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VERTICAL FIRM BOUNDARIES: SUPPLIER-CUSTOMER CONTRACTS AND VERTICAL INTEGRATION

BY

RYAN MARION WILLIAMS

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

Doctor of Philosophy

In the Robinson College of Business

Of

Georgia State University

GEORGIA STATE UNIVERSITY
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2012

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ACCEPTANCE

This dissertation was prepared under the direction of the *RYAN MARION WILLIAMS* Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ABSTRACT

VERTICAL FIRM BOUNDARIES: SUPPLIER-CUSTOMER CONTRACTS AND VERTICAL INTEGRATION

BY

RYAN MARION WILLIAMS

APRIL 20, 2012

Committee Chair: *OMESH KINI*

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I empirically examine the choice of a firm's vertical boundaries—specifically, the decision to use supplier-customer contracts instead of either using markets or vertical integration. I examine the determinants of supplier-customer contracts using data on a customer's contractual purchase obligations with its suppliers. Contracting propensity is positively related to supplier relationship-specific investments (RSI), the supplier's relative bargaining power, and vertical integration costs, and negatively related to contracting costs, alternative sources of information about the customer, and the percentage of a customer's input traded on financial markets. I also find that customer firms which have product market contracts with their suppliers have better relative performance. These performance effects are enhanced by relationship-specific investments and are robust to corrections for endogeneity. Additionally, I examine the choice between vertical integration versus supplier-customer contracts and find that the choice is predicted by the type of RSI. Consistent with theory, RSI measured using tangible (intangible) assets are positively related to integration (contracts). Further, positive (negative) shocks to industry-level intangible investment are related to increases in a firm's contracting activity and decreases (increases) in the level of vertical integration, while positive (negative) shocks to industry-level tangible investment are related to decreases in contracting activity and increases (decreases) in the level of vertical integration. My results suggest that market frictions play an important role in shaping supplier-customer contracting activity and firm boundaries.

Vertical firm boundaries: supplier-customer contracts and vertical integration [+]

Ryan Williams[*]

This version: April 2012

Abstract

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Vertical firm boundaries: supplier-customer contracts and vertical integration

Transaction cost economics and the boundaries of the firm have gained considerable attention in the financial economics literature in recent years.[1] Although the extant literature pays much attention to the question of why firms shape their boundaries through corporate restructuring activities like corporate takeovers and divestitures, the more basic question of when do firms enter into explicit contracts with their suppliers instead of either using markets or vertical integration to exchange goods and services has received scant attention.[2] I provide a comprehensive examination of this question by building a database containing information on a specific type of supplier-customer contract, namely, a customer's purchase obligations to suppliers.[3] I then develop testable hypotheses and empirically examine the determinants of a firm's explicit contracts with suppliers. Contingent on entering these contracts, I then examine the determinants of the length of these supplier-customer contracts. In addition, I investigate the impact of these contracts on firm performance. Finally, I explore the firm's equilibrium choice between contracts and vertical integration, as well as firm-level changes in integration and contracting behavior in response to industry-level shocks to relationship-specific investments (RSI).

Theory suggests that supplier incentives influence the propensity to contract. Specifically, hold-up problems created by a supplier's relationship-specific and site-specific investments create incentives for a supplier to require customer firms to enter into contractual

[1] See, e.g., Allen and Phillips (2000), Zingales (2000), Chipty (2001), Burch and Nanda (2003), Fee, Hadlock, and Thomas (2006), Kale and Shahrur (2007), Acemoglu, Johnson, and Mitton (2009), Jain, Kini, and Shenoy (2011), and Kedia, Ravid, and Pons (2011), among others.

[2] For example, Masten (1984), Joskow (1987), Crocker and Masten (1988), Hubbard and Weiner (1991), Allen and Lueck (1993), and Crocker and Reynolds (1993) explore firm organization in industry-specific industrial organization studies. Chiappori and Salanie (2003) note that many empirical predications in this area remains untested.

[3] Purchase obligations arise when a customer commits to purchase some quantity of a supplier's output at a contractual price for a set number of years.

purchase obligations (Williamson, 1975; Williamson, 1985). The supplier's bargaining power also positively impacts its ability to require its customers to enter into these contracts (Tirole, 1988). Additionally, from both the perspective of the supplier and customer, contracting costs and vertical integration costs are also important factors to consider when solving hold-up problems (Coase, 1937; Acemoglu, Johnson, and Mitton, 2009). If contracting costs are high, both suppliers and customers are less likely to engage in explicit contracts, whereas if vertical integration costs are high, suppliers and customers are more likely to use supplier contracts as a solution to transaction costs. Further, stock prices can contain private information about a firm's product market position (Chen, Goldstein, and Jiang, 2007). Suppliers and customers may obtain information about the customer's product market position either from contracts or from alternative measures such as stock price informativeness.[4] As stock price informativeness about a customer increases, the need for suppliers and customers to enter into costly contracts as a source of information decreases. Additionally, the extant literature suggests that the cost of information acquisition increases in distance (Petersen, 2004; Alam, Chen, Ciccotello, and Ryan, 2012). If contracts serve as an alternative source of information, a supplier's distance from its customers is also likely to positively affect contracting behavior.[5] Finally, the structure of purchase obligation contracts is similar to that of forward contracts. If customers are trying to use fixed-price contracts to hedge, they are less likely to enter into supplier contracts if they can use financial markets, such as futures markets, to hedge more efficiently.

[4] In theory, a common way for suppliers to obtain information through contracts is to offer a menu of contracts to the customer (e.g., Tirole, 1988). The supplier can generate information by observing the customer's choice of contract.

[5] The information hypothesis and hold-up problems associated with site-specific investment generate conflicting predictions on how proximity should affect contracting activity. If the information effect dominates, one expects a positive relation between distance and contracting. If the previously mentioned hold-up problems associated with site-specific investments dominate, one expects a negative relation.

I test the above hypotheses using data on a firm's contractual purchase obligations with its suppliers.[6] Using the Perl scripting language, I collect this data from 10-K filings covering all public companies over the fiscal years 2003 – 2008. Consistent with the previous discussion, I find evidence that supplier relationship-specific investments, the supplier's relative bargaining power, and vertical integration costs positively affect the propensity for suppliers and customers to contract. I also find evidence that the propensity for suppliers and customers to contract is negatively related to contracting costs, the customer's stock price informativeness, and the percentage of a customer's input traded on financial markets. In addition, the proxy variable for proximity between suppliers and customers is negatively related to the propensity for suppliers and customers to contract. Furthermore, in an examination of the determinants of contract length, I find that relationship-specific investments and relative bargaining power are positively related to contract length. I also find that price informativeness and supplier-customer proximity decrease contract length.

Further, in an examination of whether contracts have an effect on customer firm performance, I find that firms with purchase obligations to their suppliers have relatively higher operating return on assets (OROA) and firm value (Tobin's Q). These results are robust to corrections for endogeneity. Thus, I find that contracting activity is positively related to performance. I also examine counterfactual evidence in an effort to show a causal link between contracting and firm performance, by investigating the effect of contracts on performance when we should not observe contracts (and vice versa). In these tests, I find that the positive relation between contracts and firm value occurs in environments where relationship-specific investment is high. In subsamples where relationship-specific investment is low, the use of contracts

[6] Note that suppliers and customers have multiple types of contractual relationships. Common supplier-customer contracts are procurement contracts, which often define input quality levels, etc. However, purchase obligations create a requirement for the customer to purchase a minimum quantity at a contractual price.

negatively affects performance. These subsample tests also help address a natural question asking why all firms do not use these contracts in equilibrium if they are performance enhancing—they are not optimal for firms in low-RSI environments.

Finally, I study the choice between explicit contracts and vertical integration as alternative solutions to different types of market frictions. In addition to probit estimates on the subsample of firms which are either integrated or use supplier contracts, I also use a two-stage process to examine this decision. In a first-stage probit estimation, I use proxies for transaction costs described earlier to model the choice between vertical integration/use of supplier-customer contracts versus transacting in markets. Next, in the second-stage probit estimation, I draw from the transaction costs and property rights literatures to identify the determinants of the choice between vertical integration and supplier contracts.

Economic theory (e.g., Williamson, 1985; Grossman and Hart, 1986; Hart and Moore, 1990), demonstrates that one cost of vertical integration is underinvestment in specific human capital by employees. This is driven by workers in the newly integrated firm who must now share any surplus from specific human capital. As a result, this type of integration cost is likely to be relatively higher in human capital intensive industries than in physical capital intensive industries. In empirical tests, I do find that the asset tangibility of the customer industry is negatively related to the propensity to contract and positively related to the propensity to vertically integrate. Conversely, I find that the R&D intensities of the supplier industry and the customer firm are positively related to the propensity to contract and negatively related to the probability of vertical integration. Additionally, I examine changes in industry-level R&D intensity, and find that positive (negative) shocks to industry-level R&D are associated with increases in the dollar amount of contracting intensity and decreases (increases) in a firm's level

of vertical relatedness. Conversely, positive (negative) shocks to industry-level CAPEX are associated with decreases in the dollar amount of contracting intensity and increases (decreases) in a firm's level of vertical relatedness. It, therefore, appears that the type of relationship-specific investment affects the structure of firm boundaries, both in equilibrium and in a firm's response to industry shocks. These results are also consistent with the empirical findings in Acemoglu, Johnson, and Mitton (2009), who find that capital intensity positively affects the propensity to integrate, and Seru (2011), who demonstrates that conglomerate firms shift R&D activity outside of the firm by utilizing joint ventures and strategic alliances. Contrary to Acemoglu, Johnson, and Mitton (2009), however, my proxy for contracting costs does not significantly predict the choice between integration and contracting.[7] I also find that contracting is more likely than vertical integration when supplier industry concentration is high, perhaps because integration in concentrated industries is likely to invite regulatory scrutiny.

My study makes the following contributions. First, it is the first study in financial economics that empirically examines the vertical boundaries of the firm using data on explicit supplier-customer contracts.[8] I show that transaction costs and other market frictions are important determinants of a firm's propensity to contract with its supplier. My study builds on the previous literature which has examined other solutions to transaction costs such as vertical integration (Chipty, 2001; Fan and Goyal, 2006; Acemoglu, Johnson, and Mitton, 2009; Shenoy, 2012) and partial equity stakes, strategic alliances, and joint ventures (Allen and Phillips, 2000; Fee, Hadlock, and Thomas, 2006). My results are also consistent with the notion that stock prices appear to contain product market-related information and, as such, support the conjecture

[7] Acemoglu, Johnson, and Mitton (2009) do find evidence that contracting costs affect vertical integration. However, their study utilizes international data and they have an inter-country proxy for contracting costs. Given that I have U.S. data, I use an inter-state proxy. Thus, the two sets of results may not be directly comparable.
[8] A contemporaneous paper by Moon (2012) uses similar data to examine corporate outsourcing behavior.

by Chen, Goldstein, and Jiang (2007) that the information derived from stock prices is likely to be about the demand for the firm's products or about its strategic landscape.

Second, this is first broad empirical study which shows that hold-up problems associated with different types of relationship-specific investments appear to have different optimal solutions. High capital intensive firms are more likely to integrate than to contract, and high human capital intensive firms are more likely to contract than to integrate. These results are consistent with the previously mentioned theoretical predictions in Williamson (1985), Grossman and Hart (1986), and Hart and Moore (1990), and empirical evidence on vertical integration in Acemoglu, Johnson, and Mitton (2009) and Seru (2011). This evidence is also consistent with studies showing that asset ownership appears to be efficiently allocated among product market participants (Maksimovic and Phillips, 2001, 2002; Hoberg and Phillips, 2010; Jain, Kini, and Shenoy, 2011; Seru, 2011).

Further, I build on the industrial organizational literature by constructing a comprehensive panel database including all U.S. public companies. Johnson and Houston (2000) examine the choice between contracts and joint ventures using a sample of 208 firms. Most other empirical papers (Allen and Lueck, 1993; Crocker and Reynolds, 1993; Crocker and Masten, 1988; Hubbard and Weiner, 1991) are similar in flavor in that they are constrained by small sample sizes. For example, previous research has studied specific types of contracts in very narrowly defined industries, such as Air Force engine procurement (Crocker and Reynolds, 1993) and crop share contracts (Allen and Lueck, 1993). In a seminal empirical paper, Joskow (1987) uses a sample of 277 coal contracts with utility companies to test theories related to supply-chain contracting. He finds that site specificity and product heterogeneity affect the existence of coal contracts as well as contract length. Typically, the above studies examine a

single year and a single industry due to issues with data availability; this current study overcomes that limitation. My data contains all U.S. public companies and the form of the contract I study (purchase obligations) is similar to the *ex ante* contracts described in theory.

Finally, I add to the recent literature examining how product markets affect hedging activity (Adam, Dasgupta, and Titman, 2007; Haushalter, Klasa, and Maxwell, 2007), and the literature discussing alternative corporate hedging behavior (e.g. Petersen and Thiagarajan, 2000; Guay and Kothari, 2003; Hankins, 2011) by noting that customers with large percentages of their input traded on futures markets are less likely to have purchase obligations with their suppliers.

I proceed as follows: In Section 1, I outline existing theoretical predictions and generate testable hypotheses. In Section 2, I describe the construction of my dataset and the variables used in the study. Section 3 contains univariate and multivariate tests exploring the determinants of supplier contracts. In Section 4, I describe robustness checks and additional tests, and in Section 5 I examine the relation between contracts and firm performance. In Section 6, I examine the choice between vertical integration and the use of supplier contracts. Section 7 concludes the paper.

1. Hypotheses Development

In this section, I draw on extant theory to develop predictions for the determinants of vertical contracting based on the extant theoretical literature in financial economics and industrial organization. Much of this literature suggests that the forces influencing the existence of product market contracts also impact the length of the contractual relationship. As such, I do not generate separate hypotheses for the economic forces that impact the length of these contracts.

1.1. *Relationship-specific investments*

Numerous theories (Williamson, 1975, 1985; Alchian and Demsetz, 1972; Klein, Crawford, and Alchian, 1978; Alchian, 1984; Tirole, 1988) predict that supplier-customer relationships requiring relationship-specific investments can generate hold-up problems. Consider a situation where relationship-specific investments are to be made by the supplier in order to produce an input for a customer, and there is no long-term contract or vertical integration with the supplier. The supplier makes the investment, manufactures the product or provides the service, and the supplier and customer subsequently bargain over the surplus created. Because relationship-specific investments are time inconsistent, they create incentives for customers to behave opportunistically. Specifically, the customer can *ex post* refuse to purchase the input from the supplier (or offer him an "unfair" price) after the supplier has already made the investment anticipating future sales. The rational supplier anticipates this and never makes the investment to begin with, causing *ex ante* underinvestment. Without long-term contracts or integration, the equilibrium results in underinvestment.

A solution to the underinvestment problem is *ex ante* contracting. The customer commits to purchase a minimum quantity at a certain price from the supplier before the supplier makes the investment. These contracts limit opportunistic behavior by the customer and induce the supplier to make the necessary investment. Thus, supplier-customer contracts should be more likely in environments where relationship-specific investments are required to be made by suppliers.

H1: If relationship-specific investments are to be made by suppliers, they will require their customers to enter into purchase obligations.

1.2. Bargaining power

Williamson (1985) and Tirole (1988) predict that the contractual relationship between a supplier and customer is affected by bargaining power. Specifically, the ability for a customer to easily switch suppliers (or vice versa) will affect the relative bargaining power in the relationship. If a customer industry is monopolistic and a supplier industry is competitive, the customer's bargaining power generally eliminates the existence of contractual purchase obligations.[9] A competitive supplier industry has little to no bargaining power over the monopolistic customer and will be unable to pressure the customer into accepting the obligation. Conversely, if a monopolistic supplier is selling to customers operating in a competitive industry, purchase obligations will be more likely. The supplier's superior bargaining power allows them to pressure customers to *ex ante* commit to some level of purchases. Additionally, a monopolistic supplier's output is unlikely to have a perfect substitute. Thus, supplier and customer bargaining power affect the propensity for a firm to enter into purchase obligations to suppliers.

H2: Supplier (customer) bargaining power is positively (negatively) related to a firm's propensity to enter into contractual purchase obligations with suppliers. Thus, the supplier's bargaining power relative to the customer's bargaining power will be positively related to the firm's propensity to enter into contractual purchase obligations with suppliers.

1.3. Contracting costs

Contracting costs likely affect a firm's decision to explicitly contract. If contracting costs are high, a firm should explore alternative methods for alleviating transaction costs, such as implicit contracts (Zingales, 2000; Baker, Gibbons, and Murphy, 2002; Kale, Meneghetti, and

[9] The customer will not need to create a liability by obligating itself to purchase from any particular supplier. If they are the sole downstream customer for a supplier industry, the supplier industry will already sell at its marginal cost.

Shahrur, 2012) or vertical mergers (Grossman and Hart, 1986; Hart and Moore, 1990; Acemoglu, Johnson and Mitton, 2009). Thus, explicit supplier-customer contracts should occur less frequently when contracting costs are high.

H3: Explicit contracting costs are negatively related to a firm's propensity to enter into contractual purchase obligations with suppliers.

1.4. Public and private information

Suppliers can infer information about customers using contracts (Bajari and Tadelis, 2001). A common theoretical mechanism (Tirole, 1988) is to offer a menu of contracts to a customer, and infer information from the customer's choice. Stock prices are also thought to contain private information about a firm's product market position (Chen, Goldstein, and Jiang, 2007). Chen, Goldstein, and Jiang (2007) calculate stock price informativeness as the component of stock returns not correlated with industry or market returns. Their measure is particularly valid because they mention that the information contained in stock prices is likely to be information about "the demand for the firm's products or other strategic issues, such as competition with other firms." This information is especially valuable to firms with product market relationships with the reference firm. If a firm's stock price is highly correlated with the industry and market, it is less likely to represent firm specific information (stock price informativeness is low). If stock price informativeness is high, it is a useful source of alternative information to parties outside the firm, especially regarding product market information, there is less need for suppliers to use costly contracts as an information-gathering mechanism.

H4: The customer's stock price informativeness is negatively related to a firm's propensity to enter into contractual purchase obligations with suppliers.

1.5. Supplier-customer proximity

Petersen (2004) discusses differences between hard and soft information. Intuitively, hard information is quantitative and easily transferable across unrelated parties, but soft information represents more intangible data that can be gathered through relationships and/or face-to-face interaction. Petersen suggests that soft information is decreasing in distance. Thus, other forms of information, such as contracting, should serve as substitutes for soft information as distance increases. Thus, if contracts represent information, one hypothesis predicts a negative relation between supplier-customer proximity and contracting intensity. Alternatively, Williamson (1985) and Tirole (1988) both mention site specificity as a special kind of relationship-specific investment. An investment is site specific if the supplier is required to invest in a specific location for a customer, i.e., the supplier needs to build a factory next to the customer's factory. In the absence of long-term contracting or integration, site specific investments present the same time-inconsistency problem as other relationship-specific investments discussed above. Once the supplier makes the site specific investment, the customer can engage in opportunistic behavior *ex post*. The rational supplier will anticipate this behavior and will not make the investment *ex ante*. One solution to this problem is a long-term contract which commits the customer to purchasing the supplier's output once the investment is made. Thus, theory predicts conflicting hypotheses.

H5: Supplier-customer proximity is negatively related to a firm's propensity to engage in contractual purchase obligations with its suppliers.

H5A: Supplier's site specificity is positively related to a firm's propensity to engage in contractual purchase obligations with its suppliers.

2. Data and Sample Description

In the following section, I describe the dataset used in this paper. I utilize 10-K filings for some variables; 10-K filings are available electronically from 1996. However, the main variable of interest, a firm's purchase obligations to suppliers, has only been reported in 10-K filings from fiscal year 2003 onward. Thus, the sample consists of all Compustat firm-years from 2003 – 2008 with an available 10-K filing on the SEC's EDGAR site. After excluding financial firms (SIC codes between 6000 and 6999), the six-year panel dataset consists of 19,749 firm-years. In the following subsections, I detail the construction of variables used in this paper.

2.1. Purchase agreements with suppliers

Firms are required to disclose purchase obligations to suppliers in a footnote discussing contractual obligations.[10] The purchase agreements, in general, contractually obligate the customer to purchase a fixed or minimum quantity at a fixed, minimum, or variable price from a supplier. Since 12/15/2003, firms with commitments to their suppliers break the disclosure out in a table contained in this footnote, usually labeled as a separate line item titled "Purchase obligations". An example of a footnote is in Appendix A. This line item also usually includes the dollar amount of supplier purchase obligations for the subsequent five years. Using the programming language Perl, I automatically search the contractual obligations footnote in all fiscal year 2003 – 2008 10-K filings for the "Purchase obligation" line item, and create an indicator variable, *Supplier Contract*, which equals one for all firms which report purchase obligations, and "0" otherwise. Further, I also use Perl to automatically extract the aggregate dollar amounts of the purchase obligations for the next five years from this footnote. If a firm uses the text "purchase obligation" in its footnote, but reports $0 for the aggregate dollar

[10] Unfortunately, the opposite is not true. If a firm enters into a *downstream* contract, an obligation to supply a product to a customer, it is not required to disclose the liability. Thus, I am only able to examine one direction in the supply chain.

amounts of the contracts, I code *Supplier Contract* equal to zero. This stringent definition of purchase obligations eliminates false positives.[11] However, it also removes firms which report purchase obligations, but in a way such that the automated data collection technique could not obtain dollar values. Using the stringent definition, roughly 20.3% of all Compustat firm-year observations are for firms which have entered into purchase contracts with their suppliers. I also construct a version of *Supplier Contract* using a less stringent definition, which is equal to one if a firm mentions purchase obligations somewhere in the footnote, but potentially reports a zero balance or does not report a balance. This approach eliminates false negatives. Using this definition of *Supplier Contract*, roughly 28.0% of all Compustat firm-years are for firms which have entered into purchase contracts with suppliers. While the stringent definition is used in all reported empirical tests, the results are robust to instead using the less stringent definition.

The raw data containing the dollar values of the aggregate purchase obligations have several potential problems. One problem is that in addition to columns for years t+1 to t+6, the footnote line item also includes a "Total" column; sometimes this occurs before year t+1 and sometimes after t+6. I am able to automatically remove the "Total" column through programming. A related problem exists for the data I collect on contract length. Although many firms report the dollar amount of purchase obligations for years t+1, t+2, t+3, t+4, t+5, t+6 *and onward*, some firms group years t+2 and t+3 together, years t+4 and t+5 together, etc. For these firms, the estimate for contract length will be systematically too short. The example footnote from Coca-Cola's 10-K in Appendix B demonstrates one such situation. I am unable to solve this problem programmatically, although firms are unlikely to systematically differ in reporting

[11] Firms occasionally use the term "purchase obligations" in their 10-K filings when they do not have them. For example, Aflac's 10-K contains a statement mentioning that Aflac "does not have any purchase obligations or other related agreements with suppliers". Additionally, firms sometimes list the line item "Purchase obligation" and have zero balances for the aggregate amount contracted.

based on the transaction cost-type variables examined here. The third problem is that firms use different scales (millions, thousands, etc) when reporting footnote tables depending on firm size. I use a combination of automated and manual techniques to identify the scale a firm is using. First, I automatically search the contractual obligations footnote for common text used to report scale (e.g., "in millions", "in 000s", etc). Second, I manually examine the time-series of the amount of each firm's supplier purchase obligations and compare the scale in consecutive years to ensure consistency. Lastly, I manually examine firms which have annual purchase obligations that are higher than current year cost of goods sold to ensure that the scale is correct. The resulting unique database identifies the existence of a firm's contractual purchase obligations to its suppliers as well as estimates of the lengths and amounts of these obligations. I next outline the construction of the main independent variables.

2.2.Key variable construction

The footnote disclosure describing purchase obligations describes the aggregate liability. Thus, the individual suppliers for each firm are not identified in the footnote. As a result, for variables related to supplier characteristics, I employ weighted average supplier industry characteristics. I construct proxy variables at the supplier-industry level for a host of transaction costs by using weighted-average supplier industry characteristics, where the weight is the percentage of input supplied from each supplier industry for a particular firm. I merge Compustat financial data with the 2002 Input-Output tables (IO Tables) from the U.S. Bureau of Economic Analysis (BEA) to aggregate supplier industry characteristics for each firm and construct the proxy variables.[12]

[12] Although previously utilizing both SIC and NAICS codes, the BEA has switched exclusively to NAICS codes. As a result, NAICS codes are used throughout this paper.

Following Fee, Hadlock, and Thomas (2006), Kale and Shahrur (2007), among others, I use supplier R&D intensity to proxy for relationship-specific investments (RSI) made by a firm's suppliers.[13] Armour and Teece (1980) argue that vertical supply chains with high R&D intensity tend to have complex inter-stage interdependencies, representing an environment where relationship-specific investments are likely to be higher. As I do not have the identity of the original suppliers, I create a weighted-average of all supplier industry R&D.

I first replace missing R&D values with zero and then aggregate firm-year R&D by two-digit NAICS code to construct industry characteristics. I define *Industry R&D* as aggregate industry R&D divided by aggregate industry assets.[14] Next, I link the industry-year R&D to each six-digit IO industry from the 2002 Input-Output tables from the BEA. For each customer industry, I use the "Use" table from the Input-Output tables and weight each six-digit supply industry characteristic by the percentage of input they supply to the customer industry. For example: if "Energy" has an R&D Intensity of 10% and it supplies 50% of a customer industry's input, and "Retail" has an R&D Intensity of 0% and it supplies the other 50% of a customer industry's input, the weighted average supplier R&D for that customer would be 5%. Mathematically, I construct *Supplier R&D Intensity* for each firm in industry *j* as follows:

$$Supplier\ R\&D\ Intensity = \sum_{\substack{i=1 \\ i \neq j}}^{n} Industry\ Input\ Coefficient_{ij} \times Industry\ R\&D_i \quad (1)$$

where *j* is the firm's primary six-digit IO industry, and *i* is the six-digit IO industry for each supplier industry, *n* is the number of industries which sell inputs to the reference firm, *Industry*

[13] Additional papers which use R&D to proxy for relationship-specific investments are Raman and Shahrur (2008), Holmstrom and Roberts (1998), and Milgrom and Roberts (1992).

[14] Note that, since R&D is a skewed variable in Compustat, this definition (total industry R&D scaled by total industry assets) reduces the impact of smaller firms with extremely high R&D intensities.

R&D is the R&D/Assets of the industry and the *Industry Input Coefficient* is the percentage of industry *j*'s input which comes from industry *i*.[15]

I use two additional variables to proxy for RSI. The first is a measure of supplier output heterogeneity based on Rauch (1999). Specifically, I start by using the two-digit Giannetti, Burkhart, and Ellingson (2011) definitions (based on Rauch, 1999) to identify each supplier industry's output as differentiated or non-differentiated. I construct a dummy variable, *Differentiated Goods,* which is equal to one if the industry's output is differentiated, and zero otherwise. I then construct *Supplier Differentiated Goods* in the same manner as *Supplier R&D Intensity* above. This variable measures the percentage of each customer firm's input which is differentiated.[16]

The last proxy for RSI is patent cross-citation intensity between the supplier and customer industry. Kale, Kedia, and Williams (2012) argue that patent cross-citation between suppliers and customers indicates research specific to the suppliers and customers. I use the NBER patent data maintained by Bronwyn Hall (Hall, Jaffe, and Trajtenberg, 2001) and identify supplier industries and customer industries with patent cross citation in a particular year. I code cross citation equal to one if either the supplier industry cites the customer industry in a patent or the customer industry cites the supplier industry in a patent for a given year. Cross citation is equal to zero if neither the supplier industry nor customer industry cites each other in a patent for a given year. I then create *Patent Cross-Citation Intensity*, which is the supplier weighted average value of all supplier-customer industry relationships from the IO tables, similar to

[15] Kale and Shahrur (2007) use a similar procedure. Following them, I also exclude intra-industry sales in the above calculations. This ensures that the captured supplier weights are for actual upstream firms.

[16] In unreported results, I include an indicator variable which is equal to one if the customer firm's own industry output is differentiated, zero otherwise. This does not significantly affect the propensity for a firm to contract with its suppliers. However, there are likely downstream effects (on the customer's customers) which cannot be observed in my data.

equation 1. Note that NBER patent data is only currently available through 2006, so the sample period using this proxy shrinks to 2003—2006.

I construct a proxy for bargaining power by calculating supplier and customer industry concentrations. I first measure each two-digit NAICS industry *Herfindahl Index,* which is the sum of squared market shares of all firms in each two-digit industry-year.[17] After calculating *Herfindahl Index* for each industry*,* I then use the same weighting methodology reported above to generate the weighted-average *Supplier Herfindahl Index*. Given that the contract is the outcome of a bargaining game, it is possible that relative bargaining power (and relative HHI) between the suppliers and customers is important, rather than the supplier/customer industry HHI in isolation. I create a measure of relative bargaining power, *Relative Herf Index*, which is the ratio of *Supplier Herfindahl Index* to the customer firm's own industry *Herfindahl Index.*[18]

The proxy for contracting costs is created by examining the legal environment for contracting in each state. For each year, I take the annual *US Chamber of Commerce State Liability Systems Ranking Survey* and use the *"State Rankings for Overall Treatment of Tort and Contract Litigation"*. The highest-ranked state in a given year is assigned a value of "50" and the lowest-ranked state a value of "1". I assign a contracting environment to each firm-year based on the location of the customer's headquarters. This variable is *Contracting Legal Rank*, and the variable used in the multivariate tests is its natural logarithm, or ln*[Contracting Legal*

[17] Note that I use a scale of 0-1 for Herfindahl Indexes rather than 1-10,000.
[18] This intuition is similar to the Kale, Kini, and Ryan (2003) study examining the relative reputation of financial advisors in corporate takeovers.

Rank].[19] Variation in contract enforcement is well-grounded in the economics literature as a transaction cost (e.g., Williamson, 2002).[20]

I construct a proxy for alternative public information about a firm by using stock price informativeness (Chen, Goldstein, and Jiang, 2007; Roll, 1988). I calculate firm-year stock *Price Informativeness* by regressing daily stock returns for each fiscal year onto daily returns for the value-weighted S&P 500 index and the value-weighted daily returns of the firm's own two-digit industry. The firm's annual stock price informative is ($1-r^2$) for each firm-year regression.

I use data contained in the IO tables to proxy for distance. *Transportation Costs* are obtained from the IO tables, which they estimate using the difference in supplier price and customer cost. I divide *Transportation Costs* by the total amount of customer cost, and then take a weighted average to obtain an average *Supplier Transportation Cost. Proximity* is defined as the additive inverse (0 – *Supplier Transportation Costs*). To the extent that transportation costs are likely to increase with distance, this variable is a proxy variable for the distance between supplier industries and customer industries.

2.3.Contracting Environment

Firms face additional exogenous factors which influencing their contracting environments. I control for two in all multivariate tests. One possible factor is alternative sources of contracts. Conditional on a firm's decision to contract, they may be less likely to use product market contracts if more efficient alternatives are available in financial markets. To control for this possibility, I construct *% of Input Traded*, which captures the percentage of a

[19] A recent paper with similar intuition is Butler, Fauver, and Mortal (2009), which examines the relation between a state's level of corruption and municipal bond yields. Among other results, they find that higher state corruption is associated with higher bond yields.

[20] Williamson (2002) states "Whereas economic orthodoxy often implicitly assumes that there is a single, all-purpose law of contract that is costlessly enforced by well-informed courts, the private ordering approach (in transaction cost economics) to governance postulates instead that each generic mode of governance is defined (in part) by a distinctive contract law regime."

firm's input which is traded on financial markets. I use the same methodology as that in Williams' (2012) study on corporate hedging by defining input industries as "traded" or "non-traded" on futures markets, and then generating a weighted-average supplier industry characteristic similar to supplier variables defined earlier.

Additionally, I control for vertical integration costs. If integration costs are low and contracting costs are high, firms will likely choose to solve high transaction costs with integration rather than contracts. One potential cost to integration is underinvestment in human capital by employees discussed in Grossman and Hart (1986) and Hart and Moore (1990). Hold-up problems associated with R&D may be difficult to solve using integration for this reason. Acemoglu, Johnson and Mitton (2009) argue that capital intensity may be an example of RSI specifically solved by integration (i.e., firms with high capital intensity may have hold-up problems, but this type of investment is typically not subject to the human capital-type problems in Grossman and Hart (1986) and Hart and Moore (1990)). Based on this literature, I use two digit industry-year median tangibility ratio, or *Industry-Median Tangibility (Net PPE/Total Assets)* to proxy for the propensity to integrate in the industry, or the opposite of industry integration costs.[21]

2.4.Control Variables

I control for a variety of firm characteristics in the multivariate tests. *% Imports* are the supplier industry-weighted average of the "Noncomparable imports" category from the IO tables to control for any foreign imports which the BEA cannot map to the IO tables. *R&D Intensity* is

[21] The results are robust to using PPE/Total Sales (Acemoglu, Johnson, and Mitton, 2009). Note that here the customer industry tangibility is used. This is done to stay consistent with the structure of the contracting data. Recall that the supplier uses contracts to protect themselves from a hold-up problem. An alternative solution is for the supplier to vertically integrate with the customer; thus, the customer's tangibility is likely to be an important factor for the supplier. Nonetheless, the results and interpretation are robust to instead using (or including) supplier tangibility.

defined as a firm's R&D expense divided by total assets (Compustat variables *XRD/AT)*. Firms which have not reported R&D expenses are assigned a *R&D Intensity* value of zero. As leverage and RSI have been shown to influence each other (Titman, 1984), I also control for *Book Leverage,* defined as total debt divided by total assets (Compustat variables (*DLC + DLTT)/AT)*. I use *Sales Growth*, defined as [($Sales_t$/ $Sales_{t-1}$) – 1] using Compustat data item *REVT* for sales, to control for possible demand-side pressures faced by the customer. Finally, I control for firm size using *Ln[Assets],* defined as the natural logarithm of total book assets (Compustat data item *AT*).

2.5.Summary Statistics

Table 1 displays summary statistics for the dataset. *Supplier Contracts* is a dummy variable equal to "1" if the firm lists purchase obligations in its 10-K and "0" otherwise. As noted earlier, roughly 20.3% of all firm-year observations report purchase obligations to suppliers in their 10-K filings. The average (median) firm using contracts reports an aggregate contract length of 2.49 years (3 years). I also report the dollar amounts under contract for each future year *i* scaled by current year cost of goods sold ($Contractual\ Dollar\ Amount_{t+i}/COGS_t$).[22] The average firm using contracts commits to purchase 12% of its COGS in year *t*+1, 7% in year *t*+2, 5% in year *t*+3, and less than 1% in future years. For the median firm, the dollar amount contracted for becomes negligible after year *t*+1.

Table 1 also presents summary statistics on supplier industry characteristics. The weighted average of *Supplier Herfindahl Index* is, on average, about 0.04, and the weighted average S*upplier R&D Intensity* is 2% of total assets. The average firm in the sample purchases 27% of its input from *Supplier Differentiated Goods* industries. The weighted average of

[22] I am not able to calculate this variable for firms which do not report COGS. As a result, I lose 44 observations when creating this variable.

supplier-customer industry *Patent Cross-Citation Intensity* is equal to 0.03, with the median supplier-customer industry pairing having no cross-citation. The average firm has 3% of its input traded on a financial market. Average *Proximity* is -0.07, indicating that transportation costs are on average 7% of the customer industry's total input cost. The firm's own industry *Industry-Median Tangibility* ratio is equal to 0.21, the average Herfindahl index for the firm's own industry is 0.04, and the average firm's industry had 0.01% of its inputs defined as non-comparable imports according to the IO tables. On average, a firm is headquartered in a state with a legal rank of 20.27 (with the best being a rank of 50). It also appears that a handful of variables (namely *R&D Intensity* and *Book Leverage*) are affected by negative equity; this allows variables scaled by book assets to appear abnormally large. This effect is also apparent from the small value of the minimum *Assets*. Although all data are winsorized at 1% and 99%, I re-run all tests after winsorizing at 2% and 98% and also re-run all tests after manually changing negative equity to zero. The results in the paper are unaffected by these alternative approaches to handling the outliers of a handful of control variables.

[Insert Table 1]

Table 2 contains correlation coefficients between the various variables of interest. Note that the three proxy variables for RSI are reasonably highly correlated with each other. For example, the correlation between *Supplier R&D Intensity* and *Supplier Differentiated Goods* is 0.68, and the correlation between *Supplier Differentiated Goods* and *Patent Cross-Citation Intensity* is 0.26. Table 3 displays supplier contract status by Fama-French industry definitions. The data indicates industry variation in the propensity to enter into supplier contracts even when using a broad industry definition.

[Insert Table 2]

[Insert Table 3]

"Shipping Containers" is the industry with the highest proportion of contracts with its suppliers. To illustrate, Owens-Illinois is one of the largest firms in this industry. It produces specialized glass and plastic containers used by soft drink companies, etc. To create these specialized glass containers, it purchases proprietary molds from suppliers (who must make relationship-specific investments to build the specialized molds). Owens-Illinois enters into contracts with suppliers for these molds. Additionally, *Supplier R&D Intensity* for the shipping containers industry is 2.7%, which is above the 95th percentile in the sample. Shipping containers is followed by Business Supplies, Shipbuilding & Railroad, Aircraft, and Precious Metals.[23] The bottom five are Tobacco, Textiles, Mining, Retail, and Other. Utilities and Energy also report a much lower propensity to enter into contacts.[24] Using the "less stringent" definition of purchase obligations described earlier does not qualitatively change this ordering.

3. Determinants of Supply Contracts

In this section, I present evidence that transaction costs and other market frictions are significant determinants in forming supplier-customer contracts. Before turning to a multivariate examination of the determinants of supplier contracts, I first present univariate tests examining differences in key independent variables between firms which have supplier purchase obligations and those that do not.

[23] One important point is that many of these industries also use purchase obligations during this sample period to hedge against steel price fluctuations. During the 2003—2008 sample period, steel is not traded on financial markets as it was deemed too heterogeneous.

[24] On first glance, this is surprising given the seminal empirical study using coal suppliers and customers in Joskow (1987). However, upon manual examination, utility industries tend to have high levels of vertical integration, which is another way of mitigating transaction costs and is examined in detail below.

3.1.Univariate tests – potential selection bias

In later empirical tests, e.g., estimating the determinants of contract length, I examine only the subsample of firms which utilize supplier contracts. However, if supplier contracts are not randomly assigned throughout the sample, traditional multivariate estimates (i.e. OLS, Probit) may be subject to a selection bias. In Table 4, I split the sample based on *Supplier Contract* status and examine whether the two samples differ across a host of various firm characteristics. I find that the two samples significantly differ at the 1% level on book assets, *Tobin's Q*, cash holdings, book leverage, sales growth, ROA, and R&D. These univariate tests indicate that sample selection is likely a concern when performing multivariate analysis on a subsample of firms with supplier contracts. I subsequently control for selection bias in empirical tests involving this subsample.

[Insert Table 4]

3.2. Univariate tests – transaction costs

Table 5 contains univariate tests examining variation in a firm's supplier contracting status across different key independent variables. I examine univariate differences in *Supplier R&D Intensity, Supplier Differentiated Goods, Patent Cross-Citation Intensity, Relative Herf Index, Contracting Legal Rank, Price Informativeness,* and *Proximity.*

Firms with higher *Supplier R&D Intensity* are more likely to have supply contracts. The difference of 12 basis points is also significant at the 1% level. Firms which have higher levels of *Supplier Differentiated Goods* are more likely to have long term contracts with their suppliers. Specifically, 28.2% of their input is differentiated, compared to 26.9% of differentiated input for firms which do not enter into purchase obligations with their suppliers. The difference of 1.3% is statistically significant at the 1% level. Firms with supplier purchase obligations have patent

cross citation intensity of 2.8% compared to 2.5% in firms without supplier purchase obligations. The difference is significant at the 5% level. I examine differences in *Relative Herf Index* between the weighted-average supplier industries and the firm's own two digit NAICS industry *Herfindahl Index.* The *Relative Herf Index* is higher by 0.046 for firms using supplier purchase obligations and the difference is significant at the 1% level. *Price Informativeness* is 69.2% for firms which enter into purchase agreements with suppliers and 76.5% for firms which do not, with the difference significant at 99%. Additionally, firms with purchase obligations to suppliers have *Proximity* of -0.070 compared to a value of -0.064 for non-purchase obligation firms, with the difference significant at the 1% level. Finally, *Contracting Legal Environment* has an average value of 20.809 for firms with supplier contracts and 20.135 for firms without supplier contracts.

[Insert Table 5]

All univariate results are consistent with the theoretical predictions. Specifically, the presence of higher transaction costs results in a higher unconditional likelihood of product market contracts between supplier and customer. Next, I examine the effect of transaction costs on product market contracts in a multivariate framework.

3.3. Multivariate tests: Firm-level

Table 6 contains multivariate probit estimates. All models predict the probability of a firm having supplier contracts using key variables representing market frictions, which were discussed earlier in the paper. All models also use some form of the following specification, including the independent variable(s) of interest:

$$\textit{Supplier Contract}_{i,t} = \beta_0 + \beta_1 \textit{Supplier R\&D Intensity}_{i,t} + \beta_2 \textit{Patent Cross-citation Intensity}_{i,t} + \beta_3 \textit{Supplier Differentiated Goods}_{i,t} + \beta_4 \textit{Relative Herf Index}_{i,t} + \beta_5 \textit{Ln[Contracting Legal Rank]}_{i,t} +$$

β_6*Price Informativeness*$_{i,t}$ + β_7*Proximity*$_{i,t}$ + Control Variables + Year dummies + Constant + $\varepsilon_{i,t.}$

(2)

Robust standard errors are clustered by firm in all specifications, and year dummy variables are included. I do not include industry dummy variables because many of the transaction costs variables are industry-level variables themselves and are thus identical across all firms within a particular industry-year. Because I examine supplier/customer bargaining power both separately and in relative terms, *Herfindahl Index*$_{i,t}$ and *Supplier Herfindahl Index*$_{i,t}$ replace *Relative Herf Index* in some specifications.

[Insert Table 6]

Models 1-3 examine the effect of supplier RSI on the propensity of suppliers and customers to contract. In Model 1, *Supplier R&D Intensity* has a coefficient of 14.80 and is significant at the 1% level. In Model 2, *Patent Cross-Citation Intensity* has a coefficient of 0.54 and is significant at the 1% level. *Supplier Differentiated Goods* is the independent variable of interest in Model 3 and has a coefficient of 0.40 and is also significant at 1%. These results are consistent with Hypothesis 1; in supply-chain relationships which require relationship-specific investments by the supplier, the supplier will require an *ex ante* contractual commitment by the customer to purchase the eventual output. This is consistent with the general idea that purchase obligations/supply contracts arise to mitigate hold-up problems faced by the supplier.

Models 4 and 5 examine the effect of relative bargaining power and private information on the propensity to contract. In Model 4, I examine the effect of relative bargaining power on the propensity to contract. *Relative Herf Index* has a coefficient of 0.05 and is significant at 10%. In Model 5, I examine the impact of private information on the propensity to contract; *Price Informativeness* has a coefficient of -0.22 and is significant at 5%. Thus, the supplier's

bargaining power relative to the customer is positively related to the existence of contractual purchase obligations. Additionally, the amount of information in stock prices is negatively related to the existence of contractual purchase obligations, consistent with Hypothesis 2 and Hypothesis 4.

In Model 6, I examine the effect of proximity on the existence of supplier-customer contracts. *Proximity* is statistically significant at the 1% level and carries a negative sign, implying that contracts are more likely when the supplier and customer are further apart. As it does not appear that supplier and customer industries are more likely to contract when they are located near each other, I do not find support for the hypothesis that *Proximity* is capturing effects related to site-specific investment by suppliers and/or customers.

In Model 7, I present results including variables for RSI, relative bargaining power, private information, and supplier-customer proximity. *Supplier R&D Intensity* has a coefficient of 11.09 and is significant at 1%, *Relative Herf Index* has a coefficient of 0.05 and is significant at 10%, and *Price Informativeness* has a coefficient of -0.21 and significant at the 5% level. Ln*[Contracting Legal Rank]* is also positive and is significant at least 10% in all specifications except for Model 6. This is consistent with Hypothesis 3, that lower contracting costs are positively related to more contracting. If a customer firm is headquartered in a state recognized as having a better legal environment for contracts, they are more likely to enter into contracts.

Proximity has a coefficient of -0.83 and is significant at 10%. Note that I control for alternative contracting possibilities and the propensity to vertically integrate in all specifications using *% of Input Traded* and *Industry-Median Tangibility*, respectively. *% of Input Traded* is significant in all specifications and carries a negative coefficient. If a large portion of a firm's input is traded on financial markets, they are less likely to use product market contracts. Finally,

Industry-Median Tangibility is negative and significant at 1% in all specifications. As discussed by Acemoglu, Johnson and Mitton (2009), capital intensity appears to be a type of RSI with low vertical integration costs. Thus, in industries with high capital intensity, integration costs are likely lower and a lower propensity to contract is observed. Contracting is negatively related to book leverage. This is likely due to the fact that contracting is positively related to RSI, and Kale and Shahrur (2007) demonstrate a negative relation between book leverage and RSI.

I also examine the economic impact of each independent variable after holding all other variables at their means. Using the final model in Table 6, I find that increasing *Supplier R&D Intensity* from the 25th percentile to the 75th percentile increases the probability of observing contracting by 38%, from 0.16 to 0.22. The economic impact of other variables are somewhat smaller; changing from the 25th to 75th percentile of *Relative Herf Index* and *Price Informativeness* are related to changes in contracting probability by 10% (from 0.20 to 0.22), and by -9% (from 0.22 to 0.20), respectively. Changing *Proximity* from its 25th to 75th percentile decreases the probability of observing contracting by 10% (from 0.21 to 0.19), and shifting from the 25th to the 75th percentile of Ln*[Contracting Legal Rank]* increases the contracting probability by 16%, from 0.19 to 0.22.

3.4.Multivariate tests: Industry-level

Note again that all supplier industry variables are linked to customer industries using the IO tables. Thus, there is no variation in supplier characteristics for customers who are grouped in the same industry-year. As robustness to the firm-level tests, I re-test the previous hypotheses using industry-level data. In order to do this, I aggregate all customer firm characteristics in each two-digit industry and construct industry-level variables. Specifically, *Industry Supplier Contracts* is the percentage of firms in a given industry-year which are using supplier contracts,

and ln[*Contracting Legal Rank*], *Book Leverage, R&D Intensity,* ln[*Assets*], and are two digit industry-year averages. *Sales Growth* represents the sales growth of the entire two-digit industry. The sample size shrinks to 295 industry-year observations when examining industry-level data.

[Insert Table 7]

The results are generally consistent with those reported in Table 6. *Supplier R&D Intensity* and *Supplier Differentiated Goods* are significantly positive at the 1% level, although *Patent Cross-citation Intensity* is not statistically significant. *Relative Herf Index* is significant at the 10% level. *% of Input Traded* and *Industry-Median Tangibility* remain significantly negative in most specifications, and ln[*Contracting Legal Rank*] remains significantly positive. One variable of note, *Proximity*, remains negative although not significantly so.

4. Robustness checks and additional tests

This section describes a variety of additional robustness tests of the above results and some additional tests.

4.1.Vertically integrated firms

Including vertically integrated firms in the sample may affect the previous results. In equilibrium, these firms likely have already solved issues related to transaction costs by integration and should be less likely to contract. For robustness, I drop vertically integrated firms and re-run the empirical specifications in Table 6. Similar to Acemoglu, Johnson and Mitton (2009), I use the *COMPUSTAT* segment tapes and the BEA IO Tables to construct a sales-weighted backward vertical integration measure, *Vertical Relatedness*, for each firm. The variable is a proxy for the percentage of a firm's input it can purchase from its own segments. I

define a firm as *Vertically Integrated* if this integration measure is above 1% and drop them from the sample.[25] The results are reported in Table 8.

[Insert Table 8]

The various proxies for RSI (*Supplier R&D Intensity, Patent Cross-citation Intensity,* and *Supplier Differentiated Goods*) remain significantly positively related to the propensity to contract. The coefficients on *Relative Herf Index* and *Price Informativeness* become statistically insignificant, and are weaker than in Table 6. The coefficients on ln[*Contracting Legal Rank*] and *Proximity*, however, become stronger. Overall, the results support the assertion that transaction costs are positively related to the probability of observing supplier-customer contracting.

4.2. Contract Length

[Insert Table 9]

I examine the determinants of contract length in Table 9. I use Poisson estimates in these tests because the dependent variable is a count variable. However, as shown earlier in Table 4, the subsample of firms using contracts is systematically different than the entire sample. Thus, Poisson estimates on the subsample may suffer from a sample selection bias. To correct for sample selection, I estimate a first stage probit using Model 7 from Table 6 and compute the inverse mills ratio. I include the inverse mills ratio in the second stage Poisson estimates on the subsample of firms using contracts. As the two-step Heckman approach may understate standard errors in the second-stage (Moffett, 1999), I bootstrap the second-stage standard errors 100 times.[26] Model 1 examines the effect of *Supplier R&D Intensity, Relative Herf Index*, *Price*

[25] As an additional, unreported, robustness test, I also drop utility companies from the sample. The results are consistent with those in Tables 5 and 7.

[26] The above methodology assumes a normal distribution in the first stage and a Poisson distribution in the second stage. I also estimate an endogenous switching Poisson model in the cross-section, which is a FIML estimation that

Informativeness, and *Proximity* on contract length using the entire sample of firm-years with supplier contracts. *Supplier R&D Intensity* has a coefficient of 23.23 and is just outside statistical significance at 10%. *Relative Herf Index* is significant at 10% percent with a coefficient of 0.13. *Price Informativeness* has a coefficient of -0.57 and is significant at 5%. Ln*[Contracting Legal Rank]* is significantly positive at the 5% level, suggesting that contracts are written for longer terms in better contracting legal environments. In Model 2, I drop firms defined as vertically integrated. The results are similar to Model 1, although slightly stronger. Note that I control for alternative contracting possibilities and the propensity to vertically integrate in all specifications using *% of Input Traded* and *Industry-Median Tangibility*. For robustness, I also estimate Poisson and Tobit models on the whole sample (a value of "0" for non-contracting firms). The inferences from these models are similar to those presented above.

4.3.Simultaneity

Note that the theoretical models discussed above do not explicitly claim causality in any one direction. Rather, the contract is an *ex-ante* solution to a potential *ex-post* hold-up problem, and the contract is agreed to by the customer to induce the supplier to make RSI. Thus, it is highly likely that some or all of the transaction costs presented in this paper are simultaneously determined with *Supplier Contracts*. Using both 3SLS and 2SLS simultaneous estimates, I do find evidence that *Supplier R&D Intensity* and *Supplier Contract* are both positively related to each other. The results are reported in Table 10.

[Insert Table 10]

I utilize the customer firm's aggregate industry R&D intensity, as well as supplier characteristics *Supplier Herf Index, Supplier Sales Growth, and Supplier Industry Tobin's Q* as

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makes use of the entire sample with an endogenous dummy (*Supplier Contract*). The results are similar to those reported in Table 9.

additional predictors of *Supplier R&D.*[27] Although *Supplier R&D Intensity* continues to predict the propensity to contract, the existence of *Supplier Contracts* also affects the supplier's decision to invest in RSI. The evidence suggests that the existence of contracts induces supplier RSI, and the potential for supplier RSI generates the need for contracts. Additionally, this evidence complements Moon (2012), who uses seemingly unrelated regressions to examine the simultaneity between purchase obligations and firm characteristics such as capital intensity and leverage.

4.4.Cross-sectional tests

Since the multivariate tests are estimated on a panel dataset, serial correlation is a potential concern, especially given that many firms continue contractual relationships with suppliers year-after-year. As such, all standard errors are clustered by firm in most of the multivariate estimates in the paper. However, for robustness, I run year-by-year tests and examine these cross-sectional estimates to ensure that any potential serial correlation is not overstating statistical significance. In general, the results in Table 11 are consistent with Table 6, as they are statistically significant in most sample years. However, the 2008 fiscal year generally has weaker results. One explanation is that the financial crisis negatively affected corporate investment (Campello, Giambona, Graham, and Harvey, 2011) and which affects empirical tests of corporate investment in this time period. Additionally, the relation between *% of Input Traded* and *Supplier Contracts* appears strongest in the 2008 fiscal year. This is potentially due to increased corporate hedging activity, as shown by Williams (2012).

[Table 11]

[27] The results are not sensitive to the choice of exogenous variables. They are robust to a wide range of different model specifications.

4.5.Industry Definitions

In the main tests, I report HHI variables computed from Compustat using two-digit NAICS codes. However, the literature has pointed to numerous issues caused by estimating Herfindahl-Hirschman indices (HHI) from Compustat data (Ali, Klasa, and Yeung, 2009; Hoberg and Phillips, 2010), primarily relating to Compustat's exclusion of private companies. Therefore, I also estimate HHI using similar methodology to Hoberg and Phillips (2010). The methodology is identical except that I use three-digit NAICS industry definitions (instead of SIC) and I use the 2007 Department of Commerce HHIs for my entire sample. Using this definition weakens the results slightly, but they are qualitatively similar to results reported elsewhere in the paper.

Additionally, I test that the results are robust to different industry definitions. I generally use a broad definition of industry (two-digit NAICS) throughout the paper. However, I also aggregate all of the weighted supplier industry-level variables (*Supplier R&D Intensity, Supplier Differentiated Goods, Supplier Herfindahl Index,* etc.) at the four-digit and six-digit level as well, and generate similar results as earlier. The results at the six-digit level are somewhat weaker, although most variables remain statistically significant. However, the bargaining power results do not hold if *Supplier Herfindahl Index* and *Relative Herf Index* are defined at the six-digit level.

5. Firm performance

5.1.Supplier Contracts and Firm Performance

In order to study normative implications of supplier-customer contracting, I next examine whether purchase agreements with suppliers affect the customer firm's performance. In Table 12, I examine three measures of performance. The first measure is operating return on assets, or

$OROA_{t+1}$, which is EBITDA divided by total assets (Compustat variables *EBITDA/AT*). The second performance measure is industry-adjusted operating return on assets, or *Ind Adj* $OROA_{t+1}$, which is $OROA_{t+1}$ minus the two digit NAICS industry-year median $OROA_{t+1}$. The last performance measure is firm value, which is *Ind Adj Tobin's* Q_t (*Tobin's* Q_t minus the two digit NAICS industry-year median *Tobin's* Q_t). In all models, I control for *R&D Intensity* (Aggarwal and Samwick, 2006), *Book Leverage* (Opler and Titman, 1994), *Sales Growth* (Brush, Bromiley, and Hendrickx, 2000), ln[*Assets*] (Sufi, 2009), *CAPEX* (Aggarwal and Samwick, 2006), and *Cash Holdings* (Sufi, 2009), which is defined as cash divided by the book value of assets. In specifications predicting operating performance, I also control for stock performance, although omitting this control does not significantly influence the results. Thus, the general empirical model is:

$$\text{Operating Performance}_{i,t+1} \text{ or Stock Performance}_{i,t} = \beta_0 + \beta_1 \textit{Supplier Contracts}_{i,t} + \beta_2 \textit{R\&D Intensity}_{i,t} + \beta_3 \textit{Book Leverage}_{i,t} + \beta_4 \textit{Sales Growth}_{i,t} + \beta_5 \text{Ln}[\textit{Assets}]_{,i,t} + \beta_6 \textit{CAPEX}_{i,t} + \beta_7 \textit{Cash Holdings}_{i,t} + \text{Year dummies} + \text{Constant} + \varepsilon_{i,t.} \quad (3)$$

Additionally, *Tobin's Q* is used a control variable in specifications where operating performance is the dependent variable.

Models 1-3 use OLS regressions to examine the effect of *Supplier Contracts* on $OROA_{t+1}$, *Ind Adj* $OROA_{t+1}$, and *Ind Adj Tobin's* Q_t, respectively. In Model 1, *Supplier Contracts* has a coefficient of 0.0150 and is significant at the 5% level. In Model 2, *Supplier Contracts* has a coefficient of 0.0186 and is significant at the 1% level. In Model 3, *Supplier Contracts* has a coefficient of 0.1725 and is significant at the 1% level. Thus, in the OLS framework, purchase obligations to suppliers are associated with a 1.5% increase in $OROA_{t+1}$, a

1.89% increase in *Ind Adj* $OROA_{t+1}$, and a 0.1725 increase in firm value after controlling for other effects.

[Insert Table 12]

Note that the above results do not control for potential endogeneity. For example, suppliers may only choose to contract with better-performing customers, or some unobserved factor could affect both contracting and performance. In order to control for this possibility, I use an instrumental variables approach and a treatment effects estimation. In Models 4-6, I present 2SLS instrumental variables estimates for $OROA_{t+1}$, *Ind Adj* $OROA_{t+1}$, and *Ind Adj Tobin's* Q_t. In Model 4, which predicts $OROA_{t+1}$, *Supplier Contracts* has a coefficient of 0.2337 and is significant at the 5% level, using the instruments *Supplier R&D Intensity* and ln*[Contracting Legal Rank]*. In Model 5, which predicts *Ind Adj* $OROA_{t+1}$, *Supplier Contracts* has a coefficient of 0.3331 and is significant at the 1% level, using the instruments *Supplier R&D Intensity* and ln*[Contracting Legal Rank]*. Finally, in Model 6, which predicts *Ind Adj Tobin's* $Q_{t.}$, *Supplier Contracts* has a coefficient of 21.0387 and is significant at the 1% level, using the instruments *Supplier Herf Index* and *Price Informativeness*. Thus, the performance results appear robust to corrections for endogeneity using an instrumental variables approach. Although I require the above instruments to pass statistical tests for overidentification, relevance, and validity and are selected from the independent variables used in Table 6, they must also pass the exclusion restriction (Roberts and Whited, 2012). Arguably, *Supplier R&D Intensity, Supplier Herf Index,* and *Price Informativeness* may affect firm performance in ways other than through their effect on *Supplier Contracts*. However, it is unlikely that ln*[Contracting Legal Rank]* affects firm performance in any way except through the firm's contracting activity. Therefore, I

also estimate an exactly identified system using ln*[Contracting Legal Rank]* as the lone instrument, and generate results similar to those presented in Table 12.[28]

For robustness, I also correct for endogeneity using a treatment effects approach. A treatment effect estimation measures the average causal difference in performance under the control (non-purchase obligation firms) and the treated sample (purchase obligation firms). The methodology has the advantage of allowing all transaction costs variables to predict *Supplier Contract* in the first stage. Thus, I use the probit estimates in Model 7 in Table 6 as the first-stage in the treatment effects estimation. In Model 7, which predicts $OROA_{t+1}$, *Supplier Contract* has a coefficient of 0.2467 and is significant at the 1% level. In Model 8, which predicts *Ind Adj* $OROA_{t+1}$, *Supplier Contract* has a coefficient of 0.3578 and is significant at the 1% level. Finally, Model 9, which predicts *Ind Adj Tobin's* $Q_{t.}$, *Supplier Contract* has a coefficient of 2.1744 and is significant at the 1% level. The results in the above section suggest that the use of purchase obligations with suppliers is positively related to firm performance and appear robust to traditional controls for endogeneity.[29]

5.2.Firm Performance and RSI

Another method to approach causality is to examine counterfactual evidence. Namely, if there truly is a causal link between contracting and firm performance, what is the effect of contracts on performance when we should not observe contracts (and vice versa)? Variation in the relation between contracting and performance, based on whether contracting should be observed or not, generates a stronger case for a causal relation. Additionally, counterfactual tests would address a related question regarding the equilibrium: if purchase agreements affect

[28] In fact, Roberts and Whited (2012) argue that this might be a better technique than using an overidentifed system. Although using multiple instruments allows one to perform overidenfication tests, Roberts and Whited (2012) point out that it is generally difficult for researchers to identify even one good instrument.

[29] Note that these results are much weaker (although generally still significant at the 10% level) when controlling for firm fixed effects.

performance, why don't all firms make the same decision? Any counterfactual evidence would suggest that contracting is not optimal for all firms, and we would observe possibly worse performance for firms which are using contracts but should not be using them.

I examine this possibility in Table 13, where I present treatment effects estimates in subsamples of firms with above sample year-median RSI measures (*Supplier R&D Intensity, Supplier Differentiated Goods,* and *R&D Intensity*).[30] Cases where the RSI measures are high represent environments where we should observe contracting, and cases where RSI is low represent environments where we do not expect to see contracting. Note that in all models, the existence of supplier contracts enhances firm value (*Ind-Adj* Q_{t+1}) when the measure of RSI is above the sample-year median. Additionally, the existence of such contracts when RSI is low *reduces* firm value. The difference in coefficients across the two subsamples is also statistically significant. We do, then, observe that when contracts are used as predicted by economic theory, they have a positive effect on performance. In counterfactual cases, they negatively affect performance. Thus, it does not appear optimal for all firms to use contracts. Additionally, the tests in Table 13 provide some support for a causal relation between contracting and firm performance.

[Insert Table 13]

6. Supplier contracts and vertical integration

Vertical integration is an alternative solution for hold-up problems. The decision to vertically integrate is well researched in both the finance and economics literature. Recent theoretical research (e.g., Whinston, 2003) and empirical studies (Acemoglu, Johnson, and Mitton, 2009; Shenoy, 2012) examine the vertical integration decision as a solution to a number

[30] I also estimate similar specifications using OLS and IV methods. These are omitted for brevity but are available upon request from the author.

of hold-up problems.[31] Vertical integration is especially likely when contracting costs are high. In this subsection's main set of empirical tests, I model the choice between contracting versus vertical integration. To my knowledge, these determinants have never been tested jointly. Additionally, I examine how firms adjust their boundaries in response to an industry-wide human capital shock in the form of a sudden industry-wide R&D increase.

6.1. Hypotheses

Similar to Hypothesis 1 which predicts RSI as a determinant of contracting, RSI is also frequently used a determinant of vertical integration. Many studies (Fee, Hadlock, and Thomas, 2006; Kale and Shahrur, 2007; Shenoy, 2012, among many others) use R&D intensity to proxy for RSI. However, Acemoglu, Johnson, and Mitton (2009) instead use a measure of asset tangibility as their measure of RSI predicting vertical integration. Their argument is that integration may lead to underinvestment in human capital by employees (Grossman and Hart, 1986; Hart and Moore, 1990). Thus, hold-up problems associated with physical investment or high capital intensity may be easier to solve with integration as this type of investment is often not associated with high amounts of human capital. However, in firms (or supply chains) where human capital is important, integration costs are likely to be relatively higher. [32] All else equal, hold-up problems associated with high R&D firms and high R&D supply chains may be better solved with contracts than with integration. I predict that the propensity to contract versus integrate is increasing in supplier R&D intensity, *Supplier R&D Intensity* and firm R&D

[31] Brickley, Linck, and Smith Jr. (2012) examine vertical mergers in the financial sector and find that integration may also occur for competitive reasons such as when a supplier is also a potential competitor.

[32] Seru (2011) also finds a similar effect in conglomerates. That is, investment requiring large amounts of human capital, measured by patent intensity, is less efficient inside a conglomerate. Conglomerates mitigate this problem by moving the R&D intensive investment outside of the firm through the use of strategic alliances and joint ventures.

intensity, *R&D Intensity*. Further, I predict that the propensity to contract versus integrate is decreasing in *Industry-Median Tangibility*.

In earlier tests, *Proximity* is negatively related to the propensity to contract—a result consistent with the notion that information asymmetry increases with distance, and inconsistent with the hypothesis that site-specific investment positively relates to supplier-customer contracting. However, another explanation is that many problems generated by site specificity are so severe that integration is needed to solve the hold-up problem as distance decreases. If so, I predict the propensity to contract is decreasing in *Proximity* and the propensity to vertically integrate is increasing in *Proximity*.

Contracting costs also affect the decision to integrate. In environments where contracting is difficult and costly, a firm may instead choose to vertically integrate. A large body of theoretical and empirical evidence suggests that vertical integration is positively related to explicit contracting costs (e.g. Coase, 1937; Klein, Crawford, and Alchian,1978; Fee, Hadlock, and Thomas, 2006; among others). I predict that the propensity to contract versus integrate is increasing in ln*[Contracting Legal Rank]*.

Finally, supplier and customer industry concentration may affect the decision to integrate. If regulators oppose integration between highly concentrated industries for foreclosure or collusion reasons (see Shenoy (2012) for a discussion of this literature), both *Supplier Herfindahl Index* and *Relative Herf Index* should positively affect the propensity to contract versus vertically integrate.

6.2. Multivariate tests - vertical integration

I next examine these hypotheses in two ways. First, in Section 6.2.1, I consider a subsample of firms which are either vertically integrated or which use supplier contracts. I then

examine the effect of the above forces on a firm's propensity to either be vertically integrated or to contract. However, it is unlikely that the subsample of firms which are vertically integrated or contracting are randomly assigned, which creates the possibility of a sample selection bias. Therefore, in Section 6.2.2, I use a two-stage Heckman-type probit framework to better identify the contract/vertical integration choice. I first model the firm's decision to do "something" (i.e. either contract or vertically integrate) and in the second stage I examine the choice between contracting or vertical integration. Both sets of tests are discussed below.

[Insert Table 14]

6.2.1 Probit Results

Table 14 contains the multivariate results. Models 1 and 2 are probit estimates on a subsample of firms which are vertically integrated or use supplier contracts. In this specification, the dependent variable is equal to one if a firm uses contracts and zero if a firm is vertically integrated and does not use contracts. A firm is considered vertically integrated if it at least has a backward vertical relatedness coefficient of 1% (Acemoglu, Johnson, and Mitton, 2009). In Models 1 and 2, *Supplier R&D Intensity* and *R&D Intensity* are positively related to the propensity to contract, while *Industry-Median Tangibility* is negatively related. *Relative Herf Index* is positive and significant, as is *Supplier Herfindahl Index.* The firm's own industry *Herfindahl Index* is negative but insignificant. The proxy for contracting costs, ln*[Contracting Legal Rank],* and *Proximity* fail to significantly predict contracts versus integration. Therefore, it appears that contracts are more likely than vertical integration at higher levels of intangible investment, and vertical integration is more likely than contracts in the presence of high levels of tangible investment.

6.2.2. Two-stage results

For both sets of results, I estimate a first-stage probit model. The dependent variable is equal to one if a firm is either vertically integrated or uses contracts and zero otherwise. Models 3 and 5 contain the first stage estimates. I include all variables from Table 6, Model 7 in the first stage except for variables expected to predict the choice between contracts and vertical integration. Thus, *Supplier R&D Intensity, Industry-Median Tangibility, Proximity,* and ln*[Contracting Legal Rank]* are omitted from the first stage because there are no clear predictions on their effect on the choice between markets and contracts/integration. *Relative Herf Index*, or *Supplier Herfindahl Index* and *Herfindahl Index* are included in the first stage because the hypotheses relating to contracting versus vertical integration are not directly related to the bargaining hypothesis discussed in the hypothesis section. Models 4 and 6 present the second stage probit estimates, which control for sample selection by including the inverse mills ratio from the first stage. The second-stage dependent variable is equal to one if the firm uses contracts, and zero if the firm is vertically integrated and does not contract.[33] In Model 4, which predicts the propensity to contract versus integration, *Supplier R&D Intensity* is significantly positive at 1%. *Industry-Median Tangibility* is negatively related and significant at 10%, and *Relative Herf Index* is positive and significant at 5%. Ln*[Contracting Legal Rank]* and *Proximity* remain insignificant. Finally, Model 6 is identical to Model 4, except *Supplier Herf Index* and the firm's own industry *Herfindahl Index* replace *Relative Herf Index*. *Supplier R&D Intensity* is significantly positive at 1%. *Industry-Median Tangibility* is negatively related and

[33] In the main results, the few firms that have both contracts and are vertically integrated are dropped. In unreported tests, I confirm that including these firms either as "contracting" firms or as "integrated" firms does not affect the results. I have also confirmed the results in Table 14 using a multinomial logit model. I am unable to estimate a nested logit model because I do not have unique independent variables for each outcome.

significant at 10%. *Supplier Herfindahl Index* and the firm's own industry *Herfindahl Index* are insignificant. In general, the results confirm the earlier hypotheses. RSI in the form of intangible investment appears to have higher integration costs; suppliers and customers are more likely to use contracts. However, when RSI is in the form of tangible investment, integration costs are lower and firms are relatively more likely to be vertically integrated.

6.3. Industry R&D & CAPEX shocks

In tables 15 and 16, I examine whether industry-wide shocks to required investment have subsequent effects on vertical firm boundaries. I define dummy variables, *Positive (Negative) Industry R&D Shock*, as equal to one if the aggregate *R&D Intensity* of a firm's two-digit industry increased (decreased) by at least 10% in a given year, and *Positive (Negative) Industry CAPEX Shock*, as equal to one if the aggregate *CAPEX* of a firm's two-digit industry increased (decreased) by at least 10% in a given year. I then examine whether there is a subsequent impact on firm boundaries. Specifically, I examine whether there is a complete change in contracting status (going from no contracts to using contracts, and vice-versa) or in vertical integration status (going from non-vertically integrated to vertically integrated, and vice-versa). In Models 1-4, I define indicator variables *Get Supplier Contract*$_{t+1}$, *Lose Supplier Contract*$_{t+1}$, *Vertically Integrate*$_{t+1}$, and *Vertically Disintegrate*$_{t+1}$, which are equal to one if a firm gets a supplier contract, loses a supplier contract, becomes vertically integrated, or vertically disintegrates, respectively in a given year.

Generally speaking, the industry shock dummy variables do not have strong statistical influences on these measures of large changes to firm boundaries, except that *Positive Industry R&D Shock* positively predicts the propensity to *Get Supplier Contract*$_{t+1}$ at the 10% level, and *Negative Industry CAPEX Shock* negatively (positively) predicts the propensity to *Get (Lose)*

Supplier Contract$_{t+1}$ at the 10% level. This evidence may suggest that firm boundaries, on average, do not dramatically change over short periods of time. Thus, I utilize finer measures of changes in firm boundaries to investigate the effect of industry R&D shocks. I construct *Percent Dollar Change*$_{t,t+1}$ which is the percentage increase in the dollar amount of the contractual commitment two years into the future at time t, to the dollar amount of the commitment one year into the future at time t+1.[34] In other words, *Percent Dollar Change*$_{t,t+1}$ captures the change in contracting intensity for a fixed point in the future. When *Percent Dollar Change*$_{t,t+1}$ increases, a firm has increased its contracting activity in dollar terms. I also construct *Integration Coefficient Change*$_{t,t+1}$, which is the change in a firm's backward vertical relatedness coefficient from year t to t+1. Increases in *Integration Coefficient Change*$_{t,t+1}$ indicate that a firm has become more vertically integrated.

[Insert Table 15]

[Insert Table 16]

Utilizing *Percent Dollar Change*$_{t,t+1}$ and *Integration Coefficient Change*$_{t,t+1}$ allow an examination of subtler changes in firm boundaries. One can examine shifts in contracting intensity and degree of vertical integration rather than dramatic shifts such as vertically integrated to not. The results with these two variables are presented in Models 5 and 6. In Panel A of Table 15, *Percent Dollar Change*$_{t,t+1}$ is significantly positively related to *Positive Industry R&D Shock* at the 5% level, indicating that industry R&D spikes cause increases in contracting activity in dollar terms. *Integration Coefficient Change*$_{t,t+1}$ is significantly negatively related to *Positive Industry R&D Shock*, which suggests that spikes in industry R&D cause a reduction in vertical integration. In Panel B of Table 15, *Percent Dollar Change*$_{t,t+1}$ is not significantly

[34] To illustrate, suppose a firm is obligated to purchase $1million in 2010 as of their 2008 year end. If, as of the firm's 2009 year-end, they are now obligated to purchase $1.5 million in 2010, *DollarChange*$_{t,t+1}$ is equal to 50%.

related to *Negative Industry R&D Shock*, but *Integration Coefficient Change*$_{t,t+1}$ is significantly positively related to *Negative Industry R&D Shock*, which suggests that downward spikes in industry R&D positively relate to increases in vertical integration. In Panel A of Table 16, I find that *Percent Dollar Change*$_{t,t+1}$ is significantly negatively related to *Positive Industry CAPEX Shock* at the 1% level, indicating that industry CAPEX spikes are related to decreases in contracting activity in dollar terms. *Integration Coefficient Change*$_{t,t+1}$ is significantly positively related to *Positive Industry CAPEX Shock*. Finally, in Panel B of Table 16, I find that *Integration Coefficient Change*$_{t,t+1}$ is significantly negatively related to *Negative Industry CAPEX Shock*.

As a whole, the results in Section 6 are consistent with the hypothesis that different types of RSI are associated with different hold-up problems requiring different solutions. Thus, *Supplier R&D Intensity* and *R&D Intensity* appear to capture a type of RSI solved relatively easier by contracting, due to the integration costs associated with human capital (e.g., Hart and Moore, 1990; Grossman and Hart, 1986). These results are also consistent with the evidence in Seru (2011), who finds that conglomerates (including vertically integrated firms) move R&D intensive activity outside of the firm using strategic alliances and joint ventures. *Industry-Median Tangibility* represents investment less affected by integration cost; thus, integration appears relatively better at solving hold-up problems associated with capital intensive investment. Relative industry concentration and supplier industry concentration are positively related to the propensity to contract relative to integration, but a firm's own industry concentration is insignificantly negative. This is consistent with the view that competitive industries find it difficult to acquire a supplier in a concentrated industry, but I do not find

evidence of regulatory pressure.[35] Additionally, I find some evidence that firms adjust their boundaries in response to industry-level shocks to the type of investment required.

7. Conclusions

Using a unique database built from 10-K filings, I empirically examine the question: why do firms enter into explicit contacts as opposed to using markets to exchange goods and services? To my knowledge, this is the first empirical study in financial economics exploring this question directly. I draw testable hypotheses from extant theory and then empirically examine the determinants of a firm's explicit contracts with suppliers. Theory predicts that the propensity to contract should be increasing in relationship-specific investments, the supplier's relative bargaining power, supplier-customer proximity, and vertical integration costs. The propensity to contract should be decreasing in stock price informativeness, and contracting costs. I also examine the determinants of the length of these supplier-customer contracts as well as investigate the impact of these contracts on firm performance.

Consistent with the above predictions, I find evidence that supplier relationship-specific investments, the supplier's relative bargaining power, and vertical integration costs are positively related to the propensity for suppliers and customers to contract, yet customer stock price informativeness, contracting costs, the proximity of suppliers and customers to each other, and the percentage of a customer's input traded on financial markets are negatively related to the propensity to contract. I also find that contract length is increasing in relationship-specific investments, supplier relative bargaining power, and vertical integration costs. Contract length is decreasing in stock price informativeness, contracting costs, and the percentage of a customer's input traded on financial markets. These collective results support the prediction that transaction

[35] This lack of evidence of regulatory pressures could be unique to the 2003-2008 sample period.

costs shape firm boundaries through supplier-customer contracting activity. Additionally, I investigate the impact of these contracts on firm performance.

I also explore the choice between contracts and vertical integration. I use a two-stage framework to examine which method a firm uses in equilibrium. Additionally, I examine industry R&D and CAPEX shocks to examine how firms modify their contracting and integration status. I find that relationship-specific investments in the form of tangible assets are negatively related to the propensity to contract versus vertically integrate, but relationship-specific investments defined as R&D intensity are positively related to the propensity to contract versus integrate. I also find that industry-level positive (negative) R&D shocks increase (decrease) contracting intensity in dollar terms and reduce (increase) the degree of vertical integration. This is consistent with theory (Grossman and Hart, 1986; Hart and Moore, 1990), which predicts that integration creates an incentive for firms to under invest in human capital, and is also consistent with recent empirical evidence in Seru (2011). My evidence suggests that hold-up problems associated with non-human capital intensive RSI are more likely to be solved through integration rather than contracting. Firms with human capital intensive RSI are likely to have high integration costs and are more likely to contract rather than integrate. I contribute to the literature in the following ways. Although the extant literature examines alternative solutions for hold-up problems (vertical integration, partial ownership, and joint ventures), this study examines the determinants of explicit product market contracts. In doing so, I also find support for the assertion in Chen, Goldstein, and Jiang (2007) that the information derived from stock prices is likely to be about the demand for the firm's products or about its strategic landscape. Additionally, I empirically examine a firm's choice between contracts and vertical integration, and show that hold-up problems associated with different types of relationship-specific

investments have different solutions. Finally, I build a comprehensive panel database containing all U.S. public companies. In doing so, I extend previous empirical research in the extant literature which has generally been limited to data for a single year and/or a single industry. Overall, this study examines a previously unexplored area of financial economics, and the results suggest many opportunities for future research.

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Appendix A

Examples of Footnote Disclosures

The following is an example of the "Contractual obligations" footnote in AAR Corp for fiscal year 2005. The "Purchase obligations" line item is the line item collected using the Perl scripting language.

Contractual Obligations and Off-Balance Sheet Arrangements

A summary of contractual obligations and off-balance sheet arrangements as of May 31, 2005 is as follows:

		Payments Due by Period					
	Total	Due in Fiscal 2006	Due in Fiscal 2007	Due in Fiscal 2008	Due in Fiscal 2009	Due in Fiscal 2010	After Fiscal 2010
On Balance Sheet:							
Debt	$ 200,632	$ 713	$ 743	$ 68,157	$ 8,716	$ 200	$ 122,103
Non-recourse Debt	28,862	1,622	1,928	2,047	2,173	21,092	—
Bank Borrowings	1,410	1,410	—	—	—	—	—
Off Balance Sheet:							
Aviation Equipment Operating Leases	38,149	10,887	18,302	3,840	3,840	1,280	—
Facilities and Equipment Operating Leases	25,408	6,521	6,293	5,223	3,995	3,205	171
Garden City Operating Lease	31,783	1,388	1,423	1,458	1,495	1,532	24,487
Purchase Obligations	75,555	71,085	3,657	718	42	37	16

Appendix B

Examples of Problems with Footnote Disclosures

Below is Coca-Cola's 2010 10-K filing for fiscal year 2008. Coca-Cola combines some future years, making an exact determination of contract length difficult for automatically collected data.

Aggregate Contractual Obligations

As of December 31, 2008, the Company's contractual obligations, including payments due by period, were as follows (in millions):

	Payments Due by Period				
	Total	2009	2010-2011	2012-2013	2014 and Thereafter
Short-term loans and notes payable[1]:					
Commercial paper borrowings	$ 5,389	$ 5,389	$ —	$ —	$ —
Lines of credit and other short-term borrowings	677	677	—	—	—
Current maturities of long-term debt[2]	465	465	—	—	—
Long-term debt, net of current maturities[2]	2,781	—	620	265	1,896
Estimated interest payments[3]	1,707	163	273	219	1,052
Accrued income taxes[4]	252	252	—	—	—
Purchase obligations[5]	10,737	7,041	1,221	517	1,958
Marketing obligations[6]	4,464	1,910	1,061	658	835
Lease obligations	631	174	231	108	118
Total contractual obligations[4]	$ 27,103	$ 16,071	$ 3,406	$ 1,767	$ 5,859

Table 1

Summary statistics

Summary statistics using 19,749 Compustat firms which filed 10-K reports for their fiscal years 2003-2008. Financial firms are excluded. *Supplier Contracts* is a dummy variable equal to "1" if a firm reports purchase obligations in their 10-K, and "0" otherwise. *Length of Contract* is equal to the number of years into the future a firm reports purchase obligations to its suppliers. The percentage amount by years break out the dollar amounts committed to as a percentage of COGS. *Supplier Herfindahl Index* is the weighted-average of all supplier industry Herfindahl Indices, weighted by the importance of each supplier industry to the firm. *Supplier R&D Intensity* is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. Supplier Differentiated Goods proxies for the heterogeneity of a firm's inputs. I first define a supplier industry as either producing differentiated output or not (using the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. *Patent Cross-citation Intensity* is the percentage of supplier industries which have patent cross-citations with the firm's own industry. *% of Input Traded* proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to "1", and "0" otherwise, and then define % of Input Traded as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *Proximity* is the additive inverse of the supplier weighted-average transportation costs from the input-output tables. *Contracting Legal Rank* is the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Industry-Median Tangibility* is the 2-digit NAICS industry-year median tangibility ratio (Net PPE/Total Assets). *Herfindahl Index* is the firm's own 2-digit NAICS industry concentration. *Price Informativeness* is the firm's stock price informativeness. *R&D Intensity* is RD/Total Assets. *Backward Integration* is the firm's sales-based vertical integration coefficient (Acemoglu, Mitton, and Johnson, 2009). *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *Sales Growth* is the firm's sales growth. Assets is a firm's book assets in millions, and Tobin's Q is the market value of assets divided by the book value of assets. All variables are winsorized at 1% and 99%.

	Mean	Median	Min	Max	Observations
Dependent Variable					
Supplier Contracts	0.20	0.00	0.00	1.00	19749
Length of Contract	2.49	3.00	1.00	6.00	4010
Percentage Amount by Year:					
Year *t+1*	0.12	0.07	0.00	0.46	3966
Year *t+2*	0.07	0.00	0.00	0.73	3966
Year *t+3*	0.05	0.00	0.00	0.50	3966
Year *t+4*	0.01	0.00	0.00	0.07	3966
Year *t+5 & onward*	0.00	0.00	0.00	0.00	3966
Supplier Industry Characteristics					
Supplier Herfindahl Index	0.04	0.04	0.02	0.32	19749
Supplier R&D Intensity	0.02	0.02	0.00	0.03	19749
Supplier Differentiated Goods	0.27	0.23	0.03	0.66	19749
Patent Cross-citation Intensity	0.03	0.00	0.03	0.42	13109
% of Input Traded	0.03	0.01	0.00	0.58	19749
Proximity	-0.07	-0.07	-0.18	0.00	19436

Continued…

Table 1 (continued)

Firm's Industry Characteristics					
Industry-Median Tangibility	0.21	0.13	0.00	0.81	19744
Herfindahl Index	0.04	0.03	0.01	0.43	19749
% Import	0.01	0.00	0.00	0.03	19749
Firm Characteristics					
Contracting Legal Rank	20.27	18.00	1.00	50.00	18898
Price Informativeness	0.75	0.83	0.00	1.00	17349
R&D Intensity	0.08	0.01	0.00	0.99	19749
Backward Integration	0.01	0.00	0.00	0.80	19749
Book Leverage	0.24	0.17	0.00	2.07	19749
Sales Growth	0.13	0.15	-1.00	0.81	19749
Assets (in millions)	2163.34	2163.34	1.02	38593.00	19749
Tobin's Q	2.40	1.61	0.54	20.27	19749

Table 2

Correlation table

Correlation table using 19,749 Compustat firms which filed 10-K reports for their fiscal years 2003-2008. Financial firms are excluded. Supplier Contracts is a dummy variable equal to "1" if a firm reports purchase obligations in their 10-K, and "0" otherwise. Vertically Integrated is equal to one if the firm has a backward integration coefficient greater than 1%. Supplier Herfindahl Index is the weighted-average of all supplier industry Herfindahl Indices, weighted by the importance of each supplier industry to the firm. Supplier R&D Intensity is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. Supplier Differentiated Goods proxies for the heterogeneity of a firm's inputs. I first define a supplier industry as either producing differentiated output or not (using the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. Patent Cross-citation Intensity is the percentage of supplier industries which have patent cross-citations with the firm's own industry. % of Input Traded proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output is traded on a financial exchange equal to "1", and "0" otherwise, and then define % of Input Traded as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. Contracting Legal Rank is the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). Industry-Median Tangibility is the 2-digit NAICS industry-year median tangibility ratio (Net PPE/Total Assets). Herfindahl Index is the firm's own 2-digit NAICS industry concentration. Price Informativeness is the firm's stock price informativeness. R&D Intensity is RD/Total Assets. Book leverage is long-term debt and current portion of long-term debt divided by book assets. Sales Growth is the firm's own industry sales growth. Ln[Assets] is the natural logarithm of a firm's book assets in millions. All variables are winsorized at 1% and 99%.

	Supplier Contracts	*Vertically Int*	*Supplier R&D*	*Patent Cross-cite*
Supplier Contracts	1.00			
Vertically Integrated	0.04	1.00		
Supplier R&D Intensity	0.07	-0.13	1.00	
Patent Cross-citation Int	0.01	-0.05	0.17	1.00
Supplier Differentiated Goods	0.03	-0.16	0.68	0.26
Relative Herf Index	0.03	-0.03	0.10	0.00
Ln[Contracting Legal Rank]	0.03	0.04	0.00	-0.06
Price Informativeness	-0.11	-0.17	0.03	0.06
Proximity	-0.05	-0.06	-0.30	-0.09
% of Input Traded	-0.02	0.11	-0.07	-0.05
Industry-Median Tangibility	-0.05	0.11	-0.36	-0.09
% Imports	-0.02	-0.10	-0.05	0.07
Herfindahl Index	-0.04	0.05	-0.33	-0.07
Book Leverage	0.00	0.06	-0.09	-0.09
R&D Intensity	-0.05	-0.14	0.07	0.11
Sales Growth	-0.02	-0.01	-0.09	0.07
Ln[Assets]	0.14	0.23	-0.08	-0.09

	Supplier Diff	*Relative Herf Index*	*Ln[Contracting]*	*Price Infor*
Supplier Differentiated Goods	1.00			
Relative Herf Index	-0.02	1.00		
Ln[Contracting Legal Rank]	-0.07	-0.02	1.00	
Price Informativeness	0.12	0.05	0.00	1.00
Proximity	-0.19	0.05	-0.03	0.14

Continued...

Table 2 (continued)

% of Input Traded	-0.28	0.06	0.03	-0.12
Industry-Median Tangibility	-0.24	-0.10	-0.02	-0.19
% Imports	0.04	-0.05	-0.03	0.19
Herfindahl Index	-0.26	-0.66	0.01	-0.04
Book Leverage	-0.15	-0.04	0.06	-0.07
R&D Intensity	0.27	-0.02	-0.10	0.24
Sales Growth	-0.08	0.10	-0.03	-0.03
Ln[Assets]	-0.17	0.01	0.02	-0.67

	Proximity	*% of Input Traded*	*Industry-Med Tang*	*% Imports*
Proximity	1.00			
% of Input Traded	-0.23	1.00		
Industry-Median Tangibility	-0.07	0.20	1.00	
% Imports	0.19	-0.15	-0.20	1.00
Herfindahl Index	0.15	-0.02	0.16	-0.02
Book Leverage	-0.03	0.09	0.17	-0.10
R&D Intensity	0.01	-0.14	-0.20	0.39
Sales Growth	0.12	-0.05	0.09	-0.03
Ln[Assets]	-0.11	0.17	0.18	-0.16

	Herf Index	*Book Leverage*	*R&D Intensity*	*Sales Growth*
Herfindahl Index	1.00			
Book Leverage	0.07	1.00		
R&D Intensity	-0.08	-0.07	1.00	
Sales Growth	-0.01	0.01	-0.07	1.00
Ln[Assets]	0.00	0.22	-0.40	0.01

Table 3

Distribution of supplier contracting

Univariate statistics using Compustat firms which filed 10-K reports for their fiscal years 2003-2008. Financial firms are excluded. A firm is defined as using Supplier Contracts if a firm reports purchase obligations in their 10-K, and "0" otherwise. The table reports the percentage of firms using Supplier Contracts by industry type using Fama-French 48-industry codes, sorted in ascending order of the percentage of firm-years which have upstream contracts.

	Contracting	No Contracting	Total Number	FF Industry Code
Shipping Containers	0.40	0.60	65	39
Business Supplies	0.38	0.63	240	38
Shipbuilding and Railroad	0.35	0.65	62	25
Aircraft	0.34	0.66	110	24
Precious Metals	0.32	0.68	77	27
Printing and Publishing	0.31	0.69	203	8
Defense	0.30	0.70	46	26
Construction Materials	0.30	0.70	390	17
Electrical Equipment	0.29	0.71	419	22
Consumer Goods	0.28	0.72	334	9
Communication	0.28	0.72	817	32
Steel	0.28	0.72	315	19
Construction	0.27	0.73	297	18
Beer and Liquor	0.26	0.74	61	4
Chemicals	0.24	0.76	494	14
Electronic Equipment	0.24	0.76	1603	36
Fabricated Products	0.24	0.76	59	20
Rubber and Plastic	0.23	0.77	184	15
Apparel	0.22	0.78	349	10
Machinery	0.22	0.78	740	21
Autos	0.22	0.78	346	23
Restaurants & Hotels	0.21	0.79	452	43
Transportation	0.21	0.79	696	40
Food	0.20	0.80	373	2
Medical Equipment	0.20	0.80	915	12
Measuring and Control Equipment	0.20	0.80	560	37
Pharmaceutical	0.19	0.81	1979	13
Wholesale	0.18	0.82	882	41
Computers	0.18	0.82	1093	35
Business Services	0.17	0.83	2683	34
Recreation	0.16	0.84	187	6
Candy and Soda	0.15	0.85	52	3
Personal Services	0.14	0.86	139	33
Entertainment	0.13	0.87	335	7
Utilities	0.12	0.88	614	31
Petroleum and Natural Gas	0.12	0.88	1060	30
Coal	0.09	0.91	64	29

Continued…

Table 3 (continued)

Other	0.07	0.93	219	48
Retail	0.07	0.93	30	42
Mining	0.05	0.95	93	28
Textiles	0.05	0.95	82	16
Tobacco	0.00	1.00	30	5
Total firm-years			19749	

Table 4

Sample characteristics: Contract users and non-users

Sample differences between contract users and non-users using Compustat firms from 2003-2008. Financial firms are excluded. A firm is defined as using *Supplier Contracts* if a firm reports purchase obligations in their 10-K, and zero otherwise. *Assets* is the firm's book assets (in millions), and *Tobin's Q* is the market value of assets divided by the book value of assets. *Cash* is cash holdings divided by total assets. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *Sales Growth* is the firm's own industry sales growth and *ROA* is net income divided by total assets. *R&D Intensity* is R&D/Total Assets. All variables are winsorized at 1% and 99%.

Variable	Firms with *Supplier Contracts*		Firms without *Supplier Contracts*		Difference in Means	
	Mean	N	Mean	N	Difference	*t*-statistic
Assets	3204	4,010	1859	15,739	1345***	13.41
Tobin's Q	2.181	4,010	2.451	15,739	-0.270***	5.65
Cash	0.143	3,984	0.162	15,631	-0.019***	5.98
Book Leverage	0.224	4,010	0.247	15,739	-0.023***	4.08
Sales Growth	0.118	3,780	0.129	13,569	-0.012***	3.06
ROA	-0.034	4,010	-0.149	15,739	0.115***	12.33
R&D Intensity	0.061	4,010	0.083	15,739	-0.023***	7.82

Table 5

Univariate tests: Supplier contracts and transaction costs

Univariate tests using Compustat firms from 2003-2008. Financial firms are excluded. A firm is defined as using *Supplier Contracts* if a firm reports purchase obligations in their 10-K, and zero otherwise. *Supplier R&D Intensity* is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Supplier Differentiated Goods* is the percentage of supplier output which is differentiated. I first define a supplier industry as either producing differentiated output or not (based on the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. *Patent Cross-citation Intensity* is the percentage of supplier industries with patent cross-citation to a firm's own industry. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. *Contracting Legal Rank* is the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Price Informativeness* is the firm's own stock price informativeness measure. *Proximity* is the additive inverse of the supplier weighted-average transportation costs from the input-output tables. All variables are winsorized at 1% and 99%.

Variable	Firms with supplier contracts			Firms without supplier contracts			Difference in Means	
	Mean	Median	N	Mean	Median	N	Difference	t-value
Supplier R&D Intensity	0.017	0.017	4,010	0.015	0.015	15,739	0.001***	10.36
Supplier Differentiated Goods	0.282	0.236	4,010	0.269	0.233	15,739	0.013***	4.62
Patent Cross-Citation Intensity	0.028	0.000	2,711	0.025	0.000	10,398	0.003*	1.85
Relative Herf Index	1.677	1.719	4,010	1.631	0.167	15,739	0.046***	3.85
Contracting Legal Rank	20.809	19.000	3,835	20.135	18.000	15,063	0.675***	2.83
Price Informativeness	0.692	0.762	3,780	0.765	0.847	13,569	-0.073***	15.76
Proximity	-0.070	-0.072	3,946	-0.064	-0.069	15,490	-0.006***	6.85

Table 6

Determinants of supplier-customer contracts

Probit estimates using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variable in all specifications is equal to one if a firm uses *Supplier Contracts*, and zero otherwise. *Supplier R&D Intensity* proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Patent Cross-citation Intensity* is the percentage of supplier industries which have patent cross-citations with the firm's own industry. *Supplier Differentiated Goods* proxies for the heterogeneity of a firm's inputs. I first define a supplier industry as either producing differentiated output or not (using the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. Ln[*Contracting Legal Rank*] is the natural logarithm of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Price Informativeness* is the firm's own stock price informativeness measure. *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. *% of Input Traded* proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to one, and zero otherwise, and then define *% of Input Traded* as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *Industry-Median Tangibility* is the industry-year median tangibility ratio (Net PPE/Total Assets). *% Imports* is the percentage of a firm's industry's nonclassifiable imports. *Herfindahl Index* is the firm's 2-digit industry Herfindahl Index. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is RD/Total Assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models include year dummy variables. *t*-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Supplier R&D Intensity	14.80***						11.09***
	(4.37)						(3.08)
Patent Cross-citation Intensity		0.54***					
		(2.79)					
Supplier Differentiated Goods			0.40***				
			(2.92)				
Relative Herf Index				0.05*			0.05*
				(1.76)			(1.80)
Ln*[Contracting Legal Rank]*	0.04*	0.06**	0.05*	0.04*	0.05*	0.04	0.05*
	(1.65)	(2.42)	(1.82)	(1.72)	(1.83)	(1.58)	(1.79)
Price Informativeness					-0.22**		-0.21**
					(-2.20)		(-2.01)
Proximity						-1.41***	-0.83*
						(-3.37)	(-1.81)

Continued…

Table 6 (continued)

% of Input Traded	-0.62***	-0.60**	-0.45*	-0.63***	-0.57**	-0.76***	-0.69***
	(-2.67)	(-2.47)	(-1.95)	(-2.75)	(-2.38)	(-3.21)	(-2.79)
Industry-Median Tangibility	-0.32***	-0.44***	-0.43***	-0.47***	-0.50***	-0.50***	-0.35***
	(-2.74)	(-3.70)	(-3.89)	(-4.29)	(-4.39)	(-4.57)	(-2.88)
% Imports	0.53	-3.28	-0.14	-0.83	-1.50	0.28	0.73
	(0.21)	(-1.21)	(-0.05)	(-0.33)	(-0.56)	(0.11)	(0.26)
Herfindahl Index	-0.51	-1.80*	-1.23				
	(-0.54)	(-1.65)	(-1.31)				
Book Leverage	-0.14*	-0.09	-0.13*	-0.15**	-0.15	-0.15*	-0.14
	(-1.92)	(-1.08)	(-1.72)	(-1.99)	(-1.64)	(-1.96)	(-1.47)
R&D Intensity	-0.08	0.03	-0.15	-0.04	-0.07	-0.10	-0.15
	(-0.54)	(0.20)	(-1.03)	(-0.28)	(-0.46)	(-0.69)	(-0.88)
Sales Growth	-0.05	-0.12	-0.06	-0.10*	-0.05	-0.05	-0.03
	(-0.85)	(-1.56)	(-1.09)	(-1.72)	(-0.90)	(-0.83)	(-0.46)
Ln*[Assets]*	0.13***	0.12***	0.13***	0.13***	0.10***	0.12***	0.09***
	(13.17)	(11.38)	(13.18)	(13.12)	(6.70)	(12.57)	(6.48)
Constant	-1.84***	-1.45***	-1.67***	-1.64***	-1.19***	-1.62***	-1.55***
	(-14.06)	(-13.06)	(-13.89)	(-15.02)	(-7.49)	(-15.81)	(-8.55)
Number of Observations	18,893	12,588	18,893	18,893	16,727	18,590	16,455

Table 7

Robustness: Determinants of supplier-customer contracts - industry-level tests

OLS estimates by two-digit NAICS industry-year from 2003-2008. Financial industries are excluded. The dependent variable in all specifications is industry-level *Supplier Contracts*, or the percentage of firms in the industry which use supplier contracts. *Supplier R&D Intensity* proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Patent Cross-citation Intensity* is the percentage of supplier industries which have patent cross-citations with the firm's own industry. *Supplier Differentiated Goods* proxies for the heterogeneity of a firm's inputs. I first define a supplier industry as either producing differentiated output or not (using the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the customer industry *Herfindahl Index*. Ln[*Contracting Legal Rank*] is the two-digit NAICS industry average of the natural logarithm of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Industry-Median Tangibility* is the industry-year median tangibility ratio (Net PPE/Total Assets). *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. *% of Input Traded* proxies for the percentage of a industry's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to one, and zero otherwise, and then define *% of Input Traded* as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *% Imports* is the percentage of a firm's industry's nonclassifiable imports. *Herfindahl Index* is the customer industry's two-digit NAICS *Herfindahl Index*. *Book Leverage* is the two-digit NAICS industry average of long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is the two-digit NAICS industry average of RD/Total Assets. *Sales Growth* is the two-digit NAICS industry sales growth. Ln[*Assets*] is the two-digit NAICS industry average of the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models include year fixed effects. *t*-Statistics are reported in parentheses and are calculated from robust standard errors clustered by industry.

	(1)	(2)	(3)	(4)	(5)	(6)
Supplier R&D Intensity	1.59***					1.86***
	(4.29)					(4.25)
Patent Cross-citation Intensity		0.04				
		(0.68)				
Supplier Differentiated Goods			0.05***			
			(3.18)			
Relative Herf Index				0.01*		0.00
				(1.91)		(0.77)
Ln*[Contracting Legal Rank]*	0.05	0.03	0.05	0.06	0.06	0.08
	(1.18)	(0.72)	(1.25)	(1.20)	(1.17)	(1.49)
Proximity					-0.02	-0.01
					(-0.39)	(-0.19)
% of Input Traded	-0.01	-0.01	-0.00	-0.01	-0.01	-0.00
	(-0.77)	(-1.17)	(-0.19)	(-0.98)	(-0.56)	(-0.26)
Industry-Median Tangibility	-0.05	-0.05	-0.06	-0.01	-0.02	-0.02
	(-1.20)	(-1.09)	(-1.32)	(-0.29)	(-0.42)	(-0.51)

Continued…

Table 7 (continued)

% Imports	-0.28	-0.50	-0.53	-0.45	-0.55	-0.24
	(-0.74)	(-0.98)	(-1.06)	(-0.90)	(-1.14)	(-0.69)
Herfindahl Index	-0.69***	-0.82***	-0.73***			
	(-5.38)	(-5.71)	(-5.01)			
Book Leverage	-0.07	-0.13	-0.10	-0.33***	-0.35***	-0.24*
	(-0.70)	(-1.15)	(-0.93)	(-2.65)	(-2.73)	(-1.83)
R&D Intensity	0.26***	0.32***	0.32***	0.45***	0.44***	0.35***
	(3.45)	(4.08)	(4.12)	(5.46)	(5.23)	(3.98)
Sales Growth	0.00	-0.00	0.00	-0.01	-0.01	-0.00
	(0.15)	(-0.13)	(0.08)	(-0.37)	(-0.49)	(-0.11)
Ln*[Assets]*	0.04**	0.05**	0.05**	0.06***	0.07***	0.06***
	(2.29)	(2.36)	(2.41)	(3.37)	(3.57)	(3.11)
Constant	-0.16	-0.09	-0.18	-0.27**	-0.28**	-0.32**
	(-1.40)	(-0.76)	(-1.39)	(-2.08)	(-2.01)	(-2.43)
Number of Observations	295	295	295	295	295	295
R^2	0.705	0.670	0.684	0.616	0.607	0.664

Table 8

Determinants of supplier-customer contracts: integrated firms excluded

Probit estimates using Compustat firms from 2003-2008. Financial firms and integrated firms are excluded. The dependent variable in all specifications is equal to one if a firm uses *Supplier Contracts*, and zero otherwise. *Supplier R&D Intensity* proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Patent Cross-citation Intensity* is the percentage of supplier industries which have patent cross-citations with the firm's own industry. *Supplier Differentiated Goods* proxies for the heterogeneity of a firm's inputs. I first define a supplier industry as either producing differentiated output or not (using the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. Ln[*Contracting Legal Rank*] is the natural logarithm of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Price Informativeness* is the firm's own stock price informativeness measure. *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. *% of Input Traded* proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to one, and zero otherwise, and then define *% of Input Traded* as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *Industry-Median Tangibility* is the industry-year median tangibility ratio (Net PPE/Total Assets). *% Imports* is the percentage of a firm's industry's nonclassifiable imports. *Herfindahl Index* is the firm's 2-digit industry Herfindahl Index. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is RD/Total Assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models include year dummy variables. *t*-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Supplier R&D Intensity	15.67***						10.82***
	(4.33)						(2.77)
Patent Cross-citation Intensity		0.54***					
		(2.72)					
Supplier Differentiated Goods			0.43***				
			(3.00)				
Relative Herf Index				0.04			0.05
				(1.40)			(1.53)
Ln*[Contracting Legal Rank]*	0.06**	0.08***	0.06**	0.06**	0.06**	0.06**	0.06**
	(2.14)	(2.88)	(2.28)	(2.19)	(2.31)	(2.09)	(2.30)
Price Informativeness					-0.15		-0.13
					(-1.35)		(-1.11)
Proximity						-1.78***	-1.19**
						(-3.91)	(-2.33)
% of Input Traded	-0.37	-0.32	-0.09	-0.30	-0.23	-0.48*	-0.47
	(-1.36)	(-1.13)	(-0.33)	(-1.13)	(-0.81)	(-1.71)	(-1.59)

Continued…

Table 8 (continued…)

Industry-Median Tangibility	-0.25**	-0.36***	-0.37***	-0.42***	-0.45***	-0.44***	-0.28**
	(-2.01)	(-2.87)	(-3.13)	(-3.58)	(-3.65)	(-3.75)	(-2.17)
% Imports	-1.00	-5.43*	-1.70	-2.70	-3.82	-1.21	-1.04
	(-0.38)	(-1.93)	(-0.65)	(-1.03)	(-1.36)	(-0.46)	(-0.36)
Herfindahl Index	-0.56	-2.37**	-1.36				
	(-0.55)	(-1.96)	(-1.31)				
Book Leverage	-0.14*	-0.09	-0.12	-0.15*	-0.15	-0.15*	-0.13
	(-1.73)	(-1.09)	(-1.55)	(-1.85)	(-1.52)	(-1.82)	(-1.30)
R&D Intensity	-0.01	0.09	-0.09	0.03	-0.01	-0.04	-0.08
	(-0.09)	(0.54)	(-0.62)	(0.20)	(-0.04)	(-0.28)	(-0.50)
Sales Growth	-0.02	-0.09	-0.03	-0.07	-0.02	-0.01	0.01
	(-0.24)	(-1.06)	(-0.41)	(-1.07)	(-0.31)	(-0.15)	(0.22)
Ln*[Assets]*	0.13***	0.12***	0.13***	0.13***	0.10***	0.12***	0.10***
	(11.93)	(10.21)	(11.95)	(11.98)	(6.33)	(11.43)	(6.10)
Constant	-1.93***	-1.48***	-1.76***	-1.71***	-1.34***	-1.73***	-1.73***
	(-13.80)	(-12.47)	(-13.61)	(-14.64)	(-7.75)	(-15.61)	(-8.76)
Number of Observations	16,675	11,119	16,675	16,675	14,658	16,429	14,437

Table 9

Subsample Poisson Estimates - Supplier Contract Length

Subsample Poisson estimates using Compustat firms from 2003-2008. Financial firms are excluded. A first stage probit equivalent to Model 7 in Table 6 is estimated and the inverse mills ratio is calculated. *Contract Length* is then estimated using Poisson estimations for the subsample after controlling for sample selection by including the inverse mills ratio. The dependent variable in all specifications is equal to the number of years into the future a firm has contracted for. *Supplier R&D Intensity* proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. *Price Informativeness* is the firm's own stock price informativeness measure. *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. Ln[*Contracting Legal Rank*] is the natural log of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Industry-Median Tangibility* is the industry-year median tangibility ratio (Net PPE/Total Assets). *% Imports* is the percentage of a firm's industry's nonclassifiable imports. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is RD/Total Assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models include year dummy variables. *t*-Statistics are reported in parentheses, are bootstrapped one hundred times, and are calculated from robust standard errors clustered by firm.

	Supplier Contract	*Contract Length*	
		(1)	(2)
	First Stage Probit	Whole Sample	Vert. Int. Excluded
Supplier R&D Intensity	11.09***	23.23	29.35*
	(3.08)	(1.60)	(1.74)
Relative Herf Index	0.05*	0.13*	0.16*
	(1.80)	(1.79)	(1.81)
Price Informativeness	-0.21**	-0.57**	-0.70**
	(-2.01)	(-2.16)	(-2.25)
Proximity	-0.83*	-2.24**	-2.44*
	(-1.81)	(-2.07)	(-1.90)
% of Input Traded	-0.69***	-1.72*	-2.08**
	(-2.79)	(-1.90)	(-1.98)
Ln*[Contracting Legal Rank]*	0.05*	0.14**	0.16**
	(1.79)	(2.23)	(2.42)
Industry-Median Tangibility	-0.35***	-1.23***	-1.47***
	(-2.88)	(-2.72)	(-2.85)
% Imports	0.73	0.23	1.77
	(0.26)	(0.10)	(0.71)
Book Leverage	-0.14	-0.28	-0.40*
	(-1.47)	(-1.47)	(-1.76)
R&D Intensity	-0.15	-0.42	-0.52*
	(-0.88)	(-1.52)	(-1.71)
Sales Growth	-0.03	-0.16***	-0.17***
	(-0.46)	(-3.06)	(-2.77)
Ln*[Assets]*	0.09***	0.41***	0.48***
	(6.48)	(3.40)	(3.40)

Continued…

Table 9 (continued)

Constant	-1.55***	3.92**	4.80**
	(-8.55)	(2.28)	(2.44)
Inverse Mills Ratio		-7.33**	-9.02**
		(-2.21)	(-2.36)
Number of Observations	16,455	3570	3044

Table 10

Joint determinants of supplier-customer contracts and RSI

Simultaneous estimates using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variables in all specifications are *Supplier Contracts* or *Supplier R&D Intensity*. A firm is defined as using *Supplier Contracts* if a firm reports purchase obligations in their 10-K, and zero otherwise. *Supplier R&D Intensity* is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. Ln[*Contracting Legal Rank*] is the natural logarithm of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Price Informativeness* is the firm's own stock price informativeness measure. *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. *% of Input Traded* proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to one, and zero otherwise, and then define *% of Input Traded* as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *Industry-Median Tangibility* is the industry-year median tangibility ratio (Net PPE/Total Assets). *% Imports* is the percentage of a firm's industry's nonclassifiable imports. *Herfindahl Index* is the firm's 2-digit industry Herfindahl Index. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is RD/Total Assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets. *Supplier Sales Growth* is the supplier-industry weighted-average of the overall industry sales growth. *Industry R&D Intensity* is the aggregate industry R&D of the customer industry. *Supplier Industry Tobin's Q* is the supplier-industry weighted-average of the supplier industry-level market value of assets to book value of assets. *t*-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm. All variables are winsorized at 1% and 99% and all models include year dummy variables.

	2SLS Simultaneous		3SLS Simultaneous	
Dependent Variable	Supplier Contracts	Supplier R&D Intensity	(4)	(5)
Supplier R&D Intensity	3.27**		7.43***	
	(2.10)		(9.59)	
Supplier Contracts		0.01***		0.01***
		(6.95)		(15.03)
Relative Herf Index	0.01*		0.06***	
	(1.67)		(14.63)	
Ln*[Contracting Legal Rank]*	0.01*		0.00	
	(1.79)		(1.57)	
Price Informativeness	-0.07**		-0.11***	
	(-2.07)		(-7.91)	
Proximity	-0.23		-0.55***	
	(-1.52)		(-8.48)	
% of Input Traded	-0.19***	0.00*	-0.29***	0.00***
	(-3.04)	(1.75)	(-7.26)	(5.83)
Industry-Median Tangibility	-0.10***		-0.07***	
	(-2.88)		(-4.28)	
% Imports	0.23		-4.44***	
	(0.30)		(-13.39)	
Book Leverage	-0.03		0.00	
	(-1.46)		(0.35)	
R&D Intensity	-0.03		-0.27***	
	(-0.78)		(-13.54)	
Sales Growth	-0.01		0.06***	
	(-0.45)		(5.13)	

Continued…

Table 10 (continued)

Ln*[Assets]*	0.03***		0.00**	
	(6.28)		(2.40)	
Supplier Herf Index		-0.08***		-0.06***
		(-5.44)		(-14.78)
Supplier Sales Growth		-0.00***		-0.00***
		(-5.54)		(-8.26)
Industry R&D Intensity		0.19***		0.19***
		(27.79)		(65.82)
Supplier Industry Tobin's Q		0.01***		0.01***
		(8.08)		(21.92)
Constant	0.01	0.00	0.06**	-0.00
	(0.14)	(1.43)	(2.28)	(-0.59)
Number of Observations	16,455	16,455	16,455	16,455

Table 11

Determinants of supplier-customer contracts: cross sectional tests

Cross-sectional probit estimates by year, using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variable in all specifications is equal to one if a firm uses *Supplier Contracts*, and zero otherwise. *Supplier R&D Intensity* proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Patent Cross-citation Intensity* is the percentage of supplier industries which have patent cross-citations with the firm's own industry. *Supplier Differentiated Goods* proxies for the heterogeneity of a firm's inputs. I first define a supplier industry as either producing differentiated output or not (using the Rauch, 1999 definitions) and then weight each supplier industry's output type by the importance of each supplier industry to the firm. *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. Ln[*Contracting Legal Rank*] is the natural logarithm of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *Price Informativeness* is the firm's own stock price informativeness measure. *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. *% of Input Traded* proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to one, and zero otherwise, and then define *% of Input Traded* as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *Industry-Median Tangibility* is the industry-year median tangibility ratio (Net PPE/Total Assets). *% Imports* is the percentage of a firm's industry's nonclassifiable imports. *Herfindahl Index* is the firm's 2-digit industry Herfindahl Index. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is RD/Total Assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models include year dummy variables. *t*-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

Year	2003	2004	2005	2006	2007	2008	Fama-MacBeth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Supplier R&D Intensity	13.31**	8.82*	17.46***	12.02**	13.52***	5.69*	11.80***
	(2.50)	(1.70)	(3.11)	(2.46)	(2.87)	(1.72)	(7.07)
Relative Herf Index	0.15***	0.04	0.00	0.06	0.02	0.05	0.06**
	(3.63)	(1.11)	(0.01)	(1.27)	(0.36)	(0.90)	(2.61)
Ln[Contracting Legal Rank]	0.08**	0.02	0.06*	0.11***	0.02	-0.01	0.05*
	(2.15)	(0.56)	(1.88)	(3.05)	(0.61)	(-0.32)	(2.53)
Price Informativeness	0.14	-0.22	-0.27*	-0.25*	-0.21	-0.42**	-0.20**
	(0.89)	(-1.49)	(-1.87)	(-1.72)	(-1.35)	(-2.50)	(-2.71)
Proximity	-1.31*	-1.78***	-0.52	-0.24	-0.43	-0.76	-0.84**
	(-1.79)	(-2.83)	(-0.82)	(-0.39)	(-0.65)	(-0.91)	(-3.49)
% of Input Traded	-0.74**	-0.88**	-0.88**	-0.79**	-0.39	-1.04***	-0.79***
	(-1.98)	(-2.49)	(-1.99)	(-1.96)	(-0.89)	(-2.84)	(-8.79)
Industry-Median Tangibility	-0.10	-0.38**	-0.33*	-0.37**	-0.42***	-0.24	-0.31***
	(-0.55)	(-2.07)	(-1.82)	(-2.35)	(-2.87)	(-1.16)	(-6.26)
% Imports	-2.80	-1.03	0.98	0.72	2.99	5.52	1.06
	(-0.74)	(-0.27)	(0.27)	(0.19)	(0.77)	(1.30)	(0.89)
Book Leverage	-0.02	-0.33**	-0.01	-0.06	-0.23*	-0.16	-0.14**
	(-0.19)	(-2.21)	(-0.10)	(-0.51)	(-1.85)	(-1.25)	(-2.65)
R&D Intensity	0.37	-0.05	-0.38	0.06	-0.24	-0.56**	-0.13
	(1.41)	(-0.20)	(-1.50)	(0.25)	(-1.02)	(-2.32)	(-0.99)
Sales Growth	-0.42*	-0.09	0.01	-0.05	0.11	-0.29	-0.12
	(-1.71)	(-0.48)	(0.04)	(-0.44)	(1.11)	(-1.39)	(-1.51)

Continued…

Table 11 (continued)

Ln[*Assets*]	0.13***	0.11***	0.07***	0.09***	0.09***	0.08***	0.10***
	(6.17)	(5.33)	(3.68)	(4.82)	(4.68)	(3.60)	(11.39)
Constant	-2.45***	-1.40***	-1.32***	-1.63***	-1.39***	-1.07***	-1.54
	(-8.60)	(-5.34)	(-5.25)	(-6.14)	(-5.36)	(-3.79)	(-7.87)
Number of Observations	2,914	2,805	2,928	2,778	2,732	2,298	16,455

Table 12

Supplier contracts and firm performance

Multivariate tests using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variables are operating return on assets (*OROA*), which is EBITDA/Total Assets, industry-adjusted operating return on assets (*Ind-Adj OROA*) which is OROA minus the industry-year median, and industry-adjusted Tobin's Q (*Ind-Adj Q*), which is *Tobin's Q* minus its industry-year median. Industries are defined by two-digit NAICS codes. Models 1-3 are OLS regressions, Models 4-6 are instrumental variables estimates, and Models 7-9 are treatment-effects estimates. The first-stage for all treatment-effects estimates is the Model 7 in Table 6. *Supplier Contracts* is a dummy variable equal to "1" if a firm reported supplier contracts in its 10-K filing. *R&D Intensity* is RD/Total Assets. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets, and *Tobin's Q* is the market value of assets divided by the book value of assets. *Capex* is capital expenditures divided by total assets, and *Cash* is cash divided by total assets. All variables are winsorized at 1% and 99% and all models include year fixed-effects. T-statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	OLS			Instrumental Variables			Treatment Effects		
Dependent Variable	*OROA*	*Ind-Adj OROA*	*Ind-Adj Q*	*OROA*	*Ind-Adj OROA*	*Ind-Adj Q*	*OROA*	*Ind-Adj OROA*	*Ind-Adj Q*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Supplier Contracts	0.0150**	0.0186***	0.1725***	0.2337**	0.3331***	21.0387**	0.2467***	0.3578***	2.1744***
	(2.300)	(2.817)	(3.233)	(2.453)	(3.253)	(2.095)	(5.296)	(7.245)	(7.128)
R&D Intensity	-1.1536***	-1.0994***	3.9058***	-1.1544***	-1.0979***	2.9286***	-1.2481***	-1.1835***	3.1426***
	(-18.547)	(-17.556)	(9.778)	(-18.124)	(-16.955)	(3.800)	(-64.704)	(-56.941)	(27.768)
Book Leverage	-0.1615***	-0.1625***	2.3847***	-0.1518***	-0.1493***	1.6145**	-0.1317***	-0.1264***	0.5525***
	(-6.495)	(-6.506)	(13.131)	(-5.700)	(-5.495)	(2.230)	(-13.035)	(-11.576)	(8.759)
Sales Growth	0.0315***	-0.0021	0.2070***	0.0320***	-0.0004	0.6074	0.0312***	-0.0012	0.1810***
	(2.805)	(-0.186)	(2.650)	(2.651)	(-0.033)	(1.429)	(2.939)	(-0.105)	(2.619)
Ln*[Assets]*	0.0371***	0.0375***	-0.2972***	0.0287***	0.0260***	-0.7586**	0.0206***	0.0176***	-0.1388***
	(17.409)	(17.455)	(-14.375)	(7.191)	(6.142)	(-2.284)	(10.660)	(8.527)	(-11.034)
Tobin's Q	-0.0188***	-0.0192***		-0.0178***	-0.0187***		0.0014	0.0005	
	(-5.043)	(-5.074)		(-4.609)	(-4.775)		(0.985)	(0.332)	
Capex	0.1786***	0.0373	3.0656***	0.2045***	0.0671	4.0278**	0.2365***	0.1167***	3.4212***
	(3.187)	(0.662)	(7.661)	(3.529)	(1.103)	(2.191)	(6.348)	(3.066)	(14.867)
Cash Holdings	-0.1664***	-0.1559***	2.3290***	-0.1791***	-0.1699***	1.9195***	-0.1801***	-0.1737***	2.3340***
	(-4.728)	(-4.404)	(9.785)	(-4.951)	(-4.568)	(2.596)	(-12.312)	(-11.758)	(26.000)
Constant	-0.0841***	-0.1684***	0.7577***	-0.0863***	-0.1726***	-0.9863	-0.0272***	-0.1194***	-0.3485***
	(-5.082)	(-10.165)	(5.378)	(-4.890)	(-9.376)	(-1.615)	(-2.582)	(-10.529)	(-4.828)
R^2	0.481	0.463	0.318						
Number of Observations	14749	14749	19593	14160	14160	17201	12913	12913	16580
Instruments Used				Supplier R&D Legal Rank	Supplier R&D Legal Rank	Supplier Herf Price Infor			

Table 13

Supplier contracts and firm performance - RSI and non-RSI environments

Subsample treatment effect estimates based on different RSI environments. All tests use Compustat firms from 2003-2008. Financial firms are excluded. The dependent variable in the multivariate tests is industry-adjusted Tobin's Q, which is Tobin's Q minus its industry-year median. Industries are defined by 2-digit NAICS codes. All multivariate estimates are treatment-effects estimates. The first-stage for all estimates is the Model 7 in Table 6. *Supplier Contracts* is a dummy variable equal to "1" if a firm reported supplier contracts in its 10-K filing. *R&D Intensity* is RD/Total Assets. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *Sales Growth* is the firm's own industry sales growth. Ln[*Assets*] is the natural logarithm of a firm's book assets, and *Tobin's Q* is the market value of assets divided by the book value of assets. *Capex* is capital expenditures divided by total assets, and *Cash* is cash divided by total assets. All variables are winsorized at 1% and 99% and all models include year fixed-effects. T-statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	Dependent variable: *Ind-Adj Qt+1*					
	Supplier Industry R&D		*Supplier Differentiated Goods*		*R&D Intensity*	
	High	Low	High	Low	High	Low
Supplier Contract	0.9282***	-1.8615***	0.5686***	-2.1226***	1.3894***	-1.2162***
	(7.074)	(-10.836)	(7.327)	(-10.951)	(8.659)	(-10.439)
R&D Intensity	-0.3138***	-0.8211***	-0.4041***	-0.9567***	-0.2456***	-13.9950***
	(-8.049)	(-11.392)	(-17.218)	(-6.750)	(-5.349)	(-3.682)
Book Leverage	-0.0165	-0.0800**	0.0213	-0.0632	-0.0056	-0.1301***
	(-0.766)	(-2.181)	(1.413)	(-1.440)	(-0.197)	(-4.717)
Sales Growth	0.2377***	0.0152	0.2437***	0.0795*	0.1720***	0.1477***
	(10.511)	(0.347)	(13.841)	(1.718)	(4.922)	(5.372)
Ln[Assets]	-0.0359***	0.0510***	-0.0247***	0.0629***	-0.0550***	0.0445***
	(-6.443)	(7.416)	(-7.209)	(7.895)	(-8.207)	(9.154)
Tobin's Q	0.9914***	1.0080***	0.9896***	1.0062***	0.9881***	1.0012***
	(344.431)	(171.969)	(524.175)	(129.009)	(287.685)	(180.807)
Capex	0.1487*	-0.0983	0.4736***	-0.2523**	0.2943**	-0.2833***
	(1.698)	(-0.982)	(8.767)	(-1.998)	(2.245)	(-4.047)
Cash Holdings	0.0018	-0.3059***	-0.0850***	-0.2163***	-0.0470	-0.2172***
	(0.069)	(-6.517)	(-5.199)	(-3.513)	(-1.603)	(-4.817)
Constant	-1.2878***	-1.0801***	-1.2557***	-1.1285***	-1.3158***	-1.1813***
	(-55.592)	(-24.522)	(-74.763)	(-22.593)	(-40.307)	(-38.092)
Number of Observations	8,347	8,233	8,156	8,424	8,545	8,035

Table 14

Supplier contracts and vertical integration

Probit and Heckman probit estimates using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variable for the probit specifications is equal to one if a firm uses supplier contracts and zero if the firm is vertically integrated and does not use contracts. The dependent variable for the first stage Heckman probit estimates is one if the firm either uses contracts or is vertically integrated, and zero if it does neither. The dependent second-stage variable is equal to one if the firm uses supplier contracts and zero if the firm is vertically integrated and does not use contracts. *Supplier R&D Intensity* proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. *Industry-Median Tangibility* is the two-digit NAICS industry-year median tangibility ratio (Net PPE/Total Assets). *Relative Herf Index* measures relative bargaining power and is the ratio of *Supplier Herfindahl Index* to the firm's own industry *Herfindahl Index*. *Proximity* is the negative of the supplier weighted-average transportation costs from the input-output tables. *Price Informativeness* is the firm's own stock price informativeness measure. Ln[*Contracting Legal Rank*] is the natural logarithm of the contract enforcement ranking for the firm's home state (1 is the worst and 50 is the best). *% of Input Traded* proxies for the percentage of a firm's input which is traded on financial markets. I code supplier industries whose output trades on a financial exchange equal to one, and zero otherwise, and then define *% of Input Traded* as the weighted-average of all supplier industries, weighted by the importance of each supplier industry to the firm. *% Import* is the percentage of a firm's industry's nonclassifiable imports. *Book Leverage* is long-term debt and current portion of long-term debt divided by book assets. *R&D Intensity* is RD/Total Assets. Ln[*Assets*] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models included year dummy variables. *t*-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	Probit		Heckman Probit		Heckman Probit	
			First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)	(5)	(8)
Supplier R&D Intensity	39.08***	41.59***		36.79***		38.83***
	(6.40)	(6.51)		(3.31)		(3.76)
Industry-Median Tangibility	-0.43**	-0.41**		-0.44*		-0.41*
	(-2.34)	(-2.21)		(-1.95)		(-1.95)
Relative Herf Index	0.12**		0.00	0.12**		
	(2.43)		(0.03)	(2.04)		
Supplier Herfindahl Index		6.61*			-0.94	6.31
		(1.88)			(-0.52)	(1.53)
Herfindahl Index		-2.07			-0.37	-2.27
		(-1.26)			(-0.41)	(-1.41)
Proximity	0.86	0.57		0.85		0.57
	(1.15)	(0.73)		(0.91)		(0.66)
Price Informativeness			-0.13		-0.13	
			(-0.64)		(-0.80)	
% of Input Traded			0.44		0.45	
			(0.94)		(1.18)	

Continued…

Table 14 (continued)

Ln*[Contracting Legal Rank]*	-0.05	-0.05		-0.04		-0.04
	(-1.07)	(-1.11)		(-0.83)		(-0.87)
% Imports	11.33**	11.61**		10.40*		10.60*
	(2.28)	(2.31)		(1.73)		(1.85)
Book Leverage	-0.25**	-0.26**	-0.12	-0.24	-0.12	-0.25
	(-2.03)	(-2.10)	(-1.40)	(-1.25)	(-1.36)	(-1.46)
R&D Intensity	2.12***	2.24***	-0.45***	2.14	-0.47***	2.22*
	(3.25)	(3.26)	(-2.80)	(1.52)	(-2.87)	(1.78)
Sales Growth			-0.12**		-0.13**	
			(-2.16)		(-2.10)	
Ln[*Assets*]	-0.00	-0.00	0.13***	-0.00	0.13***	0.00
	(-0.26)	(-0.15)	(7.66)	(-0.01)	(8.47)	(0.03)
Constant	-0.00	-0.09	-1.21***	-0.23	-1.16***	-0.35
	(-0.00)	(-0.30)	(-5.46)	(-0.09)	(-5.59)	(-0.19)
Number of Observations	5384	5384	17034	17034	17034	17034

Table 15

Supplier contracts and vertical integration - shocks to human capital RSI

Probit and OLS estimates using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variables for the Probit specifications are Get Supplier Contract (Lose Supplier Contract) which are dummy variables equal to one if the firm gains (loses) supplier contracts in year t+1., and Vertically Integrate (Vertically Disintegrate), which are dummy variables equal to one if a firm becomes vertically integrated (disintegrated) in year t+1. The dependent variables for the OLS estimates are Percent Dollar Change, which is the percentage increase in next year's dollar obligations from year t to t+1, and Integration Coefficient Change, which is the increase in a firm's vertical relatedness coefficient. Positive (Negative) Industry R&D Shock is a dummy variable equal to one if a firm's industry R&D increased (decreased) by 10%, zero otherwise. All specifications also control for the following variables: Supplier R&D Intensity proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. Industry-Median Tangibility is the two-digit NAICS industry-year median tangibility ratio (Net PPE/Total Assets). Book Leverage is long-term debt and current portion of long-term debt divided by book assets. R&D Intensity is RD/Total Assets. Ln[Assets] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models included year dummy variables. t-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	Probit				*OLS*	
	Get Supplier Contract$_{t+1}$	*Lose Supplier Contract*$_{t+1}$	*Vertically Integrate*$_{t+1}$	*Vertically Disintegrate*$_{t+1}$	*Dollar Change*$_{t,t+1}$	*Integration Coefficient Change*$_{t,t+1}$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Positive Industry R&D Shock	0.09*	0.01	-0.00	-0.05	8.67**	-0.08***
	(1.93)	(0.21)	(-0.03)	(-0.74)	(2.00)	(-2.68)
Supplier R&D Intensity	11.80***	5.82*	-13.48***	-7.62*	2,382.09***	-7.43*
	(3.93)	(1.86)	(-3.02)	(-1.75)	(4.98)	(-1.95)
Industry-Median Tangibility	-0.05	-0.23**	-0.16	-0.22	6.93	-0.06
	(-0.52)	(-1.98)	(-1.12)	(-1.50)	(0.62)	(-0.50)
Book Leverage	-0.31***	0.05	0.07	-0.01	-20.91*	0.05
	(-3.21)	(0.70)	(0.57)	(-0.08)	(-1.91)	(0.57)
R&D Intensity	0.03	0.14	-1.70***	-2.13***	-19.62	-2.59***
	(0.18)	(1.05)	(-2.61)	(-4.62)	(-0.59)	(-6.70)
Ln[Assets]	0.03***	0.03***	0.04***	0.04***	-2.60**	0.17***
	(3.83)	(2.94)	(2.86)	(3.59)	(-2.18)	(14.30)
Constant	-2.25***	-2.06***	-6.32	-6.35	10.15	-1.43***
	(-21.44)	(-20.07)	(0.632)	(0.631)	(0.85)	(-12.85)
Number of Observations	14,521	14,521	19,744	19,744	1,783	14,926

Continued…

Table 15 (continued)

	Get Supplier Contract$_{t+1}$	*Lose Supplier Contract*$_{t+1}$	*Vertically Integrate*$_{t+1}$	*Vertically Disintegrate*$_{t+1}$	*Dollar Change*$_{t,t+1}$	*Integration Coefficient Change*$_{t,t+1}$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B						
Negative Industry R&D Shock	-0.09	-0.07	0.08	0.02	-4.73	0.12***
	(-1.54)	(-1.26)	(1.17)	(0.25)	(-1.39)	(3.77)
Supplier R&D Intensity	10.18***	4.98	-12.47***	-7.11	2,266.13***	-5.53
	(3.37)	(1.55)	(-2.73)	(-1.59)	(4.93)	(-1.45)
Industry-Median Tangibility	0.01	-0.22*	-0.16	-0.24*	11.71	-0.11
	(0.05)	(-1.93)	(-1.20)	(-1.74)	(1.01)	(-0.93)
Book Leverage	-0.31***	0.05	0.07	-0.01	-21.14*	0.05
	(-3.15)	(0.73)	(0.56)	(-0.10)	(-1.92)	(0.51)
R&D Intensity	0.00	0.14	-1.68***	-2.11***	-25.18	-2.53***
	(0.01)	(1.00)	(-2.59)	(-4.60)	(-0.75)	(-6.65)
Ln[Assets]	0.03***	0.03***	0.04***	0.04***	-2.64**	0.17***
	(3.79)	(2.96)	(2.88)	(3.62)	(-2.22)	(14.35)
Constant	-2.16***	-2.04***	-6.33	-6.39	0.11	-1.52***
	(-22.55)	(-20.97)	(0.64)	(0.63)	(0.01)	(-13.97)
Number of Observations	14,521	14,521	19,744	19,744	1,783	14,926

Table 16

Supplier contracts and vertical integration - shocks to physical capital RSI

Probit and OLS estimates using Compustat firms from 2003-2008. Financial firms are excluded. The dependent variables for the Probit specifications are Get Supplier Contract (Lose Supplier Contract) which are dummy variables equal to one if the firm gains (loses) supplier contracts in year t+1., and Vertically Integrate (Vertically Disintegrate), which are dummy variables equal to one if a firm becomes vertically integrated (disintegrated) in year t+1. The dependent variables for the OLS estimates are Percent Dollar Change, which is the percentage increase in next year's dollar obligations from year t to t+1, and Integration Coefficient Change, which is the increase in a firm's vertical relatedness coefficient. Positive (Negative) Industry CAPEX Shock is a dummy variable equal to one if a firm's industry CAPEX increased (decreased) by 10%, zero otherwise. All specifications also control for the following variables: Supplier R&D Intensity proxies for RSI (relationship-specific investment) and is the weighted-average of all supplier industry's R&D/Total Assets, weighted by the importance of each supplier industry to the firm. Industry-Median Tangibility is the two-digit NAICS industry-year median tangibility ratio (Net PPE/Total Assets). Book Leverage is long-term debt and current portion of long-term debt divided by book assets. R&D Intensity is RD/Total Assets. Ln[Assets] is the natural logarithm of a firm's book assets. All variables are winsorized at 1% and 99% and all models included year dummy variables. t-Statistics are reported in parentheses and are calculated from robust standard errors clustered by firm.

	Get Supplier Contract$_{t+1}$	*Lose Supplier Contract$_{t+1}$*	*Vertically Integrate$_{t+1}$*	*Vertically Disintegrate$_{t+1}$*	*Dollar Change$_{t,t+1}$*	*Integration Coefficient Change$_{t,t+1}$*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Positive Industry CAPEX Shock	0.07	0.04	0.00	-0.00	-13.36***	0.00*
	(1.23)	(0.64)	(0.02)	(-0.02)	(-4.24)	(1.84)
Supplier R&D Intensity	11.26***	5.83*	-13.47***	-7.30*	2,282.12***	-7.07*
	(3.79)	(1.86)	(-3.02)	(-1.68)	(4.94)	(-1.85)
Industry-Median Tangibility	-0.02	-0.24**	-0.16	-0.24*	13.20	-0.08
	(-0.16)	(-2.04)	(-1.16)	(-1.71)	(1.14)	(-0.67)
Book Leverage	-0.31***	0.05	0.07	-0.01	-21.46*	0.05
	(-3.18)	(0.70)	(0.57)	(-0.09)	(-1.95)	(0.58)
R&D Intensity	0.01	0.14	-1.70***	-2.11***	-25.58	-2.56***
	(0.05)	(1.04)	(-2.61)	(-4.60)	(-0.76)	(-6.66)
Ln[Assets]	0.04***	0.03***	0.04***	0.04***	-2.68**	0.17***
	(3.85)	(2.96)	(2.86)	(3.62)	(-2.25)	(14.23)
Constant	-2.20***	-2.06***	-6.32	-6.38	0.18	-1.47***
	(-23.00)	(-21.24)	(0.64)	(0.63)	(0.02)	(-13.34)
Number of Observations	14,521	14,521	19,744	19,744	1,783	14,926

Continued…

Table 16 (continued)

	Get Supplier Contract$_{t+1}$	*Lose Supplier Contract*$_{t+1}$	*Vertically Integrate*$_{t+1}$	*Vertically Disintegrate*$_{t+1}$	*Dollar Change*$_{t,t+1}$	*Integration Coefficient Change*$_{t,t+1}$
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B						
Negative Industry CAPEX Shock	-0.09*	0.10*	0.08	-0.04	-4.04	-0.11***
	(-1.84)	(1.95)	(1.14)	(-0.55)	(-1.07)	(-2.74)
Supplier R&D Intensity	10.66***	5.97*	-13.31***	-7.33*	2,314.79***	-6.84*
	(3.59)	(1.90)	(-2.97)	(-1.69)	(4.95)	(-1.79)
Industry-Median Tangibility	-0.04	-0.19*	-0.13	-0.25*	9.72	-0.09
	(-0.38)	(-1.67)	(-0.94)	(-1.80)	(0.84)	(-0.76)
Book Leverage	-0.31***	0.05	0.07	-0.01	-21.02*	0.05
	(-3.13)	(0.67)	(0.56)	(-0.10)	(-1.91)	(0.54)
R&D Intensity	0.02	0.13	-1.72***	-2.11***	-22.67	-2.56***
	(0.12)	(0.93)	(-2.67)	(-4.58)	(-0.68)	(-6.68)
Ln[Assets]	0.03***	0.03***	0.04***	0.04***	-2.62**	0.17***
	(3.78)	(2.88)	(2.84)	(3.63)	(-2.20)	(14.36)
Constant	-2.25***	-2.06***	-6.33	-6.38	0.67	-1.44***
	(-22.99)	(-20.85)	(0.68)	(0.63)	(0.07)	(-13.41)
Number of Observations	14,521	14,521	19,744	19,744	1,783	14,926