Customers' Risk Factor Disclosures and Suppliers' Investment Efficiency*

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ABSTRACT

This study examines the effect of downstream firms' (i.e., customers') risk factor disclosures contained in annual reports on the investment efficiency of upstream firms (i.e., suppliers). We find that more informative disclosures of customers' risk factors are associated with less under- or over-investment by suppliers. In addition, this inverse association is stronger when the suppliers are at a bargaining disadvantage, when they operate in the durable goods industries, and when they are more concerned about the volatility of future demand. Overall, our results suggest that risk factor disclosures provided by firms in their annual reports contain useful information that could potentially help their suppliers achieve better investment efficiency.

Divulgation d'information sur les facteurs de risque des clients et efficience de l'investissement des fournisseurs

RÉSUMÉ

Les auteurs étudient l'incidence de la divulgation d'information, dans les rapports annuels, sur les facteurs de risque des sociétés en aval (les clients) sur l'efficience de l'investissement des sociétés en amont (les fournisseurs). Ils constatent que la divulgation de renseignements plus éclairants sur les facteurs de risque des clients est associée à une fréquence moins grande de sous-investissement ou de sur-investissement des fournisseurs. De plus, cette relation inverse s'accentue lorsque les fournisseurs sont en situation de désavantage dans la négociation, lorsqu'ils exercent leurs activités dans des secteurs de biens durables et lorsqu'ils sont plus préoccupés par la volatilité de la demande future. Dans l'ensemble, les résultats de l'étude semblent indiquer que la divulgation des facteurs de risque par les sociétés dans leurs rapports annuels livre de l'information utile susceptible d'aider leurs fournisseurs à accroître l'efficience de leurs investissements.

1. Introduction

Along the supply chain, the upstream supplier usually moves first to acquire capacity or invest in research and development (R&D) to support production for its customers. At this point in time, outcomes from the supplier's investments are not perfectly describable, and thus the contract between the

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supplier and the customer is implicit and can be renegotiated, enabling the customer to extract some of the supplier's quasi-rents (Tirole 1999; Baiman et al. 2001). Since supplier investment is often specialized for the customer, it has a lower value outside the specific customer-supplier relationship (e.g., Williamson 1983; Joskow 1987). Once the investment is made, it is difficult for the supplier to limit the customer's ability to extract the quasi-rents generated from its investment. Anticipating the customer's ex post rent extraction, the supplier faces a classic hold-up problem and tends to underinvest in capacity (Taylor and Plambeck 2007). The supply chain management literature emphasizes the benefits of information sharing by customers in achieving supply chain investment efficiency (e.g., Kouvelis et al. 2006). Yet, since the cost of extra capacity is borne by suppliers, customers would prefer suppliers to have more capacity available to prevent inventory stock-out in case of high demand, which is documented in the supply chain management literature as the "bullwhip" effect (e.g., Lee et al. 1997; Cachon and Lariviere 2001). As a result, customers tend to overstate their demand or nonbinding orders to induce their suppliers to invest more in capacity or R&D, leading to overinvestment and/or unused capacity by suppliers.[1]

If suppliers are more informed about their customers' risk and ability to fulfill contracts, this would allow them to better assess the future prospects and outcomes of their investments, leading to better investment efficiency. In this study, we examine whether the information regarding firms' risk exposures disclosed in the risk factor section of the annual report, that is, risk factor disclosure (RFD), can be useful to suppliers for making investment decisions and, in turn, improving their investment efficiency. In 2005, the U.S. Securities and Exchange Commission (SEC) issued a rule that requires firms to discuss "the most significant factors that make the offering speculative or risky" under Item 1A—Risk Factors in 10-K filings.[2] By adding this new section to corporate filings, the SEC aims to improve investors' understanding of firms' material risks associated with their investments. While RFDs are provided mainly for capital market participants, they could contain information useful to other stakeholders of the firm as well. For example, in Item 1A of its 2007 annual report, Motorola discussed its restructuring plan to spin off the Mobile Devices business. The firm stated, among other factors, "perceived uncertainties as to our future direction may have a negative impact on our relationships with our customers, suppliers, vendors and partners and may result in the loss of business opportunities." One of Motorola's suppliers, Forward Industries, considered this spin-off as a risk factor that could materially and adversely affect its business, and went on to disclose such information in the risk factor section of its 2008 10-K filing.[3] This example suggests that suppliers take into account risk exposures of their customers (especially their major customers, as in the example of Forward Industries) and that customer RFDs are likely to contain information that could be useful to their suppliers.

The risk factor information disclosed in customers' annual reports can be useful to suppliers in two ways. First, RFDs might contain incremental risk information unknown to suppliers. Because risk information is primarily negative news, customers may not want to fully share such information with their suppliers privately if they are not obliged to do so, especially in the case of small suppliers with relatively

1. Suppliers may rationally anticipate customers' incentive to inflate demand and thereby discount customers' demand information in their capacity choice. Therefore, whether there is overinvestment by suppliers depends on the extent to which suppliers discount the demand forecasts provided by customers.
2. See the SEC Release No. 33-8591, *Securities Offering Reform* (SEC 2005, 257). Previously, firms were only required to provide RFDs in registration statements for public offerings. Other than in Item 1A, the annual report may also contain narrative risk disclosures in other sections, such as in Item 7. Kravet and Muslu (2013) examine the changes in textual risk disclosures in the whole 10-K filing and find that they increase investors' risk perception. However, suppliers might not be as diligent as investors in going through every detail of the annual report. It is likely that they simply look at certain sections, especially the section dedicated to the discussion of risk factors, to understand the risk profile of their customers. The focus of this study is thus on the RFDs in Item 1A of the 10-K. The results remain unchanged when we control for the disclosures in Item 7.
3. Please see supporting information, "Appendix" as an addition to the online article for the excerpted RFDs from the 10-K filings of Motorola and Forward Industries.

weak bargaining power.[4] Consistently, a few accounting studies document that the information disclosed in firms' annual reports or the quality of such information matters to their suppliers (e.g., Raman and Shahrur 2008; Dou et al. 2013). Second, although firms can receive demand information directly from their customers through private communications, the private information shared by customers might not necessarily be reliable. Hence, audited annual reports can provide credence or verification to the private information received by suppliers from their customers or other sources. Radhakrishnan et al. (2014) show that customers' capital market information quality serves as a commitment mechanism to the information shared privately with suppliers and is thus associated with better supplier operating performance. Similarly, in the context of our study, RFDs in annual reports can lend credibility to the information communicated by firms privately to their suppliers, even if the disclosed information is not new to the suppliers. In other words, even if the information contained in customer RFDs overlaps with what suppliers have already gathered from other sources, this does not completely take away the usefulness of RFDs to firms' suppliers, given that RFDs provided in audited annual reports tend to be more reliable than the information from other sources and thereby could potentially serve a verification role.

We construct a sample of publicly listed supplier firms in the United States that disclose the names of their major customers that individually account for more than 10 percent of their sales. The final sample consists of 1,829 supplier firm-year observations during the period of 2005–2011. We measure the informativeness of RFDs by: (i) the total number of words; (ii) the number of risk keywords; and (iii) the number of forward-looking keywords in the risk factor section (Item 1A) of the 10-K. Admittedly, these three measures could also capture the amount of firm risk disclosed in RFDs and, in turn, affect suppliers' assessments of customer business risk and uncertainty. To control for the effect of RFDs on influencing the risk perception of suppliers, we include the customers' pre- and post-disclosure firm risk measures in our regression model when testing the relation between customers' RFDs and suppliers' investment efficiency. Consistent with our hypothesis, we find that the informativeness of major customers' RFDs is significantly and negatively associated with the likelihood of their suppliers' under- and overinvestment, after controlling for factors shown to affect investment efficiency in prior studies (e.g., Biddle et al. 2009). This finding suggests that RFDs in 10-K reports contain useful information about firms' business risk that could potentially assist suppliers to better evaluate the outcomes of their investments and improve their investment efficiency.

Further investigation reveals that the association between customer RFDs and supplier investment efficiency is stronger when customers have greater bargaining power over suppliers. Suppliers are likely at an information disadvantage when their customers have stronger bargaining power, because, in this situation, customers are less likely to share accurate demand information with them. As a result, RFDs in annual reports could become a more important information source for suppliers to understand the risk profile of these customers. In addition, we find that the documented association is more pronounced for suppliers in the durable goods industries. Durable goods suppliers invest largely in relationship-specific assets, the outcomes of which are closely tied to the business risk of their customers. Therefore, the information from customer RFDs would be more useful for the investment decisions of suppliers in the durable goods industries than those in nondurable goods industries. Finally, we find a stronger association between customer RFDs and the investment efficiency of suppliers who disclose demand risk in the risk factor section of their *own* 10-K reports. This suggests that when suppliers are particularly concerned about the volatility of future demand, they tend to assess their customers' risk exposures more thoroughly, in which case customers' RFDs could become more relevant.

Our study contributes to the accounting literature in the following ways. First, critics of the SEC's risk disclosure requirement argue that RFDs are vague and likely to be boilerplate because they are

4. This is the case of our sample. SFAS Nos. 14 and 131 require firms to provide the names of principal customers that individually account for more than 10 percent of sales. We rely on such disclosures to link suppliers with their customers. In this sense, the supplier firms in our sample are mostly dependent suppliers whose business is heavily dependent on a few major customers; however, most of them are not necessarily major suppliers to those customers. As a result, the size of these supplier firms in our sample is much smaller than that of major customer firms.

simply qualitative descriptions of all potential risks and uncertainties faced by firms (Malone 2005). Recent studies (e.g., Campbell et al. 2014; Hope et al. 2016; Chiu et al. 2017) document that RFDs are informative and useful in that they enhance investors' assessment of firm risk and meanwhile reduce the information asymmetry in the capital market. Unlike previous studies that primarily focus on the information role of RFDs in the capital market, we address the usefulness of RFDs from the perspective of product market participants. We provide evidence that more informative customer RFDs are associated with better supplier investment efficiency, which suggests that RFDs are not boilerplate as criticized; instead, they provide risk information that appears to be useful not only to capital market participants but also to other stakeholders (e.g., suppliers) of the firm. Second, our findings have implications for the information transfer along the supply chain. Recent accounting studies have begun to look into the informativeness of firms' annual reports to their supply chain partners, particularly their suppliers and suppliers' stakeholders (e.g., Raman and Shahrur 2008; Pandit et al. 2011; Hui et al. 2012; Dou et al. 2013). Our study adds to this growing literature by showing that RFDs in customers' annual reports could be relevant to suppliers' investment decisions and help improve their investment efficiency. Third, our study contributes to the literature on the usefulness of textual disclosures in corporate filings. We analyze the content of the textual information in the risk factor section of 10-K filings and generate evidence on its usefulness from the perspective of upstream suppliers. Consistent with prior research (e.g., Li 2008; Brown and Tucker 2011; Kravet and Muslu 2013), our results imply that qualitative disclosures are incrementally informative to quantitative disclosures.

Furthermore, our study complements the supply chain management literature. This literature has long identified the problem of supply chain investment inefficiency stemming from noncontractual relations (e.g., Macaulay 1963). Various mechanisms to achieve the investment efficiency and maximize the total profit of the supply chain have been investigated in the literature, including customer information sharing (e.g., Özer and Wei 2006; Taylor and Xiao 2010), vertical integration (e.g., Geyskens et al. 2006), and relational contracts (e.g., Plambeck and Taylor 2006; Taylor and Plambeck 2007). We find that mandated disclosures such as the RFDs in annual reports, through which the SEC intends to improve capital market participants' understanding of firm risk, could spill over along the supply chain, potentially helping suppliers make more informed decisions and achieve better investment efficiency.[5]

This article proceeds as follows. Section 2 reviews the relevant literature and develops our hypothesis. Section 3 describes the research design. Section 4 presents the empirical analyses, including the sample, data, descriptive statistics, and primary and cross-sectional analyses. Section 5 discusses additional analyses and robustness checks. Section 6 concludes the article.

2. Relevant literature and hypothesis development

Prior studies (e.g., Williamson 1983; Titman 1984; Joskow 1987) argue that supply chain investments are usually relationship-specific. For example, a supplier invests in equipment and machinery with characteristics that are specific to or customized for its transactions with particular customers (Joskow 1987). The more specific the investment is, the lower the value of the investment is outside a particular customer-supplier relationship (Williamson 1975). In addition, when the supplier moves first to make a relationship-specific investment, the outcomes from the investment are not perfectly describable; thus, the supplier cannot write a binding contract with the customer on the price, production capacity, or production quantity at that point in time (Tirole 1999; Taylor and Plambeck 2007). As a result, once the relationship-specific investment is made, the customer is able to appropriate most of the surplus generated by the investment because the supplier barely has an alternative use for the investment.

5. As mentioned earlier, the information contained in customer RFDs is likely to correlate with the information that suppliers gather from other sources. We acknowledge that such a possibility could lessen our contribution to this literature. However, as suggested by the results of our cross-sectional analyses, customer RFDs appear to be more useful to suppliers at an information disadvantage in the supply chain (e.g., those with lower bargaining power over customers). In addition, customer RFDs in 10-K reports can help suppliers verify the customer risk information obtained elsewhere. Therefore, customer RFDs could still be incrementally useful to suppliers in general.

Anticipating rent extraction by customers decreases suppliers' ex ante investment incentive and thereby results in underinvestment by suppliers, which is identified by economics researchers as the "hold-up" problem (Klein et al. 1978; Grossman and Hart 1986; Hart and Moore 1988, 1990).

Joskow (1987) suggests that reputational considerations may impose a natural market constraint on "bad behavior" ex post. By maintaining long-term relationships and honoring implicit contracts with suppliers, firms receive a reputational "premium" that could lead to discounted prices or more favorable trading terms. Levin (2003) considers a repeated game setting in which the principal (customer) promises to pay the agent (supplier) based on the outcome of its action but cannot write a formal contract. If the customer reneges, the supplier can refuse to cooperate in the future. However, for customers in distress or facing greater risks, the gains from reneging are likely to be larger than the present value of the reputational premium or future cooperation with suppliers (Dou et al. 2013). The supply chain management literature suggests that carefully designed relational contracts can reduce customers' incentives to renege and mitigate the hold-up problem faced by suppliers (e.g., Debo and Sun 2004; Taylor and Plambeck 2007). However, optimal relational contracts can be very complex and often rely on the repeated game setting to create incentives for customers to adhere to the contracts. Again, a customer in distress may care less about future gains deriving from a good relationship with its supplier, and thus is more likely to renege on the relational contract.

The supplier overinvestment problem, conversely, is caused by customers' incentives to inflate their demand to suppliers, which is well documented in the supply chain literature (e.g., Lee et al. 1997; Cachon and Lariviere 2001; Sahin and Robinson 2002; Chatfield et al. 2004). Forrester (1958) first identifies the supply chain's natural tendency to amplify demand information and names it the "bullwhip" effect. Typically, customers provide demand forecasts in advance so that suppliers can build production capacity. Such demand forecasts are usually provided through informal relationship-based communications, and thus provide no legal recourse. Since the cost of suppliers' extra capacity is not borne by customers, customers would prefer their suppliers to have sufficient capacity to prevent inventory stock-out in case that demand happens to be high. As a result, customers tend to bias their demand information upward when communicating with their suppliers privately. Especially, when suppliers sell only to a limited number of major customers, these customers have relatively strong bargaining power and can exert greater pressure on dependent suppliers to maintain a higher level of production capacity and inventory holdings (e.g., Porter 1974; Cachon and Terwiesch 2012).[6]

To better evaluate the value of relationship-specific investments and to achieve higher investment efficiency, it is important for supplier firms to be informed about their customers' future prospects and ability to fulfill obligations (Kreps et al. 1982; Raman and Shahrur 2008; Dou et al. 2013). Effective for filings submitted on or after December 1, 2005, the SEC requires firms to provide RFDs under Item 1A—Risk Factors in 10-K and 10-Q reports. By mandating a separate risk factor section in corporate filings, the SEC aims to enhance investors' understanding of firms' fundamental risks and to assist investors in making more informed decisions. Although the mandated RFDs are deemed as boilerplate or redundant by critics (Malone 2005), recent papers (e.g., Campbell et al. 2014; Hope et al. 2016; Chiu et al. 2017) document that the amount and specificity of risk disclosures in the annual report increase investors' perception of firm risk, while decreasing information asymmetries in the equity and debt markets. These findings suggest that RFDs are useful to capital market participants. Similarly, Kravet and Muslu (2013) examine the textual risk disclosures in the whole 10-K and provide consistent evidence that these textual disclosures increase investors' risk perceptions. Together, these studies suggest that narrative risk disclosures, either in the risk factor section alone or in the entire 10-K, are relevant to debt and equity investors.

Different from the studies discussed above, we attempt to examine the usefulness of firms' RFDs in annual reports from the perspective of product market participants, in particular, firms' suppliers. Since RFDs contain information about firms' fundamental risk that is critical to suppliers

6. In contrast, Patatoukas (2012) and Ak and Patatoukas (2016) show that a more concentrated customer base improves suppliers' operating performance because it facilitates supply chain collaboration.

in evaluating the outcome of their relationship-specific investments, such disclosures could affect suppliers' investment decisions and, in turn, their investment efficiency. For instance, suppliers can learn from their customers' RFDs about factors that may adversely affect their customers' sales, profitability, and operations, which could help them better assess the outcomes of their relationship-specific investments. It is unclear, however, whether public disclosures made by customers can be incrementally informative to suppliers. Through a close customer-supplier relationship (or other private channels), it is probable that suppliers can obtain information that is timelier or richer than publicly disclosed information. However, as mentioned earlier, the information provided by customers in their private communication with suppliers is not necessarily credible (e.g., inflated demand forecasts by customers), especially when the suppliers have less bargaining power over customers (e.g., dependent suppliers whose sales are reliant on a few major customers). In addition, small suppliers are also less likely to receive privileged information from sources other than their customers' public disclosures (e.g., from consulting firms or dominant customers), considering their limited resources and bargaining disadvantages. Therefore, the audited annual reports would be a more reliable and easily accessible source for suppliers to gather information about their customers' business risks. Particularly, the reliability or credibility of RFDs in annual reports comes from the legal liability faced by firms when failing to disclose a material risk publicly to their shareholders. For example, Credit Suisse was sued in a recent securities class action lawsuit for concealing the degree of its risk exposure to mortgage-backed securities in its SEC filings (Campbell et al. 2014).

To shed light on the usefulness of accounting information along the supply chain, recent studies provide evidence that the quality of accounting information matters to firms' suppliers (e.g., Raman and Shahrur 2008; Hui et al. 2012; Dou et al. 2013; Radhakrishnan et al. 2014). Raman and Shahrur (2008) and Dou et al. (2013) contend that through income smoothing, customers signal low distress risk to their suppliers, thereby increasing their suppliers' relationship-specific investments. Hui et al. (2012) document that firms report earnings more conservatively when their suppliers or customers have greater bargaining power, suggesting that firms' reported earnings matter to their suppliers and customers. If customers' RFDs provide incrementally useful information to their suppliers, it will assist suppliers in assessing customers' risks and ability to fulfill contracts, allowing them to better predict the outcomes of their relationship-specific investments. It is well noted in the research on information sharing along the supply chain that information credibility is one of the key factors determining the effectiveness and efficiency of information sharing and hence the overall investment efficiency of the supply chain (e.g., Sahin and Robinson 2002). Radhakrishnan et al. (2014) argue that high-quality capital market information, as a commitment mechanism, can build trust in the demand information provided to suppliers via private communications. Consistent with this argument, they find that high-quality capital market information is associated with better operating performance of firms' suppliers.

Based on the above discussions, we contend that customer RFDs in 10-K filings allow suppliers either to collect additional information about their customers' business risks or to verify the information that they have known from other channels regarding their customers' risk exposures. Consequently, we expect more informative customer RFDs to be associated with better investment efficiency of suppliers and propose the following hypothesis, stated in alternative form:

HYPOTHESIS. *The informativeness of major customers' RFDs is negatively associated with the likelihood of their suppliers' under- or overinvestment, all else being equal.*

3. Research design

Measurement of RFD informativeness

We conduct textual analysis on the risk factor section of 10-K filings to measure the informativeness of RFDs in firms' annual reports. We first download 10-Ks from the SEC's Electronic Data Gathering, Analysis, and Retrieval (EDGAR) FTP server and use the Python programming language to parse and extract Item 1A—Risk Factors. We attempt to capture the informativeness of

RFDs or how detailed firms are in describing their risk factors, using the following three measures. The first two measures, following Campbell et al. (2014), are the length of the disclosure (*LENGTH*) and the number of risk-related words therein (*RISK_WORDS*), respectively. *LENGTH* measures the total number of words in the risk factor section of the 10-K. When more words are used, it is likely that additional explanations are offered when discussing firms' risk factors. As a result, more details can be learned or verified by suppliers regarding their customers' business risk. *RISK_WORDS* is the number of risk keywords, as defined by Campbell et al. (2014), contained in Item 1A.[7] The number of risk keywords in RFDs, to some extent, reflects how firm-specific the risk disclosures are, and more firm-specific (i.e., less generic) RFDs tend to be more informative regarding the various business risks faced by firms. In addition to these two measures, we use the number of forward-looking keywords in Item 1A (*FL_WORDS*) as the third measure to capture the amount of forward-looking information contained in the risk factor section. Suppliers can learn or verify more of their customers' business risks and future prospects when customer RFDs contain more forward-looking information. We follow Li (2010) and Muslu et al. (2015) in defining the forward-looking keywords.[8]

Overall, these three measures are expected to reflect the amount of information/details regarding firms' underlying risk that their suppliers can obtain from their RFDs, which can help reduce the information gap between firms and their suppliers. As suppliers know more about their customers' specific business risk, they can make more optimal decisions and achieve better investment efficiency. These three measures, however, might also capture the level of firm risk. Suppliers are more likely to underinvest when they perceive their customers to be of higher risk. To control for this effect, we follow Campbell et al. (2014) to include both pre- and post-disclosure measures of firm risk as control variables when testing the relation between customer RFDs and supplier investment efficiency. In this way, it enables us to test whether the disclosures improve suppliers' investment efficiency conditional on their risk perceptions.

Identification of major customers

Following previous research (e.g., Banerjee et al. 2008), we identify a firm's major customers using the information provided by COMPUSTAT. SFAS Nos. 14 and 131 require firms to disclose any customer that accounts for more than 10 percent of sales. The names of those major customers are obtained from the COMPUSTAT industry segment customer file, and are manually matched with their corresponding COMPUSTAT identifiers (GVKEY). When a supplier firm sells to a few major customers, a large proportion of its sales depend on those customers. As a result, the firm has a more or less bilateral relationship with each of its major customers, and its assets become specific to those major customers or the firm has to invest in relationship-specific assets to support the unique transactions with its major customers (Banerjee et al. 2008). Since the supplier firms in our sample are dependent suppliers with major customers that account for more than 10 percent of their total sales, their investments tend to be largely relationship-specific.

Regression model

To test our hypothesis, we follow the approach of Biddle et al. (2009) to measure a firm's deviation from the expected level of investment and identify under- and overinvestment using the residuals from the following equation:

$$INVEST_{t+1} = \alpha_0 + \alpha_1 SGrowth_t + \varepsilon_{t+1}, \quad (1)$$

7. Please see supporting information in the online Appendix for the list of risk keywords defined by Campbell et al. (2014).
8. Please see supporting information in the online Appendix for forward-looking keywords used in Li (2010) and Muslu et al. (2015).

where $INVEST_{t+1}$ is total investment at year $t + 1$, measured as the sum of R&D expense, capital expenditure, and acquisition expenditure, less cash receipts from the sale of property, plant, and equipment (PPE) and depreciation and amortization, scaled by lagged total assets.[9] Because a large subset of firms report missing R&D in their financial statements, we set the missing R&D expenditure to the yearly industry average, with the industry membership defined according to the 4-digit Standard Industrial Classification (SIC) code.[10] $SGrowth_t$ is the percentage change in sales from year $t - 1$ to t. Following Biddle et al. (2009), equation (1) is estimated by year and industry for all SIC 2-digit industries with at least 20 observations in a given year. In each sample year, we sort firms into quartiles based on the residuals from equation (1).[11] We then define a categorical variable R_INVEST_{t+1} according to the quartiles of the residuals from equation (1). This variable R_INVEST_{t+1} is set to 1 for firm-years with the most negative residuals in the bottom quartile (i.e., the underinvesting group), 2 for firm-years with residuals in the middle two quartiles (i.e., the benchmark group), and 3 for firm-years with the most positive residuals in the top quartile (i.e., the overinvesting group).[12]

Next, we estimate the following multinomial logistic model to predict the likelihood of a firm being in the under- or overinvesting group as opposed to the benchmark group:

$$\begin{aligned} R\_INVEST_{t+1} = {} & \beta_0 + \beta_1 CRISKF_t + \beta_2 CWORD\_10K_t + \beta_3 CRETURN_t + \beta_4 CSTDRET_t \\ & + \beta_5 CRETURN_{t+1} + \beta_6 CSTDRET_{t+1} + \sum \beta_l Control_{l,t} + \varepsilon_{t+1}, \end{aligned} \tag{2}$$

where $CRISKF_t$ is one of the following three measures used to proxy for the informativeness of customer RFDs: *CLENGTH*, *CRISK_WORDS*, or *CFL_WORDS*, calculated as the natural logarithm of the weighted average of *LENGTH*, *RISK_WORDS*, or *FL_WORDS*, respectively, for disclosed major customers of each supplier firm.[13] Specifically, *CLENGTH* is the natural logarithm of the weighted average of the total number of words in customers' RFDs, where the weight is a supplier's sales to a major customer divided by the supplier's total sales to all disclosed major customers. *CRISK_WORDS* is the natural logarithm of the weighted average of the number of risk-related words featured in customers' RFDs, with the risk keywords being those defined in Campbell et al. (2014). *CFL_WORDS* is the natural logarithm of the weighted average of the number of forward-looking keywords, as defined by Li (2010) and Muslu et al. (2015), featured in customers' RFDs. For *CRISK_WORDS* and *CFL_WORDS*, the weight is the same as in calculating *CLENGTH*. Since equation (2) estimates simultaneously the probability of being in the under- or overinvesting group against the benchmark group, β_1 is expected to be negative, given

9. Following Biddle et al. (2009), we include both capital and non-capital expenditure in total investment. The inferences of the results remain qualitatively similar if we exclude non-capital expenditure (acquisitions) from the measurement, although the results regarding overinvestment become weaker in terms of statistical significance.
10. Koh and Reeb (2015) find that firms that report missing R&D file 14 times more patents than firms that report zero R&D, suggesting that it is not appropriate to set missing R&D as being equal to 0. Their Monte Carlo simulation results indicate that setting missing R&D to the industry mean is a better method to handle missing R&D than setting it to 0. Albeit weaker, our main results remain qualitatively similar if we set missing R&D to 0.
11. Our results remain similar if we use terciles instead of quartiles to classify the observations as under-, over-, and normal investment.
12. Alternatively, we adopt an expanded model of the expected level of investment, following Richardson (2006), to define under-, over-, and normal investment. Specifically, in the first-stage model, we regress total investment on a variety of firm characteristics, including growth opportunities, leverage, cash balance, firm age, size, stock returns, total investment in the previous year, and year and industry fixed effects to estimate the expected level of investment. We then use the residuals from the first-stage regression to classify observations into under-, over-, and normal investment groups (using the same approach as in the main analyses). The inferences of the results remain the same.
13. The results estimated using customer-supplier-firm-year observations are qualitatively similar.

that our hypothesis predicts the informativeness of customers' RFDs to be associated with a lower likelihood of under- or overinvestment by suppliers.

The number of words in RFDs tends to be highly correlated with the total length of the 10-K. Prior studies (e.g., Li 2008) also suggest that a lengthy 10-K represents a low degree of readability.[14] Hence, we include the length of customers' 10-Ks (*CWORD_10K*) in equation (2) to control for the correlation between the length of RFDs and 10-K length as well as the effect of 10-K readability. *CWORD_10K* is measured as the natural logarithm of the sales-weighted average of the total number of words in customers' 10-Ks. By controlling for the length of 10-Ks, our RFD measures are intended to capture the portion of the 10-K report pertinent to the descriptions and discussions of risk factors, and thus are more likely to reflect the informativeness of RFDs.

Campbell et al. (2014) argue that when a firm is perceived as riskier, information asymmetry increases because the firm or informed investors may have a greater information advantage (Kyle 1985; Demsetz 1986; Jayaraman 2008). In the context of our study, the RFD itself is expected to decrease the information gap between the firm and its suppliers. However, it may also represent higher customer risk, possibly increasing the information gap between the firm and its suppliers instead. To exclude the confounding effect of RFDs on changing perceived customer risk, we follow Campbell et al. (2014) to control for pre- and post-disclosure customer risk. Due to the difficulty of measuring suppliers' perception of customers' underlying risks, we use equity investors' risk perception as a proxy and include the following market-based measures of firm risk in equation (2): *CRETURN*, the weighted average of customers' annual stock returns, and *CSTDRET*, the weighted average of customers' standard deviation of daily abnormal stock returns for the 250 trading days ending two trading days before the 10-K release. The abnormal stock returns are the error terms from the market model, with a firm-specific coefficient on market returns.[15]

Following Biddle et al. (2009), a set of governance variables (*GOV*) are included to control for the effect of corporate governance on investment efficiency, including institutional holdings (*INST*), analyst following (*NUMEST*), and the governance index (i.e., G-index) developed by Gompers et al. (2003) (*GINDEX*). We also include other firm characteristics, as in Biddle et al. (2009), to control for their effects on investment efficiency. These variables include firm size (*SIZE*), book-to-market ratio (*BM*), cash flow, sales, and investment volatility (*STDCFO*, *STDSALE*, and *STDINVEST*), Altman's Z-score (*ZSCORE*), asset tangibility (*TAN*), leverage (*LEV*), industry leverage (*LEV_IND*), operating cash flows relative to sales (*CFOSALE*), cash slack relative to PPE (*SLACK*), dividend payout (*DIV*), firm age (*AGE*), operating cycle (*OPCYCLE*), and loss (*LOSS*).[16] Detailed definitions of these variables are provided in the Appendix.

4. Empirical analyses

Sample, data, and descriptive statistics

Our initial sample consists of 36,264 firm-years with textual analysis data available for 10,222 firms from their 10-Ks filed via EDGAR over the period 2005 to 2011. After merging with COMPUSTAT, 9,392 firm-years of 3,242 firms are dropped because of no corresponding GVKEYs. Within this sample, we identify 4,315 firm-years for 1,444 firms that disclose the names of their major customers. We further exclude 260 firm-years for 83 firms in the financial industries. After requiring the necessary data from

14. Li (2008) argues that, as 10-Ks become lengthier and more complex, information users find it more difficult to understand the content. In his paper, 10-K length is used as a measure of readability.

15. We observe that customer and supplier RFDs are significantly correlated (with a correlation of 0.2 and above). To address the concern that customer RFDs capture similar risks faced by suppliers and, in turn, affect suppliers' investment efficiency, we control for suppliers' risk levels using market-based risk measures (i.e., annual stock return and stock return volatility) before and after the filing of customers' RFDs, and find qualitatively similar results.

16. As a robustness check, we also include additional control variables, such as customer profitability, volatility of customer profitability, as well as supplier effective tax rate and financing activities. Our results remain unchanged. To preserve our sample size, we do not include these control variables in the main analyses.

TABLE 1
Sample selection

	Firm-years	Firms
Textual data from 10-Ks filed during 2005–2011	36,264	10,222
Less:		
Observations dropped when merging with the GVKEYs in COMPUSTAT	(9,392)	(3,242)
Observations without the required data on major customers	(22,557)	(5,536)
Firms in financial industries (SIC 6000–6999)	(260)	(83)
Observations without necessary data to construct regression variables	(2,226)	(681)
Final sample	1,829	680

Notes: This table reports the sample selection procedure during the sample period of 2005–2011.

COMPUSTAT, the Center for Research in Security Prices (CRSP), the Institutional Brokers' Estimate System (I/B/E/S), the Thomson-Reuters Institutional Holdings (13F), and the Institutional Shareholder Services (ISS) databases to construct the regression variables, the final sample consists of 1,829 firm-years of 680 firms. The sample selection procedure is summarized in Table 1.

Panel A of Table 2 presents the descriptive statistics of major regression variables. The mean of R_INVEST_{t+1} is 1.899, with the median, Q1, and Q3 being 2, suggesting that there are more firm-years in the underinvesting group than in the overinvesting group in our sample. Before we take the logarithm, the mean and median of $CLENGTH_t$ are 4,219 and 3,502, respectively. Given the mean and median of 10-K length (51,203 and 47,101, respectively, for *CWORD_10K*), the risk factor section accounts for approximately 8 percent of the entire 10-K. It also shows that, on average, firms disclose 207 risk keywords (*CRISK_WORDS*) and 149 forward-looking keywords (*CFL_WORDS*) in the risk factor section of their 10-Ks, and a median firm discloses about 167 risk keywords and 115 forward-looking keywords in Item 1A.

Panel B of Table 2 reports the results of a univariate analysis based on the quartiles of customer RFDs. Specifically, we present the percentage of firm-years with under-, over-, and normal investment in each quartile based on *CLENGTH*, *CRISK_WORDS*, and *CFL_WORDS*, respectively.[17] In panel B, we observe an increase in the percentage of observations with normal investment from the lower to the upper quartiles of *CLENGTH* and *CRISK_WORDS*. The percentage of overinvestment observations also seems to decrease as the informativeness of customer RFDs increases. For underinvestment, there is no clear pattern across different quartiles. Taken together, the increase in the likelihood of normal investment and the decrease in the likelihood of overinvestment from the lower to the upper quartiles of customer RFDs suggest that as customers' RFDs become more informative, suppliers' investment efficiency is improved, providing preliminary support for our hypothesis.

Panel C of Table 2 reports the correlations between major regression variables. Because our dependent variable *R_INVEST* captures investment inefficiency at both ends of its distribution, it is difficult to interpret the correlations between *R_INVEST* and other variables. We observe strong and positive correlations among the three test variables *CLENGTH*, *CRISK_WORDS*, and *CFL_WORDS*, indicating that these three variables capture similar constructs. In addition, the

17. In the initial sample that we use to estimate the model of the expected level of investment in equation (1), under- and overinvestment observations each constitute about 25 percent of the sample, and normal investment observations constitute about 50 percent of the sample. When requiring the firms to have data on the identities of major customers, the sample size drops significantly as shown in Table 1, and this requirement restricts our sample to relatively small-size supplier firms that disclose the names of their major customers. In this step, there is a larger loss of overinvestment observations in the sample (by proportion), possibly because those small suppliers are more cash/resource constrained and thus are less likely to overinvest. As a result, the final sample consists of about 22 percent underinvestment, 66 percent normal investment, and 12 percent overinvestment observations, respectively.

TABLE 2
Descriptive statistics and correlations

Panel A: Summary statistics on major variables

	N	Mean	Median	S.D.	Q1	Q3
R_INVEST_{t+1}	1,829	1.899	2.000	0.571	2.000	2.000
$CRISKF_t$: *CLENGTH*	1,829	4,219.422	3,502.444	2,885.658	2,346.000	5,396.000
$CRISKF_t$: *CRISK_WORDS*	1,829	207.183	166.690	145.788	111.490	264.000
$CRISKF_t$: *CFL_WORDS*	1,829	149.417	115.397	103.301	75.208	200.000
$CWORD\_10K_t$	1,829	51,203.071	47,101.000	26,728.214	34,302.000	62,714.802
$CRETURN_t$	1,829	0.093	0.075	0.406	−0.116	0.243
$CSTDRET_t$	1,829	0.016	0.014	0.010	0.010	0.019
$CRETURN_{t+1}$	1,829	0.104	0.060	0.432	−0.107	0.233
$CSTDRET_{t+1}$	1,829	0.016	0.014	0.010	0.010	0.019
$INST_t$	1,829	0.573	0.631	0.334	0.290	0.857
$NUMEST_t$	1,829	5.781	4.000	6.406	1.000	9.000
$GINDEX_t$	1,829	−0.584	0.000	2.316	0.000	0.000
$SIZE_t$	1,829	5.707	5.590	1.830	4.359	7.017
BM_t	1,829	0.678	0.642	0.322	0.437	0.864
$STDCFO_t$	1,829	0.108	0.068	0.159	0.041	0.113
$STDSALE_t$	1,829	0.292	0.197	0.347	0.100	0.353
$STDINVEST_t$	1,829	0.201	0.071	0.536	0.034	0.168
$ZSCORE_t$	1,829	4.120	3.313	6.207	1.676	5.725
TAN_t	1,829	0.185	0.123	0.189	0.056	0.237
LEV_t	1,829	0.124	0.035	0.175	0.000	0.190
LEV_IND_t	1,829	0.124	0.100	0.081	0.066	0.156
$CFOSALE_t$	1,829	−0.059	0.077	0.989	0.009	0.161
$SLACK_t$	1,829	5.774	1.551	13.397	0.323	5.328
DIV_t	1,829	0.247	0.000	0.431	0.000	0.000
AGE_t	1,829	2.655	2.639	0.731	2.197	3.178
$OPCYCLE_t$	1,829	4.714	4.778	0.690	4.373	5.119
$LOSS_t$	1,829	0.387	0.000	0.487	0.000	1.000

(The table is continued on the next page.)

TABLE 2 (continued)

Panel B: Distribution of under-, over-, and normal investment based on the quartiles of customer RFDs

CLENGTH	1st quartile (*N* = 457)	2nd quartile (*N* = 457)	3rd quartile (*N* = 458)	4th quartile (*N* = 457)
Underinvestment	21.88%	20.57%	22.71%	22.32%
Normal investment	64.77%	65.86%	67.25%	67.61%
Overinvestment	13.35%	13.57%	10.04%	10.07%
CRISK_WORDS	1st quartile (*N* = 457)	2nd quartile (*N* = 457)	3rd quartile (*N* = 460)	4th quartile (*N* = 455)
Underinvestment	22.10%	21.66%	22.61%	21.10%
Normal investment	64.99%	65.21%	67.39%	67.91%
Overinvestment	12.91%	13.13%	10.00%	10.99%
CFL_WORDS	1st quartile (*N* = 457)	2nd quartile (*N* = 457)	3rd quartile (*N* = 458)	4th quartile (*N* = 457)
Underinvestment	21.44%	19.47%	23.14%	23.41%
Normal investment	65.86%	66.96%	65.28%	67.40%
Overinvestment	12.69%	13.57%	11.57%	9.19%

(The table is continued on the next page.)

TABLE 2 (continued)

Panel C: Pearson correlations

Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	R_INVEST_{t+1}	1.000													
2	$CLENGTH_t$	−0.020	1.000												
3	$CRISK\_WORDS_t$	0.004	**0.970**	1.000											
4	CFL_WORDS_t	−0.020	**0.973**	**0.954**	1.000										
5	$CWORD\_10K_t$	**−0.076**	**0.394**	**0.386**	**0.381**	1.000									
6	$CRETURN_t$	0.018	0.028	0.037	0.013	0.036	1.000								
7	$CSTDRET_t$	0.008	**0.310**	**0.298**	**0.316**	**0.078**	**−0.125**	1.000							
8	$CRETURN_{t+1}$	−0.037	**0.093**	**0.096**	**0.084**	**0.095**	**−0.200**	**0.378**	1.000						
9	$CSTDRET_{t+1}$	0.006	**0.264**	**0.249**	**0.265**	**0.047**	**−0.294**	**0.661**	−0.019	1.000					
10	$INST_t$	0.006	−0.033	**−0.041**	**−0.045**	−0.012	0.003	−0.006	−0.015	0.010	1.000				
11	$NUMEST_t$	**−0.057**	0.024	0.018	0.009	0.037	−0.019	−0.036	−0.026	−0.026	**0.524**	1.000			
12	$GINDEX_t$	−0.024	**0.062**	**0.058**	**0.067**	−0.004	0.010	**0.092**	0.037	**0.069**	**−0.185**	**−0.162**	1.000		
13	$SIZE_t$	**0.045**	0.026	0.025	0.000	**0.046**	−0.019	−0.035	0.003	−0.018	**0.590**	**0.702**	**−0.216**	1.000	
14	BM_t	**0.078**	0.016	0.032	0.016	0.015	**−0.044**	**0.148**	**0.161**	**0.063**	**−0.149**	**−0.304**	**0.087**	**−0.054**	1.000
15	$STDCFO_t$	**−0.051**	0.034	0.030	**0.041**	0.010	−0.017	0.028	−0.030	0.019	**−0.192**	**−0.120**	**0.059**	**−0.288**	**−0.127**
16	$STDSALE_t$	−0.014	0.006	−0.005	0.010	−0.002	−0.001	**0.056**	0.031	0.026	**−0.174**	**−0.158**	**0.063**	**−0.233**	0.016
17	$STDINVEST_t$	−0.036	0.036	**0.050**	**0.044**	**0.074**	−0.012	0.001	0.017	0.000	**−0.151**	**−0.085**	**0.045**	**−0.166**	**−0.049**
18	$ZSCORE_t$	**0.044**	**−0.048**	**−0.050**	**−0.050**	**−0.091**	**0.041**	**−0.076**	−0.031	**−0.069**	**0.204**	**0.161**	**−0.090**	**0.107**	**−0.275**
19	TAN_t	**0.129**	**0.047**	**0.131**	**0.054**	**0.085**	0.018	**0.065**	0.026	**0.091**	**−0.061**	0.000	**0.043**	**0.120**	**0.090**
20	LEV_t	**0.072**	−0.007	0.003	−0.014	0.025	**−0.067**	**0.050**	**0.065**	0.020	**0.077**	0.022	0.002	**0.314**	**0.317**
21	LEV_IND_t	**0.151**	0.016	0.029	0.012	**−0.040**	**−0.057**	**0.182**	**0.166**	**0.105**	**0.041**	**−0.044**	0.032	**0.200**	**0.236**
22	$CFOSALE_t$	−0.014	**−0.053**	**−0.039**	**−0.048**	−0.003	−0.003	−0.006	0.020	0.014	**0.078**	**0.075**	**−0.044**	**0.183**	**0.123**
23	$SLACK_t$	**−0.078**	**0.050**	0.033	**0.043**	0.014	**0.077**	0.006	−0.033	−0.023	**−0.057**	**−0.048**	0.014	**−0.180**	**−0.105**
24	DIV_t	**0.126**	**−0.075**	**−0.074**	**−0.099**	−0.026	−0.013	−0.002	0.018	0.008	0.038	**0.086**	**−0.078**	**0.290**	**−0.046**
25	AGE_t	**0.104**	−0.025	−0.035	**−0.041**	0.027	**0.051**	**−0.051**	**0.052**	**−0.068**	**0.082**	**0.041**	**−0.099**	**0.200**	**0.137**
26	$OPCYCLE_t$	**0.116**	**−0.122**	**−0.122**	**−0.108**	**−0.130**	0.008	**−0.094**	−0.038	**−0.063**	**0.127**	0.003	**−0.049**	**0.063**	**0.042**
27	$LOSS_t$	**−0.091**	**0.062**	**0.055**	**0.071**	−0.007	0.009	**0.111**	0.021	0.033	**−0.192**	**−0.209**	**0.088**	**−0.282**	**0.121**

(The table is continued on the next page.)

TABLE 2 (continued)

Panel C: Pearson correlations

Variables		15	16	17	18	19	20	21	22	23	24	25	26	27
1	R_INVEST_{t+1}													
2	$CLENGTH_t$													
3	$CRISK\_WORDS_t$													
4	CFL_WORDS_t													
5	$CWORD\_10K_t$													
6	$CRETURN_t$													
7	$CSTDRET_t$													
8	$CRETURN_{t+1}$													
9	$CSTDRET_{t+1}$													
10	$INST_t$													
11	$NUMEST_t$													
12	$GINDEX_t$													
13	$SIZE_t$													
14	BM_t													
15	$STDCFO_t$	1.000												
16	$STDSALE_t$	**0.425**	1.000											
17	$STDINVEST_t$	**0.371**	**0.235**	1.000										
18	$ZSCORE_t$	**−0.114**	0.033	**−0.078**	1.000									
19	TAN_t	**−0.119**	**−0.172**	**0.078**	**−0.080**	1.000								
20	LEV_t	**−0.125**	**−0.088**	0.024	**−0.278**	**0.338**	1.000							
21	LEV_IND_t	**−0.111**	**−0.049**	−0.006	**−0.054**	**0.319**	**0.414**	1.000						
22	$CFOSALE_t$	**−0.254**	0.002	**−0.079**	**0.166**	**0.132**	**0.078**	**0.102**	1.000					
23	$SLACK_t$	**0.229**	**0.085**	0.031	**0.090**	**−0.317**	**−0.212**	**−0.206**	**−0.259**	1.000				
24	DIV_t	**−0.119**	**−0.142**	**−0.040**	**0.056**	**0.124**	**0.107**	**0.239**	**0.089**	**−0.117**	1.000			
25	AGE_t	**−0.250**	**−0.207**	**−0.188**	**0.060**	−0.034	**0.055**	**0.128**	**0.100**	**−0.123**	**0.285**	1.000		
26	$OPCYCLE_t$	**−0.118**	**−0.164**	**−0.134**	**0.131**	**−0.158**	**−0.045**	**−0.126**	**0.063**	**−0.104**	0.014	**0.184**	1.000	
27	$LOSS_t$	**0.201**	**0.046**	**0.100**	**−0.349**	**−0.060**	**0.074**	**−0.095**	**−0.261**	**0.125**	**−0.231**	**−0.201**	**−0.061**	1.000

Notes: Panel A presents the descriptive statistics on the major regression variables. Panel B reports the distribution of under-, over-, and normal investment observations based on the quartiles of customer RFDs. Panel C reports the Pearson correlations between the major regression variables, where the values in bold are significant at the 0.10 level or better. All variables are as defined in the Appendix.

TABLE 3
Customer RFDs and supplier investment efficiency

	Underinvestment vs. normal investment			Overinvestment vs. normal investment		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable = R_INVEST_{t+1}	*CLENGTH*	*CRISK_WORDS*	*CFL_WORDS*	*CLENGTH*	*CRISK_WORDS*	*CFL_WORDS*
$CRISKF_t$	−0.280**	−0.332***	−0.274**	−0.274**	−0.265*	−0.297**
	(−2.43)	(−3.08)	(−2.49)	(−2.00)	(−1.94)	(−2.36)
$CWORD\_10K_t$	0.434***	0.456***	0.431***	0.113	0.103	0.130
	(2.59)	(2.69)	(2.58)	(0.55)	(0.50)	(0.64)
$CRETURN_t$	−0.252	−0.243	−0.264	−0.341*	−0.341*	−0.348*
	(−1.21)	(−1.17)	(−1.28)	(−1.65)	(−1.65)	(−1.70)
$CSTDRET_t$	1.408	2.287	2.194	21.642*	21.480*	22.720*
	(0.13)	(0.21)	(0.20)	(1.71)	(1.70)	(1.79)
$CRETURN_{t+1}$	0.377**	0.380**	0.364**	−0.236	−0.230	−0.245
	(2.28)	(2.31)	(2.21)	(−1.17)	(−1.14)	(−1.22)
$CSTDRET_{t+1}$	16.006**	16.169**	15.582*	6.655	6.400	6.403
	(1.97)	(1.99)	(1.93)	(0.54)	(0.52)	(0.53)
$INST_t$	0.115	0.105	0.111	0.420	0.421	0.424
	(0.33)	(0.30)	(0.32)	(1.05)	(1.05)	(1.06)
$NUMEST_t$	0.027	0.028	0.028	−0.022	−0.022	−0.022
	(1.32)	(1.32)	(1.32)	(−0.88)	(−0.88)	(−0.87)
$GINDEX_t$	0.017	0.017	0.017	−0.026	−0.027	−0.026
	(0.65)	(0.64)	(0.65)	(−0.84)	(−0.86)	(−0.83)
$SIZE_t$	−0.120	−0.117	−0.122	−0.105	−0.105	−0.108
	(−1.43)	(−1.39)	(−1.46)	(−1.01)	(−1.00)	(−1.04)
BM_t	−0.199	−0.188	−0.201	0.563	0.571	0.560
	(−0.66)	(−0.62)	(−0.66)	(1.60)	(1.62)	(1.60)
$STDCFO_t$	−0.077	−0.080	−0.076	−0.451	−0.448	−0.447
	(−0.13)	(−0.13)	(−0.13)	(−0.44)	(−0.44)	(−0.44)
$STDSALE_t$	−0.093	−0.094	−0.094	0.559*	0.560*	0.560*
	(−0.38)	(−0.38)	(−0.39)	(1.95)	(1.95)	(1.95)
$STDINVEST_t$	0.443	0.453	0.447	0.512*	0.520*	0.516*
	(1.53)	(1.54)	(1.55)	(1.86)	(1.87)	(1.87)
$ZSCORE_t$	−0.025	−0.025	−0.025	−0.011	−0.012	−0.011
	(−1.55)	(−1.55)	(−1.55)	(−0.46)	(−0.47)	(−0.46)

(The table is continued on the next page.)

TABLE 3 (continued)

	Underinvestment vs. normal investment			Overinvestment vs. normal investment		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable = R_INVEST_{t+1}	*CLENGTH*	*CRISK_WORDS*	*CFL_WORDS*	*CLENGTH*	*CRISK_WORDS*	*CFL_WORDS*
TAN_t	−3.525***	−3.407***	−3.514***	−1.287**	−1.178*	−1.277**
	(−5.79)	(−5.55)	(−5.78)	(−2.07)	(−1.89)	(−2.06)
LEV_t	−0.018	−0.056	−0.032	−0.412	−0.442	−0.417
	(−0.03)	(−0.09)	(−0.05)	(−0.58)	(−0.62)	(−0.59)
LEV_IND_t	−1.279	−1.279	−1.262	2.774*	2.740*	2.786*
	(−1.12)	(−1.12)	(−1.10)	(1.90)	(1.88)	(1.91)
$CFOSALE_t$	0.283**	0.281**	0.285**	−0.135**	−0.134**	−0.134**
	(2.04)	(2.03)	(2.05)	(−2.13)	(−2.12)	(−2.13)
$SLACK_t$	−0.010	−0.010	−0.010	−0.020	−0.020	−0.020
	(−1.12)	(−1.10)	(−1.14)	(−1.17)	(−1.16)	(−1.18)
DIV_t	−0.131	−0.144	−0.140	0.506**	0.502**	0.496**
	(−0.56)	(−0.62)	(−0.60)	(2.06)	(2.04)	(2.02)
AGE_t	−0.240*	−0.241*	−0.242*	−0.057	−0.058	−0.061
	(−1.87)	(−1.88)	(−1.89)	(−0.35)	(−0.36)	(−0.37)
$OPCYCLE_t$	−0.814***	−0.813***	−0.809***	−0.483***	−0.478***	−0.478***
	(−5.22)	(−5.23)	(−5.20)	(−3.07)	(−3.05)	(−3.03)
$LOSS_t$	−0.042	−0.040	−0.041	−0.726***	−0.727***	−0.725***
	(−0.23)	(−0.23)	(−0.23)	(−3.37)	(−3.38)	(−3.37)
Intercept	2.071	1.198	1.139	1.260	0.454	0.249
	(1.05)	(0.61)	(0.58)	(0.55)	(0.20)	(0.11)
N	1,829	1,829	1,829	1,829	1,829	1,829
Pseudo R^2	0.110	0.111	0.110	0.110	0.111	0.110

Notes: This table presents the estimated results of multinomial logistic regressions of the informativeness of customers' RFDs on suppliers' investment efficiency. *Z*-statistics in parentheses are calculated using robust standard errors clustered by firm. All variables are as defined in the Appendix. The superscripts *, **, and *** represent significance levels of 0.10, 0.05, and 0.01, respectively, in a two-tailed test.

length of 10-Ks (*CWORD_10K*) is positively and significantly correlated with the three test variables, reflecting the need to control for *CWORD_10K* in the regression model. The three test variables also have significantly positive correlations with the market-based measures of firm risk ($CSTDRET_t$, $CRETURN_{t+1}$, and $CSTDRET_{t+1}$), suggesting that the inclusion of those market-based risk measures could help mitigate the effect of RFDs on changing risk perceptions.

Primary analyses

We estimate equation (2) using a multinomial logistic regression to predict the likelihood that a firm falls into the underinvesting (*R_INVEST* = 1) or overinvesting (*R_INVEST* = 3) group against the benchmark group with normal investment levels (*R_INVEST* = 2). The results are reported in Table 3. Columns (1), (2), and (3) report the results regarding underinvestment. The coefficient on *CRISKF* is negative and statistically significant at less than the 5 percent level for all three customer RFD measures (−0.280 with $z = -2.43$ for *CLENGTH*; −0.332 with $z = -3.08$ for *CRISK_WORDS*; −0.274 with $z = -2.49$ for *CFL_WORDS*). These results suggest that the informativeness of customer RFDs is associated with a lower likelihood of underinvestment by suppliers. Columns (4), (5), and (6) present the estimated results of equation (2) regarding overinvestment. In these three columns, the coefficients on *CRISKF* are all significantly negative, as predicted (−0.274 with $z = -2.00$ for *CLENGTH*; −0.265 with $z = -1.94$ for *CRISK_WORDS*; −0.297 with $z = -2.36$ for *CFL_WORDS*). These results indicate that customer RFD informativeness is also negatively associated with suppliers' overinvestment likelihood.[18] In addition, we test the difference in the coefficients on *CRISKF* between under- and overinvestment groups and find that the difference is not statistically significant, indicating that, in general, customer RFDs have a similar association with the likelihood of under- and overinvestment by suppliers.[19]

To gauge the economic significance, we estimate the change in the probability of an average firm falling into the under- or overinvestment group as the measure of customer RFDs increases. For example, for the measure of *CLENGTH*, the estimated probability is 19 percent and 10 percent for under- and overinvestment, respectively, for an average firm. When *CLENGTH* increases by 25 percent, the probability of under- or overinvestment decreases by about 6.7 percent and 3.6 percent, respectively. The economic significance of customer RFDs on supplier investment efficiency is comparable to that of other factors that have been shown to be associated with investment efficiency, such as operating cycle (*OPCYCLE*). The probability of under- or overinvestment decreases by about 10.4 percent and 3.4 percent, respectively, when an average firm's operating cycle increases by 25 percent.[20]

As to control variables, the coefficient on *CWORD_10K* is significantly positive at less than the 1 percent level in columns (1), (2), and (3), suggesting that suppliers' likelihood of underinvestment increases with the length of customers' 10-K reports, while in columns (4), (5), and (6), the coefficient on *CWORD_10K* is positive but insignificant in predicting the likelihood of overinvestment. This result implies that the readability of customers' 10-K filings may affect the quality of suppliers'

18. We also run additional analyses by replacing $CRISKF_t$ with $CRISKF_{t-1}$ and $CRISKF_{t-2}$, respectively. We find that the coefficients on $CRISKF_{t-1}$ are all negative and significant. In contrast, the coefficients on $CRISKF_{t-2}$ are all negative but only significant in the case of underinvestment. Overall, these results seem to suggest that customers' RFDs are associated with suppliers' investment efficiency in two years and some association remains after three years.

19. The *p*-value for the difference in the coefficients on *CLENGTH*, *CRISK_WORDS*, and *CFL_WORDS* between under- and overinvestment is 0.973, 0.673, and 0.881, respectively.

20. It is difficult to interpret the marginal effect of a continuous variable such as *CRISKF* in a multinomial logistic regression. Therefore, to gauge the economic magnitude of the documented effect, we first calculate the probability of an average firm falling into the under- or overinvestment category as $\pi_{ij} = \frac{e^{x_i' \beta_j}}{\sum_\gamma e^{x_i' \beta_\gamma}}$ at the mean values of all independent variables, where *j* represents the three investment categories as denoted by *R_INVEST*. To estimate the change in the probability, we then compute the probability of under- or overinvestment when *CRISKF* increases by 25 percent. The estimates for the other two measures of customer RFDs (*CRISK_WORDS* and *CFL_WORDS*) are of similar magnitude to those of *CLENGTH*. For brevity, we omit discussion on the economic magnitude of these two measures.

investment decisions; in particular, less readable customer annual reports are likely associated with supplier underinvestment problems.

For the market-based measures of firm risk (*CRETURN* and *CSTDRET*), we do not have predictions on the signs of the coefficients. The results indicate that the two post-disclosure firm risk measures ($CRETURN_{t+1}$ and $CSTDRET_{t+1}$) are positively and significantly associated with the likelihood of underinvestment. The coefficient on $CRETURN_t$ is significantly negative and the coefficient on $CSTDRET_t$ is significantly positive in predicting the likelihood of overinvestment. The coefficients on the control variables taken from Biddle et al. (2009) are mostly in line with those reported in their study.

Overall, the results reported in Table 3 support our hypothesis that the informativeness of customer RFDs is negatively associated with the likelihood of supplier under- or overinvestment. These findings suggest that customer RFDs contain useful information that could potentially help suppliers better predict the outcomes of their relationship-specific investment and hence make more informed investment decisions. The information in customer RFDs could be used by suppliers either to understand the underlying risk of their customers or to verify the information about customer risk that they have obtained elsewhere (e.g., from private communications with customers). However, we cannot rule out the possibility that customer RFDs could be simply redundant to the customer risk information that suppliers learn from other channels, considering that firms that are more forthcoming about their business risk in their RFDs are also likely to be more credible when communicating with their suppliers or making other types of disclosures. Therefore, we caution against drawing strong causal inferences from the negative association between customers' RFDs and suppliers' investment efficiency documented in Table 3.

Cross-sectional analyses

Relative bargaining power

Suppliers with weak bargaining power relative to their customers tend to be at an information disadvantage because their customers are less likely to provide them with accurate demand information in private communications. In addition, due to resource constraints, small suppliers with weak bargaining power are less able to collect and process additional information about their customers' demand risk from sources other than public disclosures. Therefore, to such suppliers, customers' RFDs in annual reports could be a relatively more useful and relevant source to obtain information about demand uncertainty. As a result, we expect the informativeness of customer RFDs to have a stronger association with suppliers' investment efficiency for those suppliers with weaker bargaining power.

We use the relative size of suppliers to their customers and customers' product market competition as proxies for the relative bargaining power between customers and suppliers (e.g., Maskin and Riley 1984; Snyder 1996; Kale and Shahrur 2007). Following prior research (e.g., Hui et al. 2012), we measure the relative size of suppliers to their customers using the average market value of firms in each customer's industry over the market value of the supplier firm and then take the sales-weighted average. To proxy for product market competition, we adopt a text-based measure of product market fluidity developed by Hoberg et al. (2014). This measure is constructed based on the textual product descriptions in firms' 10-Ks and captures the degree to which rivals offer similar products.[21] Firms with higher (lower) fluidity scores face more (less) competition from their rivals. To measure customers' product market competition, for each supplier firm-year, we calculate a weighted average fluidity score for the major customers.

Next, we partition our sample based on the median value of the respective measure of relative bargaining power and estimate the multinomial logistic regression of equation (2) separately for each subsample. Panels A and B of Table 4 present the results of under- and overinvestment, respectively, for each subsample partitioned based on suppliers' relative size. In panel A, the results of underinvestment are similar between the two subsamples of relatively small and large

21. The measure from Hoberg et al. (2014) captures product differentiation in addition to competition. If customers' products are unique, suppliers' investments are more specific to the bilateral customer-supplier relationship. The results are qualitatively similar, albeit weaker, when we use the Herfindahl-Hirschman index at the industry level to proxy for industry competition.

TABLE 4
Cross-sectional analysis based on the relative size of suppliers

	(1)		(2)		(3)	
	CLENGTH		*CRISK_WORDS*		*CFL_WORDS*	
Dependent variable = R_INVEST_{t+1}	Large suppliers	Small suppliers	Large suppliers	Small suppliers	Large suppliers	Small suppliers
Panel A: Underinvestment vs. normal investment						
$CRISKF_t$	−0.311**	−0.259**	−0.397***	−0.280**	−0.274**	−0.261**
	(−2.07)	(−1.99)	(−2.97)	(−2.20)	(−2.02)	(−2.02)
p-value for *diff.* between subsamples	0.793		0.526		0.942	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	914	915	914	915	914	915
Pseudo R^2	0.124	0.130	0.127	0.130	0.124	0.131
Panel B: Overinvestment vs. normal investment						
$CRISKF_t$	−0.044	−0.432***	−0.019	−0.424***	−0.037	−0.497***
	(−0.23)	(−2.73)	(−0.10)	(−2.78)	(−0.22)	(−3.32)
p-value for *diff.* between subsamples	0.118		0.103		0.042	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	914	915	914	915	914	915
Pseudo R^2	0.124	0.130	0.127	0.130	0.124	0.131

Notes: This table presents the estimated results of multinomial logistic regressions of the informativeness of customers' RFDs on suppliers' investment efficiency conditional on the relative size of suppliers to their customers, measured as the sales-weighted ratio of the average market value of firms in each customer's industry to the market value of the supplier firm. *Z*-statistics in parentheses are calculated using robust standard errors clustered by firm. All other variables are as defined in the Appendix. The superscripts ** and *** represent significance levels of 0.05 and 0.01, respectively, in a two-tailed test.

suppliers. However, the results of overinvestment reported in panel B indicate that the coefficient on *CRISKF* is significantly negative only for the subsample of relatively small supplier firms. In addition, the difference in the coefficients between the two subsamples is statistically significant at less than the 5 percent level when *CRISKF* is measured by *CFL_WORDS* and marginally significant (at about the 10 percent level) when *CRISKF* is measured by *CLENGTH* or *CRISK_WORDS*. Panels A and B of Table 5 report cross-sectional results conditional on customers' product market competition for under- and overinvestment, respectively. The results in both panels A and B show that the coefficient on *CRISKF* is significantly negative only for the subsample of firms with customers facing lower competition in the product market. In addition, for the underinvestment results in panel A, the difference in the coefficients on *CRISKF* between the two subsamples is statistically significant at less than the 10 percent level when *CRISKF* is measured by *CLENGTH* or *CRISK_WORDS*.

Taken together, the findings in Tables 4 and 5 indicate a stronger association between customer RFDs and supplier investment efficiency for suppliers with information disadvantages. The results suggest that such suppliers are more likely to turn to public disclosures, such as the RFDs in customers' annual reports, for pertinent information to evaluate customers' demand risk.

Durable and nondurable goods industries

Suppliers that produce durable goods are more likely to invest in irreversible relationship-specific assets to support the unique products ordered by their customers (Kale and Shahrur 2007; Banerjee et al. 2008). Hence, compared with nondurable goods suppliers, it is more important for suppliers in the durable goods industries to thoroughly evaluate the potential risk exposures of their customers, and customer RFDs thus could be a more useful source of information to them. We define durable goods suppliers as those suppliers categorized by four-digit SIC codes between 1000 and 4783. We then partition the sample into two subsamples based on whether the firm operates in the durable goods industries, and estimate equation (2) separately for each subsample using the multinomial logistic regression. The estimated results in Table 6 support our prediction. In both panels A and B that report the results of under- and overinvestment, respectively, we find that the coefficients on all three measures of *CRISKF* are negative and significant only for supplier firms in the durable goods industries. In addition, the difference in the coefficients on *CRISKF* between the two subsamples is significant for most *CRISKF* measures in both panels.

It is noteworthy that the magnitude of the coefficient on *CRISKF* is larger for underinvestment in panel A than that for overinvestment in panel B for suppliers in the durable goods industries. Moreover, the difference in coefficients between panels A and B is statistically significant for all three measures of *CRISKF* for suppliers in the durable goods industries. These results imply that customers' RFDs are more helpful in mitigating the underinvestment than the overinvestment problem for durable goods suppliers, because these suppliers are subject to more severe rent extraction by customers due to the relationship-specific nature of their investment.

Demand risk concern by suppliers

When suppliers are more concerned about the volatility of future demand, they are likely to be more diligent in gathering information to make themselves better acquainted with customer risk, and thus may pay closer attention to their customers' RFDs in annual reports. Therefore, the relation between the informativeness of customer RFDs and supplier investment efficiency is expected to be more pronounced for suppliers with greater demand risk concerns. To test this argument, we identify whether suppliers express concerns about the volatility of future demand in their own RFDs of the 10-Ks. We use the measure from Bao and Datta (2014), who categorize and quantify the types of risk disclosed in Item 1A of the 10-K.[22] We separate supplier firms that

22. Bao and Datta (2014) employ the latent Dirichlet allocation topic model and its learning algorithm to quantify and classify the risk factors disclosed in Item 1A into 30 risk types. See Figure 6 of their paper for the risk types identified from RFDs.

TABLE 5
Cross-sectional analysis based on customers' product market competition

	(1)		(2)		(3)	
	CLENGTH		*CRISK_WORDS*		*CFL_WORDS*	
Dependent variable = R_INVEST_{t+1}	High	Low	High	Low	High	Low
Panel A: Underinvestment vs. normal investment						
$CRISKF_t$	−0.103	−0.511***	−0.151	−0.532***	−0.130	−0.444***
	(−0.71)	(−2.81)	(−1.09)	(−3.36)	(−0.94)	(−2.58)
p-value for *diff.* between subsamples	0.074		0.064		0.144	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	910	910	910	910	910	910
Pseudo R^2	0.136	0.155	0.137	0.157	0.137	0.155
Panel B: Overinvestment vs. normal investment						
$CRISKF_t$	−0.063	−0.414**	−0.058	−0.420**	−0.130	−0.376**
	(−0.30)	(−2.05)	(−0.26)	(−2.23)	(−0.66)	(−2.02)
p-value for *diff.* between subsamples	0.224		0.210		0.354	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	910	910	910	910	910	910
Pseudo R^2	0.136	0.155	0.137	0.157	0.137	0.155

Notes: This table presents the estimated results of multinomial logistic regressions of the informativeness of customers' RFDs on suppliers' investment efficiency conditional on customers' product market competition using the measure from Hoberg et al. (2014). *Z*-statistics in parentheses are calculated using robust standard errors clustered by firm. All other variables are as defined in the Appendix. The superscripts ** and *** represent significance levels of 0.05 and 0.01, respectively, in a two-tailed test.

TABLE 6
Cross-sectional analysis based on suppliers' durable goods industry membership

	(1)		(2)		(3)	
	CLENGTH		*CRISK_WORDS*		*CFL_WORDS*	
Dependent variable = R_INVEST_{t+1}	Durable goods	Nondurable goods	Durable goods	Nondurable goods	Durable goods	Nondurable goods
Panel A: Underinvestment vs. normal investment						
$CRISKF_t$	−0.651***	0.373	−0.697***	0.290	−0.661***	0.303
	(−4.74)	(1.11)	(−5.43)	(1.14)	(−4.86)	(1.06)
p-value for *diff*. between subsamples	0.005		0.001		0.002	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	1,432	397	1,432	397	1,432	397
Pseudo R^2	0.102	0.253	0.105	0.253	0.104	0.253
Panel B: Overinvestment vs. normal investment						
$CRISKF_t$	−0.313**	0.448	−0.338**	0.545	−0.356***	0.392
	(−2.10)	(0.99)	(−2.28)	(1.24)	(−2.58)	(1.06)
p-value for *diff*. between subsamples	0.108		0.054		0.056	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	1,432	397	1,432	397	1,432	397
Pseudo R^2	0.102	0.253	0.105	0.253	0.104	0.253

Notes: This table presents the estimated results of multinomial logistic regressions of the informativeness of customers' RFDs on suppliers' investment efficiency conditional on suppliers' durable goods industry membership. Suppliers with SIC codes between 1000 and 4783 are classified as those in the durable goods industries, and the rest are classified as those in nondurable goods industries. *Z*-statistics in parentheses are calculated using robust standard errors clustered by firm. All other variables are as defined in the Appendix. The superscripts ** and *** represent significance levels of 0.05 and 0.01, respectively, in a two-tailed test.

disclose demand risk in their 10-Ks from those that do not, and then estimate equation (2) separately for each subsample using the multinomial logistic regression. The estimated results are reported in Table 7. Panels A and B present results regarding under- and overinvestment, respectively. In panel A, we find that customer RFDs are more strongly associated with supplier investment efficiency for the group of suppliers that are more concerned about volatile demand. The difference in the coefficients on *CRISKF* between the two subsamples is statistically significant at about the 10 percent level across all three columns. However, we do not find clear evidence regarding overinvestment in panel B.

5. Additional analyses and robustness checks

In the additional analyses, we follow another approach in Biddle et al. (2009) to examine whether the informativeness of customer RFDs is positively (negatively) associated with suppliers' investment levels when suppliers are more likely to underinvest (overinvest), and estimate the following model:

$$\begin{aligned} INVEST_{t+1} = {} & \beta_0 + \beta_1 CRISKF_t + \beta_2 CRISKF_t \times OverI_t + \beta_3 CWORD\_10K_t \\ & + \beta_4 CWORD\_10K_t \times OverI_t + \beta_5 OverI_t + \beta_6 GOV_t + \beta_7 GOV_t \times OverI_t \\ & + \beta_8 CRETURN_t + \beta_9 CSTDRET_t + \beta_{10} CRETURN_{t+1} + \beta_{11} CSTDRET_{t+1} \\ & + \sum \beta_l Control_{l,t} + Industry\ Indicators + Year\ Indicators + \varepsilon_{t+1}, \end{aligned} \tag{3}$$

where *OverI* is a ranked variable used to identify the situations in which under- or overinvestment is more likely. Following Biddle et al. (2009), we focus on two firm-specific characteristics, cash balance and leverage, to estimate a firm's tendency to under- or overinvest. Prior studies suggest that firms with a large cash balance are more likely to overinvest because of lower financial constraints and greater agency problems (Jensen 1986; Blanchard et al. 1994). Conversely, firms with high leverage are more financially constrained and prone to suffer from a debt overhang problem, resulting in a higher likelihood of underinvestment (Myers 1977). We take the average of the decile rank scores of firm cash balance deflated by total assets and the negative of firm leverage and scale it to range between 0 and 1 as our composite score of overinvestment (*OverI*). Firms with a low (high) value of *OverI* are more likely to underinvest (overinvest). Our hypothesis predicts that the informativeness of customer RFDs is negatively related to suppliers' tendency to under- and overinvest, and thus we expect that $\beta_1 > 0$, $\beta_2 < 0$, and $\beta_1 + \beta_2 < 0$.[23]

We include the interaction term between *CWORD_10K* and *OverI* in equation (3) to control for the effect of 10-K readability. In addition, we interact the governance variables with *OverI* to control for their effects on investment efficiency. The remaining control variables are the same as those in equation (2), except that *SLACK* and *LEV* are excluded because they are used in defining *OverI.* Finally, we incorporate industry and year fixed effects to control for the potential cross-industry and inter-temporal variations in the investment level.

The results in Table 8 show a significant and positive coefficient on *CRISKF* across all three columns, suggesting that the informativeness of customer RFDs is positively associated with the investment level among supplier firms that tend to underinvest. Table 8 also indicates that the coefficient on *CRISKF*×*OverI* is significantly negative across all three columns. Moreover, the sum of the coefficients on *CRISKF* and *CRISKF*×*OverI* is negative and significant when *CRISKF* is measured by *CLENGTH* or *CRISK_WORDS* and is marginally significant for *CFL_WORDS.* These results suggest that customer RFD informativeness is negatively associated with the investment level of firms that tend to overinvest. Overall, the results in Table 8 are in line with our

23. Taking this approach, firms are partitioned into the under- or overinvesting group based on their financial constraints rather than information uncertainty. Therefore, we do not adopt this approach in our main analyses.

TABLE 7
Cross-sectional analysis based on whether the supplier discloses demand risk in its own risk factor section

	(1)		(2)		(3)	
	CLENGTH		*CRISK_WORDS*		*CFL_WORDS*	
Dependent variable = R_INVEST_{t+1}	Yes	No	Yes	No	Yes	No
Panel A: Underinvestment vs. normal investment						
$CRISKF_t$	−0.877**	−0.223*	−0.972**	−0.283**	−0.900**	−0.223*
	(−2.23)	(−1.82)	(−2.40)	(−2.54)	(−2.26)	(−1.93)
p-value for *diff.* between subsamples	0.107		0.095		0.098	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	215	1,614	215	1,614	215	1,614
Pseudo R^2	0.344	0.125	0.349	0.126	0.345	0.125
Panel B: Overinvestment vs. normal investment						
$CRISKF_t$	−0.418	−0.237*	−0.372	−0.226	−0.516	−0.257**
	(−0.77)	(−1.72)	(−0.70)	(−1.63)	(−0.95)	(−2.07)
p-value for *diff.* between subsamples	0.740		0.784		0.637	
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	215	1,614	215	1,614	215	1,614
Pseudo R^2	0.344	0.125	0.349	0.126	0.345	0.125

Notes: This table presents the estimated results of multinomial logistic regressions of the informativeness of customers' RFDs on suppliers' investment efficiency conditional on whether the supplier discloses demand risk in its own risk factor section of 10-Ks. *Z*-statistics in parentheses are calculated using robust standard errors clustered by firm. All other variables are as defined in the Appendix. The superscripts * and ** represent significance levels of 0.10 and 0.05, respectively, in a two-tailed test.

TABLE 8
Alternative test of investment efficiency

Dependent variable = $INVEST_{t+1}$	(1) *CLENGTH*	(2) *CRISK_WORDS*	(3) *CFL_WORDS*
$CRISKF_t$	0.148**	0.169**	0.144**
	(2.09)	(2.32)	(1.98)
$CRISKF_t \times OverI_t$	−0.253**	−0.301**	−0.240**
	(−2.30)	(−2.47)	(−2.10)
p-value for $CRISKF_t + CRISKF_t \times OverI_t$	0.069	0.041	0.121
$CWORD\_10K_t$	−0.044	−0.058	−0.044
	(−0.32)	(−0.41)	(−0.30)
$CWORD\_10K_t \times OverI_t$	0.223	0.252	0.219
	(1.00)	(1.09)	(0.95)
$OverI_t$	−0.445	−1.281	−1.309
	(−0.24)	(−0.65)	(−0.65)
$INST_t$	−0.394*	−0.398*	−0.395*
	(−1.76)	(−1.77)	(−1.75)
$NUMEST_t$	0.016**	0.016**	0.017**
	(2.25)	(2.24)	(2.30)
$GINDEX_t$	−0.010	−0.011	−0.010
	(−1.26)	(−1.34)	(−1.25)
$NUMEST_t \times OverI_t$	−0.010	−0.010	−0.011
	(−1.17)	(−1.16)	(−1.24)
$INST_t \times OverI_t$	0.381	0.378	0.379
	(1.17)	(1.15)	(1.15)
$GINDEX_t \times OverI_t$	−0.004	−0.003	−0.004
	(−0.32)	(−0.24)	(−0.30)
$CRETURN_t$	−0.077*	−0.075*	−0.079*
	(−1.86)	(−1.83)	(−1.88)
$CSTDRET_t$	−2.242	−2.045	−2.320
	(−0.88)	(−0.80)	(−0.92)
$CRETURN_{t+1}$	−0.042	−0.044	−0.042
	(−0.78)	(−0.81)	(−0.78)
$CSTDRET_{t+1}$	3.400	3.481	3.392
	(0.72)	(0.75)	(0.72)
$SIZE_t$	−0.088***	−0.087***	−0.088***
	(−4.04)	(−4.02)	(−4.03)
BM_t	−0.025	−0.028	−0.025
	(−0.25)	(−0.29)	(−0.25)
$STDCFO_t$	−0.397*	−0.393*	−0.398*
	(−1.83)	(−1.82)	(−1.83)
$STDSALE_t$	−0.025	−0.027	−0.026
	(−0.36)	(−0.39)	(−0.37)
$STDINVEST_t$	0.278**	0.279**	0.279**
	(2.42)	(2.43)	(2.42)
$ZSCORE_t$	0.000	0.000	0.000
	(0.04)	(0.08)	(0.05)
TAN_t	−0.019	−0.023	−0.025
	(−0.10)	(−0.13)	(−0.14)
LEV_IND_t	−0.042	−0.038	−0.044
	(−0.12)	(−0.11)	(−0.13)

(The table is continued on the next page.)

TABLE 8 (continued)

Dependent variable = $INVEST_{t+1}$	(1) *CLENGTH*	(2) *CRISK_WORDS*	(3) *CFL_WORDS*
$CFOSALE_t$	−0.015*	−0.016*	−0.015*
	(−1.71)	(−1.80)	(−1.66)
DIV_t	0.037	0.033	0.037
	(0.73)	(0.66)	(0.73)
AGE_t	0.009	0.010	0.009
	(0.35)	(0.42)	(0.37)
$OPCYCLE_t$	−0.045	−0.045	−0.045
	(−1.41)	(−1.43)	(−1.42)
$LOSS_t$	−0.019	−0.019	−0.020
	(−0.47)	(−0.47)	(−0.47)
Intercept	0.061	0.304	0.510
	(0.05)	(0.24)	(0.40)
Industry fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
N	1,829	1,829	1,829
Adjusted R^2	0.144	0.146	0.144

Notes: This table presents the estimated results of the OLS regressions of the informativeness of customers' RFDs on suppliers' investment levels. *t*-statistics in parentheses are calculated using robust standard errors clustered by firm. *OverI* is a ranked variable based on the average of the decile ranks of cash (*CASH*) and the negative of leverage (*LEV*), where *CASH* is the ratio of cash to total assets and *LEV* is the ratio of long-term debt to the sum of long-term debt and the market value of equity. All other variables are as defined in the Appendix. The superscripts *, **, and *** represent significance levels of 0.10, 0.05, and 0.01, respectively, in a two-tailed test.

main results reported in Table 3, suggesting that the informativeness of customer RFDs is negatively associated with under- and overinvestment by suppliers.

In the main regression model, we explicitly control for known factors associated with firms' investment efficiency; yet, it is still possible that some omitted factors contribute to both the informativeness of customer RFDs and better investment efficiency of suppliers.[24] To mitigate this concern, we perform a changes analysis. Specifically, we replace the dependent variable in equation (2) with the change in the absolute value of the residuals estimated from equation (1) (*ΔAR_INVEST*).[25] A smaller magnitude of residuals (*AR_INVEST*) indicates less deviation from the expected investment level and thus represents better investment efficiency. The test variable (*CRISKF*) in equation (2) is replaced with the sales-weighted average of the percentage change in *LENGTH*, *RISK_WORDS*, or *FL_WORDS* of customers' RFDs (Δ*CRISKF*).[26] The rest of the continuous independent variables (except *AGE*) in equation (2) are replaced with their first difference. The results of the changes analysis are reported in Table IA1 in the online Appendix.

24. For example, it is possible that customer firms with capable management are better able to provide informative disclosures and identify suppliers with superior investment efficiency. In this case, management ability would be a factor that drives the association between customer RFD informativeness and supplier investment efficiency.

25. In equation (2), the dependent variable is a categorical variable with a value equal to 1 for the underinvestment group, 2 for the benchmark group, and 3 for the overinvestment group, according to the residuals estimated from equation (1). To capture the change, we use the absolute value of the residuals to proxy for investment inefficiency and do not distinguish between under- and overinvestment.

26. We measure the change in percentage because the distribution of the percentage change is less skewed than the raw change.

Table IA1 shows that the coefficient on $\Delta CRISKF$ is negative and statistically significant at less than the 5 percent level for all three measures of *CRISKF*, indicating that the increase in the informativeness of customer RFDs is positively and significantly related to the improvement in supplier investment efficiency.

To further alleviate the endogeneity concern that the documented relation between customer RFDs and supplier investment efficiency could be attributable to some correlated omitted variables, we utilize the SEC mandate of RFDs to examine whether the effect of the RFD mandate on investment efficiency is more pronounced for dependent suppliers than for nondependent suppliers. Because the outcome of dependent suppliers' investments is more closely tied to the business risk of their major customers, it is more important for them to evaluate the customer risk thoroughly. Hence, relative to nondependent suppliers, dependent suppliers are more likely to refer to the newly added risk factor section in customers' 10-K reports to obtain information about their customers' business risk. We thus expect the RFD mandate to have a stronger impact on dependent suppliers than nondependent suppliers. Consistent with our expectation, we find a significant increase in the investment efficiency for dependent suppliers following the RFD mandate but not for nondependent suppliers (see Table IA2 in the online Appendix).

Lastly, Raman and Shahrur (2008) and Dou et al. (2013) find that earnings management, such as income smoothing, affects the investment behavior of suppliers and customers. Hui et al. (2012) also document that conservative accounting affects the contracting between customers and suppliers. As a robustness check, we further control for customers' income smoothing and accounting conservatism in the regression model, and find qualitatively similar results (see Table IA3 in the online Appendix), suggesting customers' RFDs as an incremental factor in explaining suppliers' investment efficiency beyond other accounting quality measures.

6. Conclusion

This study examines whether customer RFDs in annual reports are related to supplier investment efficiency. When suppliers invest in production capacity and R&D, the outcomes of their investments are uncertain. Thus, suppliers rely mainly on implicit contracts rather than explicit, legally binding contracts with their customers when it comes to capacity choice and R&D spending. Previous studies on relationship-specific investments find that suppliers face a hold-up problem and tend to underinvest because the implicit contract can be renegotiated and enables customers to extract quasi-rent from their suppliers ex post (e.g., Baiman et al. 2001). Conversely, the supply chain management literature documents amplified demand information communicated from downstream customers to upstream suppliers, which could lead to unused capacity and/or overinvestment by suppliers (e.g., Kouvelis et al. 2006). We therefore contend that if suppliers are more informed about their customers' underlying risk and ability to fulfill contracts, they are less likely to under- or overinvest.

We examine the risk factor section in firms' audited annual reports as a source from which suppliers could gather information about their customers' risk exposure or verify the information that they obtain from other channels. We hypothesize and find that more informative customer RFDs are associated with more optimal investment decisions by suppliers (i.e., a lower likelihood of under- or overinvestment). Moreover, we demonstrate that this association is more pronounced when suppliers have weak bargaining power relative to their customers, when they operate in the durable goods industries, and when they are more concerned about the volatility of future demand.

Supply chain researchers have investigated various mechanisms to create incentives for customers to share reliable demand information or to honor implicit contracts with their suppliers, such as carefully designed relational contracts and vertical integration. One important insight from our findings is that suppliers can use the information prepared by customer firms for capital market participants to assess the outcome of their relationship-specific investments and their customers' ability to fulfill contracts ex post, thereby achieving better investment efficiency.

Our study has two limitations. First, there is a possibility that the information contained in customer RFDs overlaps or correlates with information that suppliers have ascertained from other

sources (such as through private channels or other corporate filings). Hence, although our findings support that RFDs contain useful information about firms' risk exposures that could benefit suppliers' investment decisions, this does not necessarily mean that the information used by suppliers comes directly from customers' RFDs in 10-K reports. Therefore, our results should be interpreted with caution as the extent of the usefulness of firms' RFDs to their suppliers varies, depending on the exact information set possessed by the suppliers. Second, compared with a customer with sound future prospects, we expect a customer with risky future prospects to pose a higher demand risk for its suppliers. Nonetheless, it is possible that customer RFDs only capture a small portion of the overall demand risk faced by suppliers. For example, even if a customer's RFDs suggest promising future prospects, it might switch to other suppliers for more favorable prices and terms or there could be design or process changes made by the customer that result in the supplier's product no longer being needed. Thus, our study does not claim that a firm's RFDs fully reflect the potential demand risk faced by its suppliers, although we find that customer RFDs are more useful to suppliers with greater concerns about the volatility of future demand.

Appendix

Variable definitions

Variable	Definition
Under- or overinvestment proxy	
R_INVEST_{t+1}	A categorical variable based on the quartiles of the residuals from a firm-specific model of investment: $INVEST_{t+1} = \alpha_0 + \alpha_1 SGrowth_t + \varepsilon_{t+1}$. $INVEST_{t+1}$ is the total investment at year t+1, measured as R&D expense plus capital expenditure plus acquisition expenditure less cash receipts from the sale of PPE less depreciation and amortization, scaled by lagged total assets. $SGrowth_t$ is the percentage change in sales from year $t - 1$ to year t. The model is estimated by year and industry for all industries with at least 20 observations in a given year. Firms are sorted yearly based on the residuals from the expected investment model into quartiles. The variable is set to 1 for firm-years with residuals in the bottom quartile, 2 for firm-years with residuals in the middle two quartiles, and 3 for firm-years with residuals in the top quartile
Customers' RFD variables	
$CRISKF_t$: *CLENGTH*	The natural logarithm of the weighted average of the total number of words in the risk factor section of the customers' 10-Ks, where the weight is a supplier's sales to a major customer divided by the supplier's total sales to all disclosed major customers
$CRISKF_t$: *CRISK_WORDS*	The natural logarithm of the weighted average of the number of risk keywords contained in the risk factor section of the customers' 10-Ks, where the risk keywords are as defined in Campbell et al. (2014)
$CRISKF_t$: *CFL_WORDS*	The natural logarithm of the weighted average of the number of forward-looking keywords contained in the risk factor section of the customers' 10-Ks, where the forward-looking keywords are defined as per Li (2010) and Muslu et al. (2015)
Customer-specific control variables	
$CWORD\_10K_t$	The natural logarithm of the sales-weighted average of the total number of words in the customers' 10-Ks
$CRETURN_t$	The sales-weighted average of the customers' one-year stock return ending three months after the end of the fiscal year t
$CRETURN_{t+1}$	The sales-weighted average of the customers' one-year stock return ending three months after the end of the fiscal year t+1
$CSTDRET_t$	The sales-weighted average of the customers' standard deviation of daily abnormal stock returns for the 250 trading day period ending two trading days before the

(The Appendix is continued on the next page.)

Appendix (continued)

Variable	Definition
	10-K release. Abnormal stock returns are calculated using the residuals from the market model
$CSTDRET_{t+1}$	The sales-weighted average of the customers' standard deviation of daily abnormal stock returns for the 250 trading day period beginning two trading days after the 10-K release. Abnormal stock returns are calculated using the residuals from the market model
Supplier-specific control variables	
$INST_t$	The percentage of the firm's shares held by institutional investors, according to the most recent data to the end of the fiscal year. If no institutional ownership is reported by the Thomson-Reuters 13F database, then the value is set to 0
$NUMEST_t$	The number of analysts following the firm. If no analyst coverage is reported by I/B/E/S for the firm, then the value is set to 0
$GINDEX_t$	The index of anti-takeover protection created by Gompers et al. (2003), multiplied by −1. If the index is missing, then the value is set to 0
$SIZE_t$	The natural logarithm of total assets
BM_t	Total assets divided by the sum of the book value of debt and the market value of equity, where the book value of debt is computed as total assets less the book value of equity
$STDCFO_t$	The standard deviation of cash flow from operations deflated by lagged total assets over the past five years
$STDSALE_t$	The standard deviation of sales deflated by lagged total assets over the past five years
$STDINVEST_t$	The standard deviation of total investment scaled by lagged total assets (*INVEST*) over the past five years
$ZSCORE_t$	Altman's Z-score, computed as 1.2 × (working capital / total assets) + 1.4 × (retained earnings / total assets) + 3.3 × (earnings before interest and taxes / total assets) + 0.6 × (market value of equity / total liabilities) + 1.0 × (sales / total assets)
TAN_t	The ratio of net PPE to total assets
LEV_t	The ratio of long-term debt to the sum of long-term debt and the market value of equity
LEV_IND_t	The average of leverage (*LEV*) for firms in the same 4-digit SIC industry group
$CFOSALE_t$	Cash flow from operations divided by sales
$SLACK_t$	The ratio of cash to net PPE
DIV_t	An indicator variable that equals 1 if the firm paid dividends, and 0 otherwise
AGE_t	The natural logarithm of the difference between the first year when the firm appears in CRSP and the current year
$OPCYCLE_t$	The natural logarithm of receivables to sales plus inventory to cost of goods sold multiplied by 360
$LOSS_t$	An indicator variable that takes the value of 1 if income before extraordinary items is negative, and 0 otherwise

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Table IA1. Changes analysis.

Table IA2. Effect of compliance with the RFD mandate on investment efficiency.

Table IA3. Controlling for customers' income smoothing and accounting conservatism.