경영학석사학위논문

The Effect of Customer Concentration on CEO Risk-Taking Incentives

고객의 집중과 분산이 경영자의 지분보상에 미치는 영향

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이 논문을 경영학석사 학위논문으로 제출함

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Abstract

The Effect of Customer Concentration on CEO Risk-Taking Incentives

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This paper examines the effect of customer base concentration ("CC"), which captures the extent to which sales to major customers account for a supplier's total annual revenue, on the supplying firm's CEO risk-taking equity incentives. Existing literature on managerial incentives predominantly uses total annual revenue as a proxy for firm size or managerial decision difficulty without examining from whom the revenue is earned. My paper decomposes total annual revenue into revenue from major customers and revenue from the rest based on the CC concept posited by Patatoukas (2012). As prior literature shows risk from high CC to be idiosyncratic and modern risk-based asset pricing theories posit that idiosyncratic return volatility is not priced amongst the risk-neutral investors, CC risk is diversifiable at the shareholder level – hence, only the performance-related net-benefits (e.g. Patatoukas, 2012) of engaging in contractual relationships with a few major customers should determine the desirability of high CC for the risk-neutral investors. However, in the midst of deficient accommodation, a risk-averse, undiversified manager may exhibit risk-aversion towards the state of high CC. Thus, I expect the BOD to recognize this potential agency problem and provide more risk-taking incentives for a CEO who manages a highly concentrated customer base. Upon empirical investigation, I document that CC exerts a positive influence over the supplier's CEO vega incentives, whereby the CEO is compensated for assuming additional CC risk as her equity wealth becomes an increasing function of the firm's stock return volatility. Furthermore, I show that less risk-taking incentives are expected when the degree of product substitution difficulty is high or the supplier's trade credit levels are low, illustrating that the predictability of CC over CEO equity incentives varies with the settings in which the suppliers and customers interact.

Keywords: *Managerial incentives, supply-chain, agency theory, risk-taking*

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1. INTRODUCTION

Equity incentives link CEO wealth to that of the investors (Jensen and Murphy, 1990; Hall and Liebman, 1998), and shareholders use these incentives as a partial remedy to reduce agency problems and lower monitoring costs via improved interest alignment between themselves and the CEO (Core and Guay, 1999). While a large body of literature examines the firm characteristics that predict the optimal level of CEO equity incentive pay, these studies tend to leave out considerations of major customers as possible determinants of the supplying firm's CEO equity incentive design. Since major customers have both performance and risk implications over the supplying firm (Ravenscraft, 1983; Kalwani and Narayandas, 1995; Piercy and Lane, 2006; Patatoukas, 2012; Dhaliwal et al., 2016; Campello and Gao, 2017), it is rational to assume that such downstream players of the vertical supply channel can cause cross-sectional variation across the supplying firms' CEO compensation package constructs. However, whether customer base concentration ("CC"), which measures the extent to which major customers account for a supplier's total annual revenue, is considered by the Board of Directors ("BOD") in setting CEO equity incentive levels has rarely been looked at (e.g. Albuquerque et al., 2014). That is, prior literature does not discriminatively examine how the risks inherent in a business model that largely relies on purchases from major customers (as opposed to one that attributes most of its sales from a diversified client pool of several non-major buyers) affect CEO equity incentive design. Hence, this paper inspects the effect of CC on CEO equity incentives.

Prior literature defines CC as the extent to which revenue from major customers make up a supplier's total annual sales (Patatoukas, 2012).[1] For example, a business model that relies on purchases from a few major customers is said to have high CC, whereas one that attributes most of its sales to a diversified client pool of several *minor* customers is said to have low CC. Existing literature shows that while working with major customers brings net positive benefits to the supplier's performance (Kalwani and Narayandas, 1995; Cen et al., 2011; Patatoukas, 2012), major customer relationships entail additional risk for the supplier (Ravenscraft, 1983; Piercy and Lane, 2006; Gosman and Kohlbeck, 2009) and this risk can be seen as idiosyncratic in its nature (Albuquerque et al., 2014; Dhaliwal et al., 2013). This suggests that CC risk is diversifiable at the shareholder level since modern risk-based asset pricing theories posit that idiosyncratic return volatility is not a risk factor that is priced amongst the risk-neutral investors (e.g., Sharpe, 1964). This also

[1] In accordance with prior literature (e.g. Patatoukas, 2012), major customers are customers that account 10% or more of the supplier's total annual sales.

suggests that shareholders are in the position to prefer the state of high CC, regardless of the associated CC risk, to the extent that higher CC garners better performance.

Yet, according to agency theory, CEOs differ in their attitudes towards risk compared to the shareholders – economic and financial literature assume that while shareholders hold relatively diversified portfolios in which they make bets on a larger number of investments and can easily diversify away firm specific idiosyncratic risk, CEOs are typically undiversified with respect to their own firms' performances, so they demonstrate risk-aversion. This may cause them to pass-up risky but positive net present value ("NPV") investments (Smith and Stulz, 1985). Thus, it stands to reason that while having a concentrated customer base that consists of a select group of major customers is desirable from a performance point-of-view (Kalwani and Narayandas, 1995; Cen et al., 2011; Patatoukas, 2012), it sets the stage for a risk-related agency problem to occur between the investors and the CEO. Prior research labels this risk-related agency problem as one of the most significant sources of shareholder value destruction in publicly-traded firms (Jensen and Ruback, 1983). Therefore, it would be in the BOD's best interest to consider how high CC affects the CEO's propensity to display risk-aversion prior to designing the CEO's compensation package. Such precaution may, for example, prevent the CEO from intentionally avoiding high CC or shunning risky but positive NPV investments in the midst of high CC.[2]

To identify the sources of CC risk, I look into prior literature. The extant literature proposes various channels through which risk from high CC can emerge. Namely, the following three lanes can guide a CEO further down the path of risk-aversion: (1) increased volatility of cash flows and earnings caused by greater fluctuations in demand (e.g. Ravenscraft, 1983; Balakrishnan et al., 1996; Gosman and Kohlbeck, 2009; Piercy and Lane, 2006), (2) higher financial distress costs associated with having to make more relationship specific investments ("RSIs") with major customers (e.g. Titman and Wessels, 1988; Banerjee et al., 2008; Wang, 2012), and (3) the simultaneous workings between (1) and (2) (e.g. Dixit and Pindyck, 1994; Schwartz and Trigeorgis, 2004).

In light of these uncertainties, one might suggest that the efficient allocation of risk between the risk-neutral shareholders and the risk-averse CEO should result in the risk-averse CEO receiving a fixed-payment while

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[2] For example, a CEO who lacks a risk-premium for assuming additional structural risk induced by higher CC can make a series of decisions that diffuse the firm's customer base, reducing both the number of major customers with which the firm interacts and the relative importance of each major customer in the firm's total annual revenue. This may negatively affect the firm's performance.

shareholders collect variable-pay (Stiglitz, 1974; Holmström, 1979). In line with this suggestion, Albuquerque et al. (2014) find that suppliers with higher CC face higher idiosyncratic risk and therefore rely less on delta (i.e. pay-to-performance sensitivity) incentives. However, while less delta incentives lower the CEO's risk exposure, it also lowers the degree of interest alignment between the CEO and the shareholders when used in isolation. This may yield a suboptimal outcome since relationships with major customers require additional managerial decisions (e.g. Arora and Alam, 2005) and the performance outcomes of these managerial choices are likely to be sensitive to the manager's interest alignment level. Thus, the provision of less variable-pay alone may result in a sub-optimal solution to the extent that it fails to maximize the CEO's effort towards major customers – hence, the classical tradeoff between efficient risk sharing and incentive pay.

Connecting all the aforementioned findings into one, I expect the BOD to provide more risk-taking incentives for a CEO who manages a highly concentrated customer base – specifically, I predict CEOs of high CC firms to have more vega incentives.[3] To test my hypothesis, I follow existing literature

[3] This prediction is predicated on the assumptions that competent CEOs require premiums for assuming additional idiosyncratic risk, especially in a competitive labor market. Nevertheless, even if certain components of higher CC risk were systematic, the systematic component of firm risk can be filtered out to provide more efficient contracting between the CEO and the investors as argued by Hölmstrom (1982) while the CEO may self-adjust her exposure to

and capture the CEO's risk-taking equity incentives through vega (Guay, 1999; Core and Guay, 2002; Coles et al., 2006). Vega is the pay-to-volatility sensitivity measure that captures the change in the dollar value of the executive's equity wealth for a one percentage point change in the annualized standard deviation of stock returns. As firm risk increases in CC and higher vega makes the CEO's equity wealth (i.e. pay) an increasing function of the firm's risk (i.e. volatility), I expect more vega incentives to (A) compensate the CEO for both current and future earnings volatility from high CC,[4] (B) exert downward pressure on the CEO's possible propensity to diffuse the firm's customer base, and (C) motivate the CEO to make all risky, positive NPV investments despite the inherent structural risk within the business model. That is, more vega incentives provide the CEO with a risk-premium for assuming additional structural risk, prevent the CEO from exerting less effort-choice on projects concerning major customers, and discourage the CEO from being guided by risk-aversion when evaluating the ex-ante risk-return tradeoffs of various investments in the midst of high CC-related risk. Altogether, vega incentives help the benefits of high CC (Kalwani and

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systematic risk (Jin, 2002).

[4] The magnitude of CC has predictive power over future firm volatility (Albuquerque et al., 2014).

Narayandas, 1995; Cen et al., 2011; Patatoukas, 2012) to eventually accrue to the shareholders.

Testing my hypothesis on a large sample of U.S. firms between 2006 to 2014, I document that CC exerts a positive influence on the year-ahead CEO vega incentives. Furthermore, drawing from previous studies that view CC as a multidimensional concept, I document that facets such as the degree of product substitutability as well as the supplier's trade credit levels interact with CC to jointly affect the CEO vega incentives. These dimensions indeed either strengthen (e.g. the supplier's trade credits) or weaken (e.g. product substitution difficulty) the effect of CC on CEO vega incentives.[5] To alleviate the possibility of endogeneity, I also approach my data with an instrumental variable ("IV") method and perform a propensity score matched ("PSM") sample analysis. Again, I find evidence in support of my prediction.

My findings make several contributions to the literature on managerial incentives. First, my paper is among the few to provide large-sample evidence on the association between CEO equity incentives and CC. Existing literature in the area of managerial incentives predominantly uses total annual revenue as a proxy for firm size or the level of resources that can be affected by

[5] For example, when a supplier's trade credit levels and CC are both high, the CEO vega levels are also greater.

managerial decisions (e.g. Demsetz and Lehn, 1985; Smith and Watts, 1992) *without* examining from *whom* the revenue is earned. My paper improves this design by decomposing total annual revenue into purchases from major customers and purchases from the rest based on the CC concept posited by Patatoukas (2012). Through this construct, I document that CC exerts a positive influence over CEO risk-taking incentives.

Second, I borrow from agency theory to extend Albuquerque et al. (2014)'s findings. Albuquerque et al. (2014) document that suppliers with higher CC face higher risk and therefore rely less on delta incentives. However, while less delta incentives lower the CEO's risk exposure, it also weakens the association between CEO wealth to that of the investors. Hence, less delta alone succeeds in efficient risk sharing but may fail in effective interest alignment. Consequently, I expect the BOD to consider vega incentives – vega incentives compensate the CEO for assuming added CC risk by making the CEO's equity wealth an increasing function of the firm's stock price volatility, which increases in CC. This motivates the risk-averse CEO to accept higher CC, allowing the performance-related benefits from high CC to flow to the shareholders (Patatoukas, 2012). Thus, my theory integrates both the risk and return implications of high CC into the CEO's equity incentive design – where greater CC signifies not only greater idiosyncratic risk but also better performance (e.g. Patatoukas, 2012; Irvine et al., 2016; Albuquerque et al., 2014; Dhaliwal et al., 2013), my results show that the BOD rewards a CEO for her accepting greater CC-risk to mitigate agency problems.

Third, my paper adds to the growing stream of literature that focuses on analyzing the settings between a firm and its non-financial stakeholders as factors that shape CEO compensation policies. In consideration of the multidimensional facets of risks triggered by high CC, I show that less risk-taking incentives are predicted when the degree of product substitution difficulty is high or the supplier's trade credit levels are low. By document two settings in which the relationship between the firm and the major customers become more or less risky, I exploit the importance of considering supplier-buyer dynamics before forming expectations between a firm's managerial equity incentives and CC levels.

2. RELATED LITERATURE AND HYPOTHESES DEVELOPMENT

2.1 CC and firm performance

CC exerts various influences over the supplier.[6] When it comes to

[6] For example, the extant literature finds significant associations between a supplier's CC and its R&D (Grinblatt and Titman, 2002; Banerjee et al., 2008), cash (Itzkowitz, 2013), and financial leverage (Banerjee et al., 2008; Kale and Shahrur, 2007).

CC's influence over the supplier's performance, despite some level of mixed evidence and potentially countervailing theories, prior literature generally indicates that the benefits of dealing with a smaller number of major customers dominate the disadvantages (Kalwani and Narayandas, 1995; Patatoukas, 2012; Cen et al., 2013).[7] Notably, Patatoukas (2012) concludes in his large-sample investigation that suppliers with concentrated customer bases improve their operating efficiencies by reducing selling, general and administrative ("SG&A") expenses per dollar of sales even while undergoing reduced operating margins. Patatoukas' (2012) findings correspond with Cowley's (1988) in that both document lower SG&A and higher efficiencies for firms with major customers. Moreover, Irvine et al. (2016) point to benefits that gradually arise from economies of scale with each major customer as the source of operating efficiencies. Hence, doing business with major customers permits operational efficiencies that are not enjoyable by suppliers with diversified customer bases.

A separate stream of literature examines supplier-buyer relationships, such as bilateral affiliations, that develop into long-term partnership as sources

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[7] One countervailing theory is that powerful customers may use their superior positions, compared to that of the suppliers, to take away the value created within the suppliers' industry for their own profits (Porter, 1980).

of competitive advantages that bring various shared benefits to both the supplier and the buyer (Treleven and Schweikhart 1988; Dyer and Singh, 1998; Burke et al., 2007). Collaboration and information sharing are among the sources, whereby prolonged customer relationships help the supplier streamline production and create repeated sales as well as cross-selling opportunities (Kalwani and Narayandas, 1995; Kinney and Wempe, 2002). Indeed, a supplier's focus on a selected number of customers would gradually foster closer working relationships and enable synergies along the existing supply-chain that would otherwise not be enjoyable by a supplier that has a diversified customer base consisting of a several *minor* buyers.

2.2 CC and CEO risk-aversion

Prior literature shows CC risk to be idiosyncratic (Albuquerque et al., 2014; Dhaliwal et al., 2013), and modern risk-based asset pricing theories posit that idiosyncratic return volatility is not a risk factor that is priced amongst the risk-neutral investors (e.g., Sharpe, 1964). Together, these findings project that CC risk is diversifiable at the shareholder level and that the performance-related *pros* of engaging in contractual relationships with a few major customers should determine the desirability of high CC for the risk-neutral investors. However, guided by risk-aversion and in the midst of insufficient accommodation, a risk-averse, undiversified CEO may purposefully diffuse the customer base to hedge against uncertainty or pass-up high risk, positive NPV projects despite their beneficial performance implications (Jensen and Ruback, 1983) when the CC-related structural risk surrounding her firm is high.

To identify the sources of CC risk that may cause such behavior, I look into prior literature. The extant literature proposes various channels through which risk from major customers emerges. Namely, the following three lanes can further magnify the CEO's risk-aversion: (1) increased volatility of cash flows and earnings (e.g. Ravenscraft, 1983; Balakrishnan et al., 1996; Gosman and Kohlbeck, 2009; Piercy and Lane, 2006), (2) higher financial distress risk from greater RSI-related sunk costs (e.g. Titman and Wessels, 1988; Banerjee et al., 2008; Wang, 2012), and (3) the simultaneous workings between (1) and (2) (e.g. Dixit and Pindyck, 1994; Schwartz and Trigeorgis, 2004).

In the following paragraphs, based on the theoretical framework of Figure 1, I present a more detailed explanation on how CC manifests managerial risk-aversion.

(FIGURE 1 Here)

First, despite their efficiencies, relationships with major customers enhance the supplier's demand uncertainty because losing one major customer can lead to a sizable drop in the supplier's cash flows (Ravenscraft, 1983; Balakrishnan et al., 1996; Piercy and Lane, 2006; Hertzel et al., 2008; Dhaliwal et al., 2013). Such large, unexpected shocks to the supplier's earnings-stream positively affect the supplier's stock return volatility because, unlike a supplier with a diversified customer base for which the loss of a single non-major customers would have a minor impact the supplier's operating performance, a supplier with high CC operates under greater demand uncertainty in which losing a major customer could cause a materially adverse effect on the supplier's future profitability.[8] In line with this theory, the announcement that a major customer declares bankruptcy negatively influences the supplier abnormal stock returns (Hertzel et al., 2008; Kolay et al., 2015). Hence, firms that rely on purchases from major customers tend to operate under higher structural risk. Consequently, a risk-averse CEO whose personal wealth is largely tied to the performance of a single investment vehicle (i.e. her firm) may exhibit additional risk-aversion attributable to the

[8] While both are non-controllable, an idiosyncratic cash-flow shock caused by one *minor* customer within a diversified customer base (i.e. low CC) can be offset by another idiosyncratic cash-flow shocks from a different customer. However, the supplier's ability to absorb unpleasant shocks from a major customer decreases in CC. Firms explicitly recognize this risk in their financial statements. Refer to Appendix II for an example.

state of high CC.

Second, major customers often require suppliers to make investments that are relationship specific (i.e. RSI) as commitments for future transactions, where such investments in “dedicated assets” (Joskow, 1988) are prerequisites to building future dealings with major customers. When the amount of trade is vast, however, the product being dealt is often customized and unique, leading to physical asset specificity that renders the investments unserviceable to alternative users (Allen and Phillips, 2000; Grinblatt and Titman, 2002; Banerjee et al., 2008; Wang, 2012; Itzkowitz, 2013). Collectively, while supplier-buyer relationships are inherently riskier for transactions involving unique products, additional CC leads to greater RSIs or firm-specific R&D expense that impairs the chances of asset-redeployment by the supplier when existing supplier-buyer relationships fail. Since investments are costly and sunk cost cannot be recovered, higher CC implies more financial distress risk for the supplying firm (e.g. Kale and Shahrur, 2007; Titman, 1984).[9] It stands to reason that in the midst of higher CC, greater financial distress risk strengthens the CEO’s propensity to discount the expected future values of

[9] High CC is associated with higher cost of equity and debt (Dhaliwal et al., 2016; Campello and Gao, 2017), so even the cost of raising external capital at times of financial distress is likely to be higher with greater CC.

investments by excessively larger proportions when evaluating the ex-ante risk-return tradeoffs. That is to say, the CEOs of high CC firms are more likely to shun high risk, positive NPV investments, some of which may concern *potential* major customers, at the detriment of the shareholders' gain. Again, without incentives that motivate a CEO to accept high structural risk, a CEO may show greater risk-aversion towards profitable growth opportunities.

Third, economics and accounting literature postulates that when the volatility surrounding her environment is greater, a CEO feels she can gain more precise information on whether or not to invest in risky projects by waiting longer, and such postponement introduces a negative relation between investment and volatility (Dixit and Pindyck, 1994; Schwartz and Trigeorgis, 2004).[10] In this case, the volatility enhancing nature of higher CC may reinforce the CEO's tendency to delay positive NPV projects as she finds greater value from exercising what is known as the manager's 'option to wait' (Arif et al., 2016). One of the most significant sources of shareholder value destruction in publicly-traded firms comes from such risk-related agency problem in which a CEO avoids (or postpones) making risky, but profitable investments (Jensen and Ruback, 1983) as she discounts the expected values

[10] Literature in economics and finance calls this the real options theory of investment (e.g. Dixit, 1992).

of investments by larger proportions than warranted by the shareholders. As the magnitude of CC positively affects future firm volatility (Albuquerque et al., 2014), a CEO who operates under higher CC is more likely to prolong her postponement of risky, positive NPV investments at the detriment of shareholders' gain.[11]

2.3 CC and CEO risk-taking incentives

As indicated above, a non-diversified customer base consisting of a select group of major customers is desirable from a performance standpoint (e.g. Patatoukas, 2012), but it sets the stage for a risk-related agency problem to occur between the owners and the CEO (e.g., Sharpe, 1964). Taking into account the aforementioned characteristics of high CC (e.g., Piercy and Lane, 2006; Gosman and Kohlbeck, 2009; Dhaliwal et al., 2013), I expect the BOD to consider the CEO's compensation package construct as an ex-ante, partial remedy.

Theory may suggest that the efficient allocation of risk should result in the CEO's receiving a fixed-payment while the shareholders collect

[11] I stay open to the possibility that the CEO may exercise her 'option to wait' on all new investments, irrespective of whether they are related to major customers or not. Nonetheless, this does not impair my theoretical framework.

variable-pay (Stiglitz, 1974; Holmström, 1979). However, additional managerial decisions are required for managing major customers along the supply-chain as meeting the major customers' goals is a complicated process given the range of requests and conflicting expectations that this stakeholder group can have for a supplier (e.g. Arora and Alam, 2005). To illustrate a case in point, a CEO who receives only fixed-pay might gradually diversify the firm's customer base by exerting less effort towards the demanding major customers.[12] The diffused customer base that results from the accumulation of such opportunistic behaviors shall be preferable for the risk-averse CEO who ends up assuming less risk for the same amount of fixed-pay, but it will deplete the shareholders from the performance-related benefits of higher CC (Patatoukas, 2012), especially when achieving better performance under high CC may require additional responsivity.

To accommodate the CEO in this situation, I predict vega incentives to be an effective solution for the following reasons: first, it would be in the BOD's best interest to provide a CEO with a risk-premium through additional

[12] For example, a CEO may exert less effort in honoring implicit contracts, including unspoken agreements on service quality, between her firm and its major customers. Such behavior may be difficult for the BOD to directly monitor until a relationship is severely broken and the firm's customer base has been diversified.

vega incentives.[13] Vega captures the change in the dollar value of the CEO's equity portfolio wealth for a one percentage point change in the annualized standard deviation of stock returns, where greater vega incentives make a CEO's expected equity wealth an increasing function of "convexity" (Hayes et al., 2012). Given that stock return volatility increases in CC, vega incentives shall compensate the CEO for managing greater structural uncertainty. Second, CEOs with more convexity in their equity incentives would be less likely to take actions to offset CC when impacted by unexpected shocks to the firm's earnings-stream. Prior work shows that in response to an exogenous shock that increases the firm's left-tail risk, CEOs with more vega incentives are less likely to make risk decreasing actions, such as decreasing the firm's leverage or reducing the firm's R&D expenses (Gormley et al., 2013). Thus, CEOs with greater vega incentives will refrain from volatility hedging actions such as customer base diffusion. Third, as prior studies posit that firms with more CEO vega incentives implement riskier policy choices, have more focus in terms of business segments, make more investments in R&D, and operate with higher leverage (Coles et al., 2006), CEOs with more vega incentives are expected to continue to make risky, positive NPV investments in the midst high CC risk.

[13] This prediction is predicated on the assumption that competent CEOs require premiums for assuming idiosyncratic risk, especially in a competitive labor market.

Hence, CEOs will refrain from passing-up high risk, positive NPV projects despite the looming financial distress risk caused by greater RSI-related sunk costs.

Combining these points, I predict more CEO vega incentives to (A) compensate the CEO for both current and future earnings volatility, (B) exert downward pressure on the CEO's propensity to diffuse the firm's customer base, and (C) motivate the CEO to make all high risk but positive NPV investments in the midst of high CC. Formally, my first hypothesis is stated as follows:

***H1**: The degree of CC in a supplier's customer base exerts a positive influence over the supplier's CEO risk-taking incentives.*

2.4 The moderating roles of product substitution difficulty and supplier's trade credits

CC should be viewed as a multidimensional concept, whereby facets such as the degree of product substitutability and the supplier's trade credits interact with CC levels to jointly affect the optimal level of the supplying firm's CEO vega incentives. In the following subsections, I provide additional insight into the association between CEO vega and CC by documenting two additional conditions that moderate the effect of CC on CEO vega incentives.

2.4.1 The moderating role of product substation difficulty

Previous studies posit that losing major customers from product substitution could trigger a sizable drop in the supplier's cash flows (e.g. Hertzel et al., 2008). Logically, selling products that are difficult for the customer to substitute (i.e. high product substitution difficulty) mitigates the supplier's risk from losing a major customer under high CC, which thereby lowers the BOD's need to provide additional vega incentives for the CEO. Thus, more (less) product substitution difficulty implies a lesser (greater) need for managerial vega incentives.

To test this hypothesis, I measure *Product_Substitution_Difficulty* as the supplier's revenue divided by its operating expense, whereby increases in the price-cost margin implies that the supplier is selling a non-generic product that is more difficult to find elsewhere (e.g. Demsetz, 1995; Nevo, 2001; Karuna, 2007). That is, the further away from perfect competition, the further the product is priced in comparison to the supplier's marginal cost, and the more difficult it becomes for customers to fulfill similar needs from switching products. I interact *Product_Substitution_Difficulty* with my measures of CC to test my second hypothesis, which is formally presented as follows:

H2: *Product substation difficulty mitigates the need of high vega incentives to be provided for a CEO who manages a concentrated customer base.*

2.4.2 The moderating role of trade credits

The extant literature postulates that the supplier's exposure to the risk of elongated receivable cycles and delays in customer payments can cause additional uncertainty, especially from liquidity constraints (Murfin and Njoroge, 2014). Not surprisingly, a supplier with more trade credits experiences larger negative abnormal stock returns around the announcement of a customer filing for bankruptcy because the outstanding receivables in relation to the bankrupted customer are rendered uncollectable (Jorion and Zhang, 2009; Kolay et al., 2015).

Since higher CC is likely to lead to the greater concentration of trade credit risk, I expect a supplier with more outstanding invoices relative to its total sales (i.e. more trade credits) to operate under greater uncertainty in relation to high CC, which thereby strengthens the need for more CEO vega incentives. I capture *Trade_Credits* as the ratio between the supplier's accounts receivable and sales. Overall, I expect the effect of CC on CEO vega to be more (less) pronounced when *Trade_Credits* is high (low).[14] Hence, the third hypothesis may be formally stated as follows:

***H3**: Higher trade credit levels strengthens the need of more vega incentives to be provided for a CEO who manages a concentrated customer base.*

3. SAMPLE, MEASURES, AND RESEARCH DESIGN

3.1 Sample

To examine the effect of CC on CEO vega incentives, I compose a sample that includes S&P 1500 firms between 2006 and 2014. Year 2006 is the beginning of my sample period because it corresponds to the year in which firms began accounting for options using the fair-value method as defined in SFAS No. 123(R), for which Hayes et al. (2012) documents that the value of stock options as a proportion of total compensation decreased by about 17 percentage points. Thus, it stands to reason that year 2006 is the start of an accounting policy driven regime change. I exclude financial firms (SIC 6000

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[14] Trade credits may be seen as a financing mechanism that captures supplier-buyer power dynamics. That is, a large body of economics and accounting literature posits that powerful customers exercise their market power to obtain favorable price discrimination or borrowing terms (e.g. Wilner, 2000; Fabbri and Klapper, 2009). Trade credits may also be seen as the supplier's passing along its cheaper access to financing to its buyers, (e.g. Ng et al., 1999). Nevertheless, in either case, the concentration of the non-payment risk is increasing in CC.

to 6999) from this sample.[15] This leaves me with a final sample of 8,296 firm-year observations.

3.2 Data

I start by obtaining CC data from the Compustat Segment Customer database. The Statement of Financial Accounting Standards No.131 (SFAS 131) requires a supplier to disclose the information about its "major customers" that represent "a significant concentration of risk" while defining "major customers" as all customers that represent "10% or more" of a supplier's total annual sales. An abbreviated excerpt of a proxy statement is provided in Appendix II to illustrate the components of an example disclosure. It is this disaggregated revenue disclosures that allows me to conduct a large-sample research from public data. I then obtain firm financial data, executive compensation data, and stock return volatility data from Compustat, Execucomp, and CRSP, respectively.

3.3 Measuring risk-taking incentives

I compute the CEO risk-taking incentive sensitivity measure through

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[15] DeYoung et al. (2010) find that the risk-taking incentives of bank CEOs diverged substantially from those of non-bank CEOs (during the early 2000s).

vega (Guay, 1999; Core and Guay, 2002; Coles et al., 2006), which is the pay-to-volatility sensitivity measure that captures the change in the dollar value of the CEO's equity portfolio wealth for a one percentage point change in the annualized standard deviation of stock returns. To quantify this concept, even when vega incentives dropped low during 2008, a one percent increase in volatility still affected an average CEO's equity wealth by $127,000 (Murphy, 2012), indicating vega's significant influence on an average CEO's equity wealth.

3.4 Measuring CC

I then capture CC by adopting Patatoukas (2012)'s Customer Herfindahl-Hirschman Index ("*Customer_HHI*") measure as my primary independent variable. Patatoukas (2012) captures the concentration level of a supplying firm's customer base by following the specification under SFAS 131, which defines major customers as all customers that represent 10% or more of a supplier's total sales. *Customer_HHI* is calculated by summing the squares of the ratios of firm *i*'s sales to its significant customers *j* in year *t* as follows:

$$Customer\ HHI_{it} \quad = \sum_{j=1}^{J} \left(\frac{Sales_{ijt}}{Sales_{it}}\right)^{\wedge 2} \quad = \sum_{j=1}^{J} \%Sales^{\wedge 2}{}_{ijj} \qquad \textbf{(1)}$$

Here, *Customer_HHI* ranges between 0 and 1, where a value closer to 1 indicates a more concentrated customer base in which a few major customers represent a large portion of the firm's total annual sales.[16] Thus, the *Customer_HHI* variable captures both the number of major customers with which the supplier transacts and the relative prominence of each major customer in the supplier's total annual revenue. In addition, I adopt two additional measures for CC. I choose a measure that captures the percent sales from the major customers, *Major_Customer_Sales_Percentage* (Banerjee et al., 2008). I also adopt a measure that counts the number of major customers, *Major_Customer_Count*. Together, these three specifications are my CC proxies.

3.5 Research design

I use the following empirical model to test H1 and estimate the effect of CC in year *t* on CEO vega in year *t+1*:

[16] For example, selling to five large customers, each responsible an average of 20% of the firm's total revenue, would result in a higher Customer HHI than if the sales were made to five relatively smaller customers, each responsible for an average of 10% of the firm's total revenue along with several non-major customers that are not captured in Patatoukas' (2012) Customer HHI because they do not represent "a significant concentration of risk," under SFAS 131 (i.e. Customer_HHI = 0.20 vs 0.05).

$$
\begin{aligned}
\text{Lead\_Log\_Vega}_{it+1} = \beta_0 &+ \beta_1\text{CC}_{it} \\
&+ \beta_2\text{Annual\_Sales}_{it} + \beta_3\text{Market\_to\_Book}_{it} \\
&+ \beta_4\text{Book\_Leverage}_{it} + \beta_5\text{CAPX}_{it} \\
&+ \beta_6\text{R\&D\_\&\_Advr\_Intensity}_{it} + \beta_7\text{Cash\_Compensation}_{it} \\
&+ \beta_8\text{Return\_Volatility}_{it} + \beta_9\text{Lead\_Log\_Delta}_{it+1} \\
&+ \beta_{10}\text{Industry Fixed Effect}_{it} + \beta_{11}\text{Year Fixed Effect}_{it} \\
&+ \varepsilon_{it+1} \qquad \textbf{(2)}
\end{aligned}
$$

For Eq. (2), the expected sign of β_1 is positive across all three specifications of CC, where (I) *Customer_HHI* is the supplier's sales-based HHI, (II) *Major_Customer_Sales_Percentage* is the fraction of a supplier's total sales to major customers, and (III) *Major_Customer_Count* is a count of the number of major customers. For my control variables, I closely follow Coles et al.'s (2006) empirical design, in which I employ variables that are known to have predictive power on vega: (1) *Annual_Sales* equals the logarithm of the supplier's sales as a proxy for managerial decision difficulty or firm size; (2) *Market_to_Book* is the market value of assets to book value of assets, as a proxy for growth opportunities; (3) *Book_Leverage* is the book value of long-term debt plus book value of debt in current liabilities divided by book value of assets; (4) *CAPX* is capital expenditures scaled by beginning total assets; (5) *R&D_&_Advr_ Intensity* equals the sum of R&D divided by assets and advertising expense divided by assets;[17] (6) *Cash_Compensation* equals total current compensation from Execucomp comprised of salary plus bonus. (7) *Return_Volatility* is the natural logarithm of the standard deviation of monthly stock returns from month *t* to month *t-12*; (8) *Lead_Log_Delta* is the natural logarithm of delta added by one. Finally, in an attempt to control for both time-variant and time-invariant unobservable factors, I include both industry fixed effects (based on Fama-French 48 industry classification) and year fixed effects. I also cluster standard errors by firms. Consistent with prior literature (Guay, 1999; Core and Guay, 1999), I winsorize the independent and dependent variables at the 1st and 99th percentiles. A detailed explanation of all variables is presented in Appendix I.

To test H2, I estimate the joint effect of product substitution difficulty and CC in year *t* on lead CEO vega in year *t+1* according to the following model:

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[17] As in other studies on managerial incentives, I set R&D as well as Advertisement expense to zero when it is missing from Compustat (e.g., Chen et al., 2015).

$$
\begin{aligned}
\text{Lead\_Log\_Vega}_{it+1} = \beta_0 + \beta_1\text{CC}_{it} + \beta_2\text{CC}_{it} \text{ x Product\_Substitution\_Difficulty}_{it} \\
+ \beta_3\text{Product\_Substitution\_Difficulty}_{it} + \beta_4\text{Cash}_{it} \\
+ \beta_5\text{Log\_Sale}_{it} + \beta_6\text{Market\_to\_Book}_{it} \\
+ \beta_7\text{R\&D\_Intensity}_{it} + \beta_8\text{CAPX}_{it} \\
+ \beta_9\text{Book\_Leverage}_{it} + \beta_{10}\text{Cash\_Compensation}_{it} \\
+ \beta_{11}\text{Return\_Volatility}_{it} + \beta_{12}\text{Lead\_Log\_Delta}_{it} \\
+ \beta_{13}\text{Industry Fixed Effect}_{it} \\
+ \beta_{14}\text{Year Fixed Effect}_{it} + \varepsilon_{it+1} \qquad \textbf{(3)}
\end{aligned}
$$

In Eq. (3), the expected sign of β_2 is negative, suggesting that the relationship between CC and CEO risk-taking incentives should be less pronounced when product substitution difficulty for the customer is high (i.e. product substitution risk faced by the supplying firm is low). That is, a negative and significant interaction term between CC and *Product_Substitution_Difficulty* implies that the higher the *Product_Substitution_Difficulty*, the smaller (i.e. more negative) the effect of CC on lead vega (and at the same time, the higher CC, the smaller the effect of *Product_Substitution_Difficulty* on lead vega). Eq. (3) closely follows the design of Eq. (2) while exploiting an additional setting (i.e. product substitution difficulty levels) that I predict to be a source of cross-sectional variation across supplying firms. I measure *Product_ Substitution_Difficulty* as the supplier's revenue divided by its operating expense (e.g. Demsetz, 1995; Nevo, 2001; Karuna, 2007). For control variables, I largely follow Eq. (2), but I augment the design of Eq. (3) by adding *Cash* as an additional control variable because cash levels can function as a safety net for a sudden disappearance of a major customer from the supplier's customer base (e.g. Itzkowitz, 2013; Bae et al., 2015).

In testing H3, I estimate the joint effect of the supplier's trade credit levels and CC in year *t* on lead CEO vega in year *t+1* based on the following model:

$$\begin{aligned} \text{Lead\_Log\_Vega}_{it+1} = {} & \beta_0 + \beta_1 \text{CC}_{it} + \beta_2 \text{CC}_{it} \text{ x Trade\_Credits}_{it} \\ & + \beta_3 \text{Trade\_Credits}_{it} + \beta_4 \text{Cash}_{it} + \beta_5 \text{Log\_Sale}_{it} \\ & + \beta_6 \text{Market\_to\_Book}_{it} + \beta_7 \text{R\&D\_Intensity}_{it} \\ & + \beta_8 \text{CAPX}_{it} + \beta_9 \text{Book\_Leverage}_{it} \\ & + \beta_{10} \text{Cash\_Compensation}_{it} + \beta_{11} \text{Stock\_Volatility}_{it} \\ & + \beta_{12} \text{Lead\_Log\_Delta}_{it} + \beta_{13} \text{Industry Fixed Effect}_{it} \\ & + \beta_{14} \text{Year Fixed Effect}_{it} + \varepsilon_{it+1} \end{aligned} \qquad \textbf{(4)}$$

In Eq. (4), the expected sign of β_2 is positive, predicting that the relationship between CC and CEO vega should be more (less) pronounced when the supplier's trade credits are high (low). Here, *Trade_Credits* is captured by the ratio of the supplier's accounts receivable to the supplier's total sales. This suggests that the riskiness of CC intensifies in supply-chain settings where the supplier extends more trade credits to its buyers. As with Eq. (3), I also add *Cash* as an additional control variable in Eq. (4) because I expect cash levels to function as a safety net for uncollectable outstanding accounts receivables for the supplier (e.g. Itzkowitz, 2013; Bae et al., 2015).

4. DESCRIPTIVE STATISTICS

Table 1 reports descriptive evidence on the CEO's risk-taking incentives, my three measures of CC, and the other determinants of CEO vega incentives for my entire sample. The mean (median) vega incentives for my sample is 133,510 USD (60,030 USD), and is similar to the results of Hayes et al. (2012), which display total vega amounts for a comparable period.[18] Similar to the findings of Albuquerque et al. (2014), the mean (median) of *Major_Customer_Sales_Percentage* equals 0.11 (0), implying that an average firm within my sample generates about 11 percent of its revenue from major customers.[19] In about 28 out of 100 of my observations (i.e. 2,375 firm-year observations out of 8,296 firm-year observations), a supplier discloses having at least one "major customer" that accounts for more than 10 percent of year's total annual revenue (i.e. *Has_Major_Customer* = 1). Finally, *Customer_HHI* has a mean (median) of 0.03 (0), in which the significance of this construct is

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[18] For total vega incentives, Hayes et al. (2012) report a mean (median) of 145,180 USD (59,480 USD) in the post SFAS 123(R) period.

[19] For the same variable, Albuquerque et al. (2014) report a mean (median) of 0.11 (0). In an un-tabulated analysis where I analyze a subsample of suppliers that report having at least one major customer, the mean (median) *Major_Customer_Sales_Percentage* rises from 0.11 (0) to 0.37 (0.32).

that it captures both the number of major customers with which the firm contracts and the relative prominence of each major customer in the firm's total annual revenue. Consistent with the notion that larger firms have more diversified customer bases, however, my choice to examine S&P 1500 firms may have resulted in a downward bias on the CC levels. Another source of downward bias stems from *Customer_HHI* equating all customer purchases below 10% as zero.

(TABLE 1 Here)

Table 2 compares the mean statistics of suppliers with at least one major customer (i.e. *Has_Major_Customer* = 1) with those that do not have any major customers (i.e. *Has_Major_Customer* = 0) at the 1%, 5%, and 10% levels, respectively, based on t-tests. On the one hand, the subsample with at least one major customer has greater *MRI*, *Tobins_Q*, *CAPX*, *R&D_Intensity*, *R&D_&_Advr_Intensity*, *ROA*, *Return_Volatility*, and *Cash*. On the other hand, this subsample has lower *Lead_Log_Vega*, *Annual_Sales*, *Market_Value*, *Log_Delta*, *Cash_Compensation*, and *Trade_Credits*.[20] Since

[20] Several prior findings support the directions of the differences stated in Column 3. Namely, suppliers with greater CC tend to realize operational efficiencies (i.e. higher ROA) (Cen et al., 2011; Kalwani and Narayandas, 1995; Patatoukas, 2012), spend more dollars on RSI's (i.e.

the subsample with at least one major customer has greater means for both *Tobins_Q* and *ROA*, I reason that the firms with at least one major customer are generally not underperforming businesses that are inherently more likely to use high-powered risk-taking incentives such as vega to seek additional growth.

(TABLE 2 Here)

Table 3 provides Spearman Rank (Pearson) correlation coefficients above (below) the diagonal between the variables for the major variables that are included in my main regression. The associations between my three CC specifications are indeed positive and strong. Other correlations are broadly in line with prior work. For example, the positive association between vega incentives and risky investments, such as more *R&D_Intensity*, is in line with the findings of Coles et al. (2006). However, opposite to my first hypothesis, vega incentives are negatively correlated with my CC specifications. One interpretation of this result is that these negative relations are sensitive to the

higher R&D_Intensity) (Grinblatt and Titman, 2002; Banerjee et al., 2008), and hold more cash (i.e. higher Cash) (Itzkowitz, 2013), but they maintain lower financial leverage ratios (i.e. lower Market_Leverage) (Banerjee et al., 2008; Kale and Shahrur, 2007).

set of controls I insert in my empirical models.

(TABLE 3 Here)

5. EMPIRICAL RESULTS

5.1 The effect of CC on CEO vega incentives

Table 4 reports the regression results of Eq. (2), which tests my main hypothesis. Column 3 present the results for the base model without my main CC variables of interest, whereas Column 4 through Column 6 present the full model. As expected, CC has a significant and positive influence over CEO vega incentives across all three indicators of CC under Column 4, Column 5, and Column 6. These results indicate that more CEO vega incentives exist for CEOs who accepts more CC risk.[21] Furthermore, the economic effects of *Major_Customer_Sales_Percentage* and *Customer_HHI* on *Lead_Log_Vega* are approximately 61 percent and 60 percent (respectively) of the magnitude of the effect of *Stock_Volatility*, demonstrating their high influences over CEO

[21] For example, in Column 4, my findings suggests that a one standard deviation increase in *Customer_HHI* increases the CEO's *Lead_Log_Vega* by 0.05, which is close to the effect of adding another major customer within the supplying firm's customer base (i.e. a value calculated by capturing the effect of a one unit increase in *Major_Customer_Count* under Column 6). However, converting these values into USDs leads to small amounts.

vega incentives in comparison to the effect of stock return volatility.[22] For the control variables, there are positive and significant associations between factors such as *R&D_&_Adver_Intensity* and *Book_Leverage* and CEO vega incentives across all four Columns.[23]

(TABLE 4 Here)

5.2 The moderating roles of product substitution difficulty and supplier's trade credits

Table 5 shows the joint effects of two moderating factors, product substitution difficulty and the supplier's trade credits, and CC on CEO vega. Panel A presents my results from estimating Eq. (3). A significant interaction term between CC and *Product_Substitution_Difficulty* implies that the higher the *Product_Substitution_Difficulty*, the smaller the effect of CC on lead vega (and at the same time, the higher CC, the smaller the effect of

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[22] I multiply the coefficient on the two CC measures by their respective standard deviations and scale this by the corresponding product for Stock_Volatility, based on the approach in Hilary et al. (2016).

[23] My findings are robust to the inclusion of industry fixed effects and year fixed effects. I also calculate the variance inflation factor ("VIF"), and find that all variables show VIFs that are far less than 10, so I conclude that the severity of multicollinearity is negligible in my main empirical model.

Product_Substitution_Difficulty on lead vega). As expected, the signs are significant and negative across all three specifications, so the effect of CC on CEO vega incentives is less pronounced when the customer's product substitution difficulty is high. This indicates that while losing a major customer could have an adverse effect on the supplier's business (e.g. Hertzel et al., 2008), product substitution difficulty diminishes the need to compensate the CEO for such risk. Collectively, Panel A presents evidence that the CC risk from losing a major customer receives less consideration when the customer's likelihood to change its supplier is low.[24]

Panel B reports results from estimating Eq. (4). As predicted, the effect of CC on CEO vega is more pronounced when the supplier's trade credits are greater, but only for *Customer_HHI* of Column 7. The results from Panel B partially support my fourth hypothesis that the CEOs of suppliers with both high CC and high trade credit levels have more vega incentives (because high CC naturally entails the concentration of trade credit risk). The control variables of Table 6 are similar to those of Table 5 except that I include *Cash* as an additional control variable because cash levels may provide a safety net

---

[24] While a significant and positive coefficient for Product_Substitution_Difficulty may be surprising, Dahliwal et al. (2016) also finds that suppliers that have customers with low switching cost, which implies greater risk for the supplying firm, have lower cost of equity.

(i.e. a hedging instrument) for unexpected CC risks (Liu and Mauer, 2011). *Cash* shows a significant and positive association in Panel A only. Collectively, the mosaic of evidence from Panel A and Panel B suggests that the BOD takes into consideration the multidimensional facets of CC risk in CEO equity incentive design, demonstrating that the association between CEO equity incentives and CC is context specific.

(TABLE 5 Here)

5.3 Addressing potential endogeneity

Thus far, my empirical models address the issue of endogeneity through their testing intertemporal relationships, using numerous control variables, and controlling for industry as well as year fixed effects through the inclusion of vectors of industry and year dummies. Nevertheless, to further reduce the likelihood that my main results are biased, I approach the data with an IV method. I also perform a PSM sample approach to correct for any endogenous assortment on observed variables.

5.3.1 IV method result

Based on the design of Dhaliwal et al. (2016), I perform a 2-Stage

Least Squares ("2SLS") regression using 2-year lagged industry level CC averages as my IV's. Industry averages should meet the relevance condition because supplies within the same industry are likely to share commonalities in their *given* vertical supply channel setting (e.g., Porter, 1980). Thus, my IVs are 'strong' in the sense that industry level averages of CC have large covariance with the endogenous variables of interest, firm level CC's. Lagged industry averages should also satisfy the exclusion condition due to the forward looking nature of equity incentives that diminishes the influence of lagged industry averages, especially upon controlling for firm level characteristics, on firm level CEO vega incentives. Hence, my industry level IVs are 'valid' in the sense that they do not directly affect my dependent variable. Hence, my two-stage design can be written as follows:

$$\mathrm{CC}_{it} = \beta_0 + \beta_1 \mathrm{2Y\_Lag\_Industry\_CC}_{it-2} + \mathrm{Controls} + \varepsilon_{it} \quad \textbf{(5a)}$$

$$\mathrm{Lead\_Log\_Vega}_{it+1} = \beta_0 + \beta_1 \mathit{Predicted\_CC}_{it} + \mathrm{Controls} + \varepsilon_{it+1} \quad \textbf{(5b)}$$

Panel A of Table 6 presents first-stage results. In the first-stage, I regress each particular customer concentration measure on its respective IV according to Eq. (5a), where *2Y_Lag_ Industry_CC_I, 2Y_Lag_ Industry_CC_II*, and *2Y_Lag_Industry_CC_III* are my predetermined variables used in obtaining predicted values for the current period endogenous CC measures. In Column 2 for example, the Wu-Hausman test (p-value = 0.001) rejects the null hypothesis that my CC measures are exogenous by themselves. The high F-statistic (p-value < 0.001) and Partial R-squared (0.05) suggest that my selected sets of IVs are valid and does not suffer from the problem of weak instruments. However,

Panel B of Table 6 shows the second-stage results that I obtain from using the predicted values from the first-stage regression as substitutes for the endogenous CC. The results from the second-stage estimation continue to present evidence that CC leads to more CEO vega incentives. Nonetheless, the use of lagged variables results in a loss of observations.

(TABLE 6 Here)

5.3.2 PSM approach result

To address the potential concern of endogeneity, I also approach my data with PSM technique. PSM technique controls for the difference in firm characteristics between firms having no corporate major customers and firms having at least one corporate major customer. It alleviates the endogeneity concern that the determinants of having a major customer simultaneously affected the supplier's equity incentive levels, whereby the propensity score represents the predicted probability of a supplier having at least one major customer based on controls for a comprehensive list of factors likely to have an impact on firm's CC level choices. I largely follow both Dhaliwal et al. (2016) and Albuquerque et al. (2014) when selecting the independent controls for the first-stage logic regression. I then match, without replacement, one major customer with another firm that has no such customers based on 0.05 calipers.

Panel A of Table 7 reports the first-stage logit regression results where the dependent variable is an indicator that a firm has at least one major customer (i.e. *Has_Major_Customer* = 1) before and after matching. Column 3 of Panel A shows the post-match regression results. The results indicate that the control variables all become statistically insignificant, implying a successful match in which the control variables of the matched sample do not explain the variations of having at least one major customer. Panel B shows the mean difference in vega incentives as well as the control variables between the treatment group (i.e. *Has_Major_Customer* = 1) and the control group (i.e. *Has_Major_Customer* = 0). With the exception of *R&D_&_Advr_Intensity*, the means are not statistically difference across the treatment and control groups. This also suggests a successful match. Finally, Panel C presents the multivariate results using the propensity score matched sample across my three CC variables. The number of samples (n = 4,750) indicates a perfect one-on-one match was performed. Again, all three Columns show that CC is significantly and positively associated with vega incentives. These outcomes continue to show that my primary findings are sound and add to the credibility of the causal relationship that I posit.

(TABLE 7 Here)

6. ADDITIONAL ANALYSES

6.1 MRI as risk-taking incentives

I use managerial risk incentives ("MRI"), which equals vega divided by delta, to capture the CEO's risk-taking incentives. This measure considers the vega incentives provided *per* unit of delta incentives as MRI (Dittmann et al., 2016). I find similar results based on this new construct across all CC specifications, results that I do not tabulate due to space constraints.

6.2 Cash as an additional control variable in Eq. (2)

Furthermore, I control for cash in my main empirical model, Eq. (2). Controlling for cash may be necessary because under the costly external finance hypothesis, firms that encourage CEO risk-taking through additional vega incentives tend to have more cash as a hedging instrument against various sources of risk that can require external financing (Liu and Mauer, 2011). Again, I find similar results as those provided in Table 4, results that I do not tabulate due to space constraints.

6.3 Additional consideration of growth opportunities in the midst of high CC

Thus far, I have developed my hypothesis while controlling for the supplier's growth opportunities. However, because equity incentives are forward looking in their nature, it is necessary to jointly consider the supplier's avenues for future growth along with CC to provide optimal vega incentives for a CEO. Figure 2 plots the relationship between CC and two proxies for growth opportunities. The vertical axis show *Market_to_Book* (in the above panel) and *Tobins_Q* (in the below panel) while the horizontal axis shows the decile ranking of *Customer_HHI*. Figure 2 illustrates a positive interplay between CC and growth opportunities.

(FIGURE 2 Here)

A naturally occurring question is whether additional or less CEO risk-taking incentives are required for a high CC firm to achieve its growth potentials. To answer this question, I examine the extant literature. Prior work suggests that higher CC firms garner improved performance through savings in SG&A expenses and/or other operational efficiency improvements such as faster inventory turnover and better working capital management (Patatoukas, 2012; Kalwani and Narayandas 1995;). Moreover, Irvine et al. (2016) find evidence in support of the 'relationship life-cycle hypothesis' in that although suppliers with high CC are more likely to suffer losses early in the relationship than firms with low CC, as the relationship matures, firms with higher levels of CC are rewarded with higher operating profits due to operational efficiencies. Overall, growth opportunities under high CC are not associated with making risky investments.

Consequently, to the extent that a high CC supplier's growth opportunities are related to improving the operational efficiency frontier, I predict that the CEO is less likely to have more risk-taking incentive because high-powered risk-taking incentives such as vega are not necessary to encourage a risk-averse CEO to enhance the utilization of existing assets. In summary, I predict a weaker association between the supplier's CEO risk-taking incentives and CC when growth opportunities are high than when growth opportunities are low. This prediction is based on the assumption that fulfilling growth opportunities under high CC does not require greater risk-taking incentives for the CEO.

Table 8 shows the regression result from testing my second hypothesis, where I use Tobins_Q to capture growth opportunities, as this measure takes into consideration both the market value and the replacement cost of firm assets, which become relevant for CEOs who make improvements on existing channels of the supply-chain or RSI. Consistent with my prediction, the coefficient on the interaction term is significantly negative across Columns 3 through Column 5. That is, while both CC and growth opportunities exert positive influences over CEO vega incentives individually, the joint effect of CC and growth opportunities is negative and significant, suggesting that the effect of CC on CEO vega is less pronounced (more pronounced) when growth opportunities are high (low). I attribute this finding to the BOD's consideration of the non-risky nature of growth opportunities under high CC.

(TABLE 8 Here)

6.4 Additional consideration of risk-taking incentives and externalities

Literature proposes that major customers, just as debtholders or blockholders do, monitor the financial health of its upstream supply-chain partner in order to rationally anticipate the sustainability of its potential supplier before entering into important bilateral relationships.[25] Most notable for my paper are the findings of Kale et al. (2015), which show a negative influence of a firm’s managerial vega incentives on both customer and supplier RSIs – that is, when customers (or suppliers) observe high risk-taking incentives inserted in their supplier’s (or customer’s) CEO compensation, the customers (suppliers) view such an incentive scheme as a risky proposition and consequently reduce their RSI expenditures that are associated with the particular supplier (customer).

For my research, additional vega incentives are intended to induce the CEO to maintain higher CC, but the outcomes of Kale et al. (2015) suggest a negative interaction between CEO vega and customers’ RSI, which *may* imply less CC for the supplier. My theory, however, can reconcile with Kale et al.’s (2015) on several points in that a supplier’s CC and vega incentives can both be high while major customers drop their RSI with respect to the supplier. First, the termination of a partnership is known to hurt suppliers disproportionately more than it does the buyers (Williamson, 1985). This suggests that suppliers

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[25] For example, Cremers et al. (2008) posit that major customers (suppliers) regularly require financial information from their supplier (customer).

and buyers have different roles within a relationship and that suppliers pick up most of the RSI tab. Therefore, even when the customer refuses to make RSI, high CC at the supplier level is still possible if the supplier pays for the RSI. Second, considering product substitution difficulty, if both high CC and high product substitution difficulty lead to less CEO vega, then customers who face higher product substitution difficulty are still likely to purchase from a supplier with high vega incentives, perhaps while cutting down on their own R&D and advertisement expense. Third, if both high CC and high customer bargaining power leads to more CEO vega, then analogical to powerful customers seeking favorable trade credit terms from their supplier, the customers can shift the burden of RSI or customization to their supplier. Thus, high CC is possible despite the negative externalities of the supplying firm's CEO vega incentives.

7. CONCLUSION

This paper examines the effect of customer base concentration on the supplying firm's CEO risk-taking equity incentives. A non-diversified customer base consisting of a select group of major customers is desirable from a performance standpoint (e.g. Patatoukas, 2012), but it sets the stage for a risk-related agency problem to occur between the owners and the CEO (e.g., Sharpe, 1964). That is, prior literature shows CC risk to be idiosyncratic (Dhaliwal et al., 2013) and modern risk-based asset pricing theories posit that idiosyncratic return volatility is not priced amongst the risk-neutral investors, so while CC risk is diversifiable at the shareholder level, a risk-averse, undiversified CEO may exhibit risk-aversion towards the state of higher CC. Consequently, I expect the BOD of high CC firms to recognize this potential agency problem and provide more risk-taking incentives for a CEO who manages a highly concentrated customer base.

Upon empirical investigation, I document that CC exerts a positive influence over the supplier's CEO vega incentives, whereby the CEO is compensated for assuming additional CC risk as her equity wealth becomes an increasing function of the firm's stock return volatility. Further, I show that less risk-taking incentives are expected when the degree of product substitution difficulty is high or the supplier's trade credit levels are low, illustrating that the predictability of CC over CEO equity incentives varies with the settings in which the suppliers and customers interact. Exploring other supply-chain contexts that my augment or lower the CEO's risk aversion may provide a fertile avenue for testing various hypothesis in managerial incentive literature.

APPENDIX I:
Variable Descriptions

DEPENDENT VARIABLES	DESCRIPTION
Lead_Log_Vega	Log(vega+1) in year t+1
Lead_MRI	Log(vega+1) / log(delta+1), all in year t+1
INDEPENDENT VARIABLES	
Customer_HHI	HHI measure for customer concentration that is calculated as the sum of the squares of the ratio of a supplier's sales to corporate major customers over its total sales (Patatoukas, 2012), in year t+1
Major_Customer_Sales_Percentage	Major customer sales / firm's total sales, all in year t
Major_Customer_Count	Number of major customers in year t
2Y_Lag_ Industry_CC_I	2-year lagged industry averages of Customer_HHI
2Y_Lag_ Industry_CC_II	2-year lagged industry averages of Major_Customer_Sales_ Percentage
2Y_Lag_ Industry_CC_III	2-year lagged industry averages of Major_Customer_Count
CONTROL VARIABLES	
Annual_Sales	Log(total annual sales) in year t
Market_to_Book	Market value of equity / book equity, all in year t
Tobins_Q	(Total assets – book equity + market value of equity) / total assets, all in year t
Book_Leverage	(Long-term debt + current liabilities) / total assets, all in year t
Market_Leverage	(Long-term debt + debt in current liabilities) / market value of equity, all in year t
CAPX	Capital expenditures / total assets, all in year t
R&D_Intensity	R&D expense / total assets, all in year t
R&D_&_Advr_Intensity	(R&D expense + advertisement expense) / total assets, all in year t
Cash_Compensation	Log(salary + bonus) of CEO in year t
Lead_Delta	Log(delta+1) in year t+1
Return_Volatility	Log(the standard deviation of monthly stock returns over months t-12 to t)
Cash	Cash and short-term investments / total assets, all in year t
ALTERNATIVE ANALYSIS VARIABLES	
Has_Major_Customer	Indicator that equals 1 if supplier has a major customer
Trade_Credits	The supplier's accounts receivable / total annual sales, all in year t
Product_Substitution_Difficulty	The supplier's total annual sales / operating expense (e.g. Demsetz, 1995; Nevo, 2001; Karuna, 2007), all in year t

APPENDIX II:
Advanced Micro Devices, Inc.'s Annual Report for the Fiscal Year Ended Dec 28, 2013

Collectively, our top five customers accounted for approximately 54% of our net revenue during the year ended 2013. In 2013, Hewlett-Packard Company, Microsoft Corporation and Sony Corporation each accounted for more than 10% of our consolidated net revenues. […]

A loss of any of these customers could have a material adverse effect on our business. […]

However, the Company does not believe the receivable balance from these customers represents a significant credit risk based on past collection experience. The Company manages its exposure to customer credit risk through credit limits, credit lines, monitoring procedures and credit approvals. Furthermore, the Company performs in-depth credit evaluations of all new customers and, at intervals, for existing customers.

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FIGURE 1
Hypothesis Development Framework

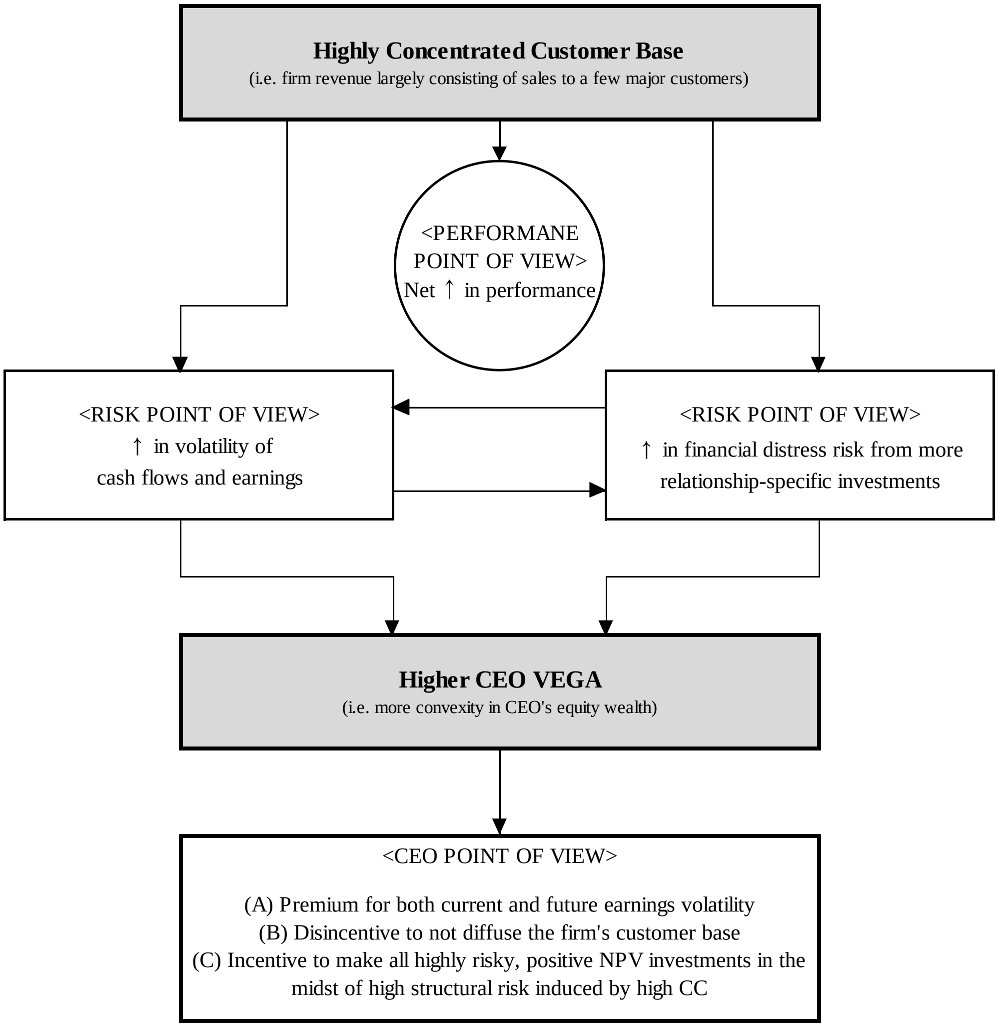
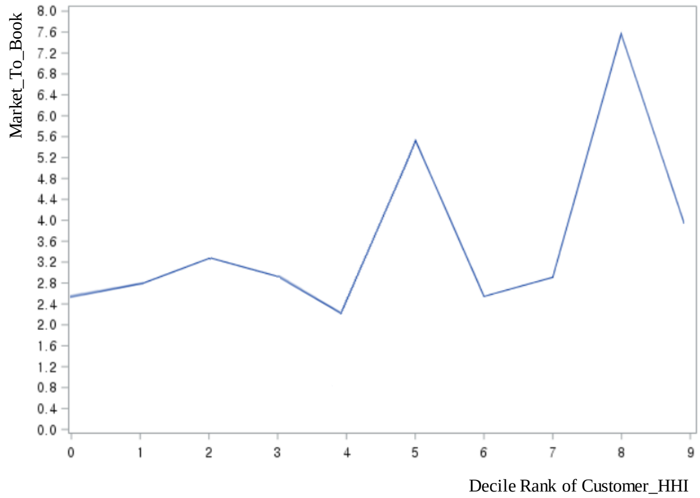


FIGURE 2
Graphical Analysis: The Relationship between CC and Growth Opportunities

Growth opportunities (Market_to_Book) per CC (Customer_HHI) deciles



Growth opportunities (Tobins_Q) per CC (Customer_HHI) deciles

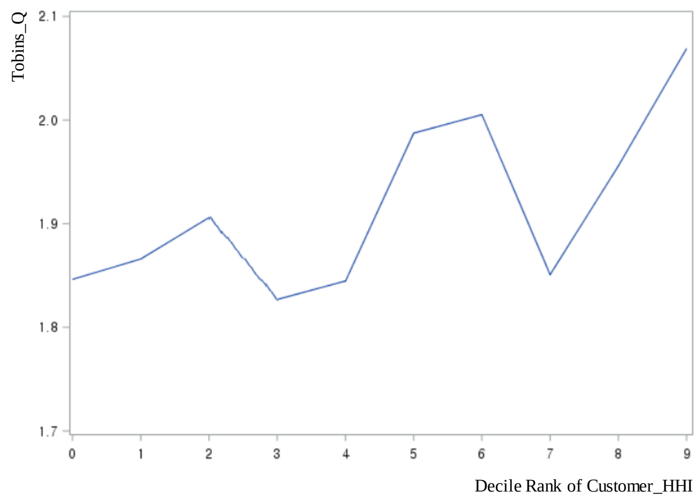


TABLE 1
Descriptive Statistics: Main Variables

Variables	Mean	Std.	Q1	Median	Q3
DEPENDENT VARIABLES					
Vega ($1,000s)	133.51	183.10	21.22	60.03	167.38
Delta ($1,000s)	465.25	727.97	81.24	202.03	512.91
Lead_Log_Vega	4.03	1.44	3.14	4.19	5.17
Lead_Log_Delta	5.29	1.32	4.37	5.30	6.22
MRI	0.77	0.21	0.66	0.81	0.91
INDEPENDENT VARIABLES					
Customer_HHI	0.03	0.07	0.00	0.00	0.02
Major_Customer_Sales_Percentage	0.11	0.20	0.00	0.00	0.14
Major_Customer_Count	0.48	0.89	0.00	0.00	1.00
CONTROL VARIABLES					
Annual_Sales	7.41	1.60	6.35	7.37	8.45
Market_to_Book	3.16	27.34	1.39	2.15	3.41
Tobins_Q	1.89	1.17	1.20	1.54	2.18
Book_Leverage	0.41	0.22	0.27	0.40	0.52
Market_Value	0.44	1.24	0.03	0.18	0.45
CAPX	0.04	0.05	0.01	0.03	0.06
R&D_Intensity	0.03	0.07	0.00	0.00	0.04
R&D_&_Advr_Intensity	0.05	0.07	0.00	0.02	0.07
Cash_Compensation	6.68	0.68	6.38	6.71	6.97
ROA	0.13	0.11	0.09	0.13	0.18
Return_Volatility	0.10	0.06	0.06	0.09	0.12
Cash	0.16	0.17	0.04	0.11	0.24
ALTERNATIVE ANALYSIS VARIABLES					
Has_Major_Customer	0.28	0.45	0.00	0.00	1.00
Trade_Credits	0.16	0.71	0.10	0.14	0.19
Product_Substitution_Difficulty	1.24	0.33	1.09	1.17	1.29

This table reports the descriptive statistics of the key variables for my total sample consisting of 8,296 firm-year observations. Detailed definitions of the variables are available in Appendix I. All variables are winsorized at the 1% and 99% levels.

TABLE 2
Descriptive Statistics: Mean Differences

(1) Variables	(2) Suppliers with major customer(s) (n = 2,375)	(3) Suppliers without a major customer (n = 5,921)	(4) Difference (2) - (3)	(5) p-value
Vega	121.03	143.08	**-18.92**	**<.0001**
Lead_Log_Vega	3.95	4.06	**-0.11**	**0.006**
MRI	0.77	0.76	**0.01**	**0.011**
Annual_Sales	6.87	7.56	**-0.69**	**<.0001**
Market_to_Book	3.29	2.77	0.53	0.423
Tobins_Q	1.91	1.77	**0.15**	**<.0001**
Book_Leverage	0.38	0.37	0.00	0.336
Market_Value	7.19	7.72	**-0.53**	**<.0001**
CAPX	0.05	0.04	**0.01**	**<.0001**
R&D_Intensity	0.06	0.02	**0.04**	**<.0001**
R&D_&_Advr_Intensity	0.07	0.03	**0.04**	**<.0001**
Log_Delta	5.14	5.34	**-0.20**	**<.0001**
Cash_Compensation	6.60	6.72	**-0.12**	**<.0001**
ROA	0.13	0.12	**0.01**	**0.001**
Return_Volatility	0.11	0.10	**0.01**	**<.0001**
Cash	0.23	0.16	**0.09**	**<.0001**
Product_Substitution_Difficulty	1.29	1.28	0.00	0.682
Trade_Credits	0.17	1.23	**-1.07**	**<.0001**

This table reports the mean differences between a subsample consisting of observations of suppliers with at least one major customers and another subsample composed of observations of suppliers that do not have a major customers. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively, according to two-sided tests. See Appendix I for variable descriptions.

TABLE 3
Correlations: Variables Concerning the Main Regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Lead_Log_Vega		**-0.073**	**-0.073**	**-0.074**	**0.569**	**0.313**	**0.142**	0.006	**0.092**	**0.512**	**-0.412**	**0.701**
		<.0001	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	0.683	**<.0001**	**<.0001**	**<.0001**	**<.0001**
(2) Major_Customer_Count	**-0.057**		**0.912**	**0.906**	**-0.253**	**-0.064**	**-0.150**	**-0.095**	**0.289**	**-0.180**	**0.124**	**-0.116**
	<.0001		**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**
(3) Major_Customer_Sales_Percentage	**-0.058**	**0.901**		**0.996**	**-0.250**	**-0.059**	**-0.138**	**-0.088**	**0.260**	**-0.166**	**0.128**	**-0.109**
	<.0001	**<.0001**		**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**
(4) Customer_HHI	**-0.046**	**0.655**	**0.881**		**-0.252**	**-0.058**	**-0.137**	**-0.088**	**0.259**	**-0.168**	**0.129**	**-0.110**
	0.001	**<.0001**	**<.0001**		**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**
(5) Annual_Sales	**0.528**	**-0.240**	**-0.263**	**-0.246**		**0.157**	**0.439**	**0.158**	**-0.298**	**0.753**	**-0.384**	**0.493**
	<.0001	**<.0001**	**<.0001**	**<.0001**		**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**
(6) Market_to_Book	**0.023**	0.021	0.021	0.019	-0.010		**0.152**	**0.094**	**0.171**	**0.147**	**-0.300**	**0.456**
	0.094	0.140	0.140	0.177	0.459		**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**
(7) Book_Leverage	**0.086**	**-0.113**	**-0.099**	**-0.068**	**0.309**	**0.052**		**0.073**	**-0.209**	**0.368**	**-0.023**	**0.079**
	<.0001	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**0.000**		**<.0001**	**<.0001**	**<.0001**	**0.095**	**<.0001**
(8) CAPX	**-0.023**	**-0.064**	**-0.062**	**-0.051**	**0.090**	**0.023**	0.016		**-0.180**	**0.084**	**-0.029**	**0.081**
	0.095	**<.0001**	**<.0001**	**0.000**	**<.0001**	**0.093**	0.239		**<.0001**	**<.0001**	**0.038**	**<.0001**
(9) R&D_&_Advr_Intensity	0.019	**0.296**	**0.316**	**0.292**	**-0.321**	**0.070**	-0.019	**-0.062**		**-0.217**	**0.091**	-0.002
	0.174	**<.0001**	**<.0001**	**<.0001**	**<.0001**	**<.0001**	0.164	**<.0001**		**<.0001**	**<.0001**	0.907
(10) Cash_Compensation	**0.365**	**-0.103**	**-0.102**	**-0.090**	**0.531**	-0.015	**0.199**	0.004	**-0.144**		**-0.324**	**0.482**
	<.0001	**<.0001**	**<.0001**	**<.0001**	**<.0001**	0.275	**<.0001**	0.765	**<.0001**		**<.0001**	**<.0001**
(11) Return_Volatility	**-0.368**	**0.091**	**0.108**	**0.113**	**-0.308**	-0.010	**0.098**	**0.023**	**0.156**	**-0.197**		**-0.419**
	<.0001	**<.0001**	**<.0001**	**<.0001**	**<.0001**	0.473	**<.0001**	**0.095**	**<.0001**	**<.0001**		**<.0001**
(12) Log_Delta	**0.668**	**-0.115**	**-0.115**	**-0.097**	**0.478**	0.013	0.014	**0.052**	**-0.071**	**0.323**	**-0.423**	
	<.0001	**<.0001**	**<.0001**	**<.0001**	**<.0001**	0.360	0.324	**0.000**	**<.0001**	**<.0001**	**<.0001**	

This table shows the correlation among our key variables for the 8,296 firm-year observations used in the main regression. Spearman correlation is on the top right whereas Pearson correlation is on the bottom left. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Statistical significant at the < 10% level are denoted in bold font. See Appendix I for variable descriptions.

TABLE 4
Main Regression Analysis: The Effect of CC on CEO Vega Incentives

(1)	(2)	(3)	(4)	(5)	(6)
Variables	(+/-)	Lead_Log_Vega	Lead_Log_Vega	Lead_Log_Vega	Lead_Log_Vega
Customer_HHI	(+)		**0.662****		
			(2.357)		
Major_Customer_Sales_Percentage	(+)			**0.204****	
				(2.141)	
Major_Customer_Count	(+)				**0.036****
					(2.249)
Annual_Sales		0.295***	0.300***	0.299***	0.297***
		(14.725)	(14.831)	(14.822)	(14.788)
Market_to_Book		0.000	0.000	0.000	0.000
		(0.922)	(0.900)	(0.884)	(0.884)
Book_Leverage		-0.052	-0.051	-0.046	-0.045
		(-0.533)	(-0.522)	(-0.471)	(-0.454)
CAPX		-1.495***	-1.539***	-1.538***	-1.530***
		(-3.776)	(-3.882)	(-3.879)	(-3.861)
R&D_&_Advr_Intensity		3.027***	2.940***	2.939***	2.946***
		(9.228)	(8.930)	(8.859)	(8.871)
Cash_Compensation		0.144***	0.142***	0.142***	0.143***
		(2.974)	(2.940)	(2.932)	(2.946)
Return_Volatility		-0.453	-0.471	-0.468	-0.463
		(-1.379)	(-1.436)	(-1.427)	(-1.412)
Lead_Log_Delta		0.442***	0.442***	0.443***	0.443***
		(20.382)	(20.404)	(20.470)	(20.491)
Constant		-1.237***	-1.281***	-1.286***	-1.276***
		(-4.322)	(-4.464)	(-4.467)	(-4.439)
Industry Fixed Effect		Yes	Yes	Yes	Yes
Year Fixed Effect		Yes	Yes	Yes	Yes
Observations		8,296	8,296	8,296	8,296
R-squared		0.420	0.421	0.421	0.420
Adj. R-squared		0.420	0.420	0.420	0.420

This table reports the estimation results of Eq. (2). For all specifications, year and industry fixed effects are included, where the industry fixed effects are based on the Fama-French 48 code. To remove the effect of outliers, all variables are winsorized at the top and bottom 1 percentiles. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors are corrected for heteroskedasticity by clustering at the firm levels. See Appendix I for variable descriptions.

TABLE 5

Regression Analysis: The Moderating Roles of Product Substitution Difficulty and Supplier's Trade Credits

		PANEL A: Interacted_Term is Product_Substitution_Difficulty				PANEL B: Interacted_Term is Trade_Credits		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	(+/-)	Lead_Log_Vega	Lead_Log_Vega	Lead_Log_Vega	(+/-)	Lead_Log_Vega	Lead_Log_Vega	Lead_Log_Vega
Customer_HHI		1.539**				0.538*		
		(2.306)				(1.927)		
Customer_HHI x Interacted_Term	(-)	-1.024**			(+)	0.203***		
		(-2.111)				(3.285)		
Major_Customer_Sales_Percentage			0.739***				0.172*	
			(2.619)				(1.720)	
Major_Customer_Sales_Percentage x Interacted_Term	(-)		-0.568***		(+)		0.033	
			(-2.718)				(1.360)	
Major_Customer_Count				0.195***				0.018
				(2.925)				(0.701)
Major_Customer_Count x Interacted_Term	(-)			-0.156***				0.057
				(-3.156)	(+)			(0.669)
Interacted_Term		0.334***	0.403***	0.431***		0.012	0.011	0.012
		(3.908)	(4.324)	(4.679)		(1.438)	(1.553)	(1.492)
Cash		0.586***	0.603***	0.609***		0.582***	0.592***	0.598***
		(3.681)	(3.782)	(3.827)		(3.623)	(3.688)	(3.729)
Constant		Yes	Yes	Yes		Yes	Yes	Yes
Other Control Variables		Yes	Yes	Yes		Yes	Yes	Yes
Industry Fixed Effect		Yes	Yes	Yes		Yes	Yes	Yes
Year Fixed Effect		Yes	Yes	Yes		Yes	Yes	Yes
Observations		8,296	8,296	8,296		8,268	8,268	8,268
R-squared		0.428	0.428	0.428		0.426	0.426	0.426
Adj. R-squared		0.427	0.428	0.428		0.425	0.425	0.425

This table reports the estimation results of Eq. (4) and Eq. (5). For all specifications, year and industry fixed effects are included, where the industry fixed effects are based on the Fama-French 48 code. To remove the effect of outliers, all variables are winsorized at the top and bottom 1 percentiles. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors are corrected for heteroskedasticity by clustering at the firm levels. See Appendix I for variable descriptions.

TABLE 6
Instrumental Variable Analysis

PANEL A: First-stage results			
(1)	(2)	(3)	(4)
Variables	Customer_HHI	Major_Customer_ Sales_Percentage	Major_Customer_ Count
2Y_Lag_ Industry_CC_I	**0.188*** **		
	(4.969)		
2Y_Lag_ Industry_CC_II		**0.141*** **	
		(5.345)	
2Y_Lag_ Industry_CC_III			**0.102*** **
			(4.082)
Annual_Sales	-0.005***	-0.016***	-0.055***
	(-4.494)	(-4.510)	(-3.625)
Market_to_Book	-0.000	-0.000	-0.000
	(-1.289)	(-0.838)	(-0.364)
Book_Leverage	-0.004	-0.027	-0.174**
	(-0.639)	(-1.574)	(-2.396)
CAPX	0.113***	0.396***	1.670***
	(3.046)	(3.827)	(4.019)
R&D_&_Advr_Intensity	0.189***	0.698***	3.357***
	(5.608)	(8.035)	(9.684)
Cash_Compensation	0.004**	0.012**	0.033
	(2.290)	(2.138)	(1.266)
Return_Volatility	0.047**	0.129**	0.456*
	(2.247)	(2.070)	(1.707)
Lead_Log_Delta	0.001	-0.001	-0.021
	(0.457)	(-0.350)	(-1.416)
Constant	0.020*	0.136***	0.765***
	(1.653)	(3.203)	(3.898)
Industry Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Observations	6,566	6,566	6,566
R-squared	0.132	0.136	0.133
Adj. R-squared	0.130	0.135	0.131
Wu-Hausman F-statistic	10.72 ($p = 0.001$)	15.13 ($p = 0.0001$)	25.94 ($p = 0.0001$)
F-statistic	275.87 ($p < 0.001$)	143.24 ($p < 0.001$)	109.25 ($p < 0.001$)
Partial R-squared	0.047	0.032	0.017

(cont.)

PANEL B: Second-stage results				
(1)	(2)	(3)	(4)	(5)
Variables	(+/-)	Lead_Log_Vega	Lead_Log_Vega	Lead_Log_Vega
Predicted_Customer_HHI	(+)	**3.976*** **		
		(3.601)		
Predicted_Major_Customer_Sales_Percentage	(+)		**2.073*** **	
			(3.957)	
Predicted_Major_Customer_Count	(+)			**0.757*** **
				(4.674)
Annual_Sales		0.320***	0.334***	0.346***
		(21.726)	(19.916)	(19.047)
Market_to_Book		0.001*	0.001	0.001
		(1.657)	(1.640)	(1.473)
Book_Leverage		0.071	0.128*	0.223***
		(1.028)	(1.734)	(2.619)
CAPX		-1.650***	-1.948***	-2.393***
		(-5.515)	(-5.806)	(-6.082)
R&D_&_Advr_Intensity		2.247***	1.805***	1.043**
		(8.575)	(5.464)	(2.366)
Cash_Compensation		0.160***	0.152***	0.154***
		(6.228)	(5.693)	(5.379)
Return_Volatility		-1.732***	-1.764***	-1.767***
		(-5.582)	(-5.504)	(-5.119)
Lead_Log_Delta		0.440***	0.446***	0.463***
		(32.087)	(31.663)	(29.438)
Constant		-0.945***	-1.223***	-1.596***
		(-4.790)	(-5.286)	(-5.688)
Industry Fixed Effect		Yes	Yes	Yes
Year Fixed Effect		Yes	Yes	Yes
Observations		6,566	6,566	6,566
R-squared		0.405	0.367	0.261
Adj. R-squared		0.403	0.365	0.260

This table reports the 2SLS results. The first-stage regression appears in Panel A and the second-stage regression appears in Panel B. I use the predicted values from the first-stage regression as the primary independent variable for the second-stage regression. For all specifications, year and industry fixed effects are included, where the industry fixed effects are based on the Fama-French 48 code. To remove the effect of outliers, all variables are winsorized at the top and bottom 1 percentiles. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors are corrected for heteroskedasticity by clustering at the firm levels. See Appendix I for variable descriptions.

TABLE 7
Propensity Score Matched Sample Analysis

PANEL A: Pre-match propensity score regression and post-match propensity score regression

(1)	(2)	(3)
Variables	Pre-match regression Has_Major_Customer	Post-match regression Has_Major_Customer
Market_Value	-0.172***	0.043
	(-5.070)	(1.118)
Tobins_Q	-0.046	-0.007
	(-1.048)	(-0.167)
Market_Leverage	-0.066	-0.032
	(-1.113)	(-0.546)
CAPX	2.859***	0.178
	(3.009)	(0.204)
R&D_&_Advr_Intensity	5.069***	0.976
	(5.728)	(1.317)
ROA	-0.645	-0.481
	(-1.307)	(-1.058)
Constant	1.194***	-0.484
	(4.130)	(-1.496)
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
Observations	8,296	4,750
Pseudo R-squared	0.05	0.00

PANEL B: Difference in observables

(1)	(2)	(3)	(4)	(5)
Variables	Suppliers with major customer(s) (n = 2,375)	Suppliers without a major customer (n = 5,921)	Difference (2) - (3)	p-value
Lead_Log_Vega	3.99	3.93	0.06	0.19
Market_Value	7.21	7.16	0.05	0.32
Tobins_Q	1.89	1.87	0.02	0.54
Market_Leverage	0.36	0.39	-0.03	0.17
CAPX	0.05	0.05	0.00	0.88
R&D_&_Advr_Intensity	0.06	0.06	**0.00**	**0.01**
ROA	0.12	0.12	0.00	0.11

(cont.)

PANEL C: Multivariate results on sample matched by propensity score				
(1)	(2)	(3)	(4)	(5)
Variables	(+/-)	Lead_Log_Vega	Lead_Log_Vega	Lead_Log_Vega
Customer_HHI	(+)	**0.757*** **		
		(2.632)		
Major_Customer_Sales_Percentage	(+)		**0.240** **	
			(2.335)	
Major_Customer_Count	(+)			**0.041* **
				(1.836)
Annual_Sales		0.323***	0.320***	0.318***
		(15.373)	(15.265)	(15.183)
Market_to_Book		-0.000	-0.000	-0.000
		(-0.328)	(-0.338)	(-0.345)
Book_Leverage		-0.143	-0.132	-0.128
		(-1.291)	(-1.194)	(-1.148)
CAPX		-1.444***	-1.441***	-1.432***
		(-3.407)	(-3.399)	(-3.375)
R&D_&_Advr_Intensity		3.213***	3.212***	3.217***
		(9.347)	(9.347)	(9.368)
Cash_Compensation		0.168***	0.167***	0.169***
		(4.173)	(4.148)	(4.200)
Return_Volatility		-0.404	-0.396	-0.391
		(-1.181)	(-1.158)	(-1.145)
Lead_Log_Delta		0.397***	0.398***	0.399***
		(16.097)	(16.189)	(16.236)
Constant		-1.390***	-1.388***	-1.380***
		(-5.378)	(-5.363)	(-5.339)
Industry Fixed Effect		Yes	Yes	Yes
Year Fixed Effect		Yes	Yes	Yes
Observations		4,750	4,750	4,750
R-squared		0.432	0.432	0.431
Adj. R-squared		0.431	0.430	0.430

For all specifications, year and industry fixed effects are included, where the industry fixed effects are based on the Fama-French 48 code. To remove the effect of outliers, all variables are winsorized at the top and bottom 1 percentiles. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Standard errors are corrected for heteroskedasticity by clustering at the firm levels. See Appendix I for variable descriptions.

TABLE 8
Regression Analysis: The Moderating Role of Growth Opportunities

(1) Variables	(2) (+/-)	(3) Lead_Log_Vega	(4) Lead_Log_Vega	(5) Lead_Log_Vega
Customer_HHI		**0.744***		
		(1.812)		
Customer_HHI x Tobins_Q	(-)	**-0.202***		
		(-1.655)		
Major_Customer_Sales_Percentage			**0.303****	
			(1.980)	
Major_Customer_Sales_Percentage x Tobins_Q	(-)		**-0.125****	
			(-2.201)	
Major_Customer_Count				**0.072****
				(2.072)
Major_Customer_Count x Tobins_Q	(-)			**-0.034*****
				(-2.585)
Tobins_Q		0.047**	0.057**	0.059**
		(2.057)	(2.412)	(2.484)
Annual_Sales		0.315***	0.314***	0.314***
		(14.419)	(14.443)	(14.449)
Book_Leverage		-0.042	-0.038	-0.041
		(-0.419)	(-0.384)	(-0.412)
CAPX		-1.420***	-1.418***	-1.416***
		(-3.571)	(-3.567)	(-3.564)
R&D _Intensity		3.452***	3.528***	3.566***
		(8.375)	(8.346)	(8.412)
Cash_Compensation		0.151***	0.152***	0.153***
		(3.068)	(3.084)	(3.098)
Return_Volatility		-0.303	-0.295	-0.298
		(-0.931)	(-0.908)	(-0.918)
Lead_Log_Delta		0.428***	0.428***	0.428***
		(17.709)	(17.718)	(17.734)
Constant		-1.438***	-1.461***	-1.462***
		(-4.783)	(-4.827)	(-4.826)
Industry Fixed Effect		Yes	Yes	Yes
Year Fixed Effect		Yes	Yes	Yes
Observations		8,296	8,296	8,296
R-squared		0.423	0.423	0.423
Adj. R-squared		0.422	0.422	0.422

For all specifications, year and industry fixed effects are included, where the industry fixed effects are based on the Fama-French 48 code. To remove the effect of outliers, all variables are winsorized at the top and bottom 1 percentiles. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

국문초록

고객의 집중과 분산이 경영자의 지분보상에 미치는 영향

서울대학교 대학원

경영학과 회계학전공

한종원

Statement of Financial Accounting Standard (SFAS) No. 131에 따라 미국의 기업은 연간 매출의 10% 이상을 올려주는 고객에 대한 공시 의무를 지닌다. 본 연구는 이러한 주요고객에 대한 기업의 의존을 경영자의 위험회피 성향을 높이는 요인으로 보고 주요고객에 대한 의존도가 경영자 지분보상의 위험추구 유인에 미치는 영향을 실증적으로 규명하는데 목적을 두고 있다. 2006년부터 2014년까지 S&P 1500 기업들의 패널자료를 실증분석한 결과, 주요고객에 대한 의존도가 커질수록 경영자의 지분보상 베가(주식 변동성에 대한 지분보상의 민감도)가 유의적으로 증가하는 것으로 파악되었다. 이는 분산투자를 통하여 특정 자산의 실적에 대한 민감도를 낮출 수 있는 주주들과는 달리 본인이 경영하는 기업의 고객 유실에 보다 민감할 수 있는 경영자에게서 발생할 수 있는 위험회피 및 과소투자와 같은 대리인 문제를 기업이 높은 지분보상 베가로 보상하는 현상으로 해석된다. 즉, 기업은 경영자의 지분보상 베가를 높임으로써 주요고객 리스크를 관리하는 경영자에게 높은 주식 변동성에 대한 보상과 보다 위험추구적인 투자를 할 유인을 제공하는 것이다. 따라서 SFAS No. 131은 정량적인 기준에 따라 매출의 원천을 파악할 수 있도록 함으로써 경영자에게서 나타날 수 있는 위험회피적 성향의 정도와 이에 대한 기업의 지분보상방향을 고객집중지수를 통하여 예측할 수 있게 한다.

주요어: 경영자 유인, 공급망, 대리인 이론, 위험추구

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