_{t+i} - r_{CT}B_{t+i-1}$. I measure the abnormal earnings using the analyst's forecasted earnings per share (FEPS). The estimation horizon is set to be five years with terminal value assuming that the abnormal earnings grow at inflation rate thereafter. The inflation rate is set equal to the risk-free rate (r_f) minus 0.03. The book value is calculated as $B_{t+i} = B_{t+i-1} + FEPS_{t+i}(1 - DPR_{t+i})$, assuming the dividend payout ratio (DPR) to be constant at 0.5. The implied cost of equity, r_{CT}, is solved using numerical method.

A.3 Ohlson and Juettner-Nauroth (2005)

$$r_{OJ} = A + \sqrt{A^2 + \frac{FEPS_{t+1}}{P_t}\left(g_2 - (\gamma - 1)\right)}$$

where

$$A = \frac{1}{2}\left(\gamma - 1 + \frac{D_{t+1}}{P_t}\right)$$

g_2 is the average between short term growth rate (STG) and long-term growth rate (LTG). The short-term growth rate is measured as $(FEPS_{t+2} - FEPS_{t+1})/FEPS_{t+1}$. The model requires positive forecasted earnings within two-year forecast horizon. γ-1 is set equal to the risk-free rate (r_f) minus 0.03. The dividend payment D_{t+1} is equal to the amount paid at year t-1.

A.4 Easton (2004)

$$P_t = \frac{FEPS_{t+2} + r_{ES}D_{t+1} - FEPS_{t+1}}{r_{ES}^2}$$

The model requires $FEPS_{t+2} > FEPS_{t+1} > 0$. The dividend payment D_{t+1} is set equal to the amount paid at year t-1. I solve the implied cost of equity, r_{ES}, using numerical method.

Vita

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