CONTRACTING BETWEEN FIRMS: EMPIRICAL EVIDENCE

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Abstract—We analyze contracts between a large buyer and her suppliers. We find that contracts with critical product suppliers contain more clauses that address moral hazard, primarily through monitoring. If holdup concerns are larger, there are more contractual protections against it. Over time, contracts with the same supplier include additional provisions that address moral hazard through monitoring. This dynamic effect is strongest for service contracts, where observability and verifiability are initially lower. Our findings indicate that contracts become more complete over time and provide support to incomplete-contracting models that argue that contracts become more complete as contracting costs decrease.

I. Introduction

CONTRACTS between firms are at the heart of economics. This paper studies how contracts that are written between buyers and sellers are shaped by opportunistic behavior in interfirm transactions. We exploit a novel database of 185 proprietary contracts signed between a large transportation company and her 89 suppliers. The data allow us to study not only static use of contracting clauses but, more important, dynamic contracting across a wide range of clauses. The jurisdiction governing the contracts is considered reliable and efficient, suggesting an important role for formal contracting and the possibility of entering into complex contracts (Lerner & Schoar, 2005).

We start with a static analysis of how contracts address moral-hazard problems—the concern of the buyer that a supplier provides insufficient effort, which can manifest in no performance at all, delayed deliveries, or poor product quality (Holmstrom, 1979). Moral-hazard concerns are ex ante larger if a supplier's products are critical to the buyer. We consider a supplier as critical if shirking has a large negative impact on the buyer's performance.[1] We find that contracts with critical suppliers contain more clauses that address moral-hazard concerns, primarily through monitoring and, to a lesser degree, incentives. Monitoring clauses include regular meetings to evaluate supplier performance, but also buyer intervention rights such as audits of supplier factories, consistent with Aghion and Bolton (1992) and Dewatripont and Tirole (1994).

We then analyze holdup problems and test specific predictions derived from property rights theory (PRT) and transaction cost economics (TCE). PRT, introduced by Grossmann and Hart (1986) and Hart and Moore (1990), focuses on ex ante incentives in situations where parties make noncontractible relationship-specific investments (RSI). The theory assumes that output is not contractible, implying that not all contingencies can be specified ex ante, which leads to ex post holdups and distorts incentives to invest initially. A party's holdup concerns are more severe if her RSI are larger. PRT predicts that the allocation of control rights is an important contractual solution to holdup concerns. We test the specific prediction that a control rights allocation to the buyer is more likely if her RSI are larger. Measuring RSI is difficult, but we assume that if these noncontractible investments are larger, then it takes more time and it is more costly to switch suppliers (Monteverde & Teece, 1982). Consistent with PRT, we find that the buyer's holdup concerns are addressed in contracts, as suppliers are more likely to transfer intellectual property rights if supplier switching takes longer or is more costly.[2] This holds after controlling for a supplier's RSI to account for the role of relative RSI.

Holdup concerns are an important element in TCE as well, pioneered by Williamson (1975, 1979, 1985) and Klein, Crawford, and Alchian (1978). Similar to PRT, TCE also focuses on contractual incompleteness, but there is less focus on how control rights are allocated through contracting. A prediction following from TCE is that if RSI are more important, contracts should be more long term, implying less repeated bargaining (Joskow, 1987). RSI are important because they generate switching costs, a form of a transaction cost, in case of renegotiation (see Tadelis & Williamson, 2013). Consistent with TCE, we find that switching costs and time are positively related to contract duration, though the effect is statistically insignificant.

The main advantage of our setting is that it allows us to study dynamic contracting. As Lafontaine and Slade (2013, p. 1005) stressed, "The entire area of dynamics . . . is under explored from an empirical point of view." Theory makes opposing predictions on how contracts should evolve. On

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[1] We exploit an internal classification of the buyer to identify suppliers of critical products. Criticality is defined at the supplier level as there is little variation in the importance of the products within a given supplier. Supplier criticality is relatively unexplored in the literature. Coase (2006) argues that supplier criticality is more important than holdup problems to understand the often-cited contracting problem between Fisher Body and GM. We have an incomplete-contract setting in the background when we refer to a product being critical, as it is difficult to completely specify all contingencies.

[2] Transfer over IP rights is a control rights allocation as it allows the controlling party, if needed, to continue production herself or move it to a third party, without interference by the supplier.

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the one hand, incomplete-contracting models predict that contracts with the same supplier become stricter over time, that is, they should contain more clauses that address moral hazard (Battigalli & Maggi, 2002; Bolton & Faure-Grimaud, 2010).[3] It is argued that contracting costs make it initially costly to specify a contract that addresses all future contingencies (Dye, 1985; Posner, 1986; Tirole, 1999). However, as incentives and the production process are better understood, contracting costs decrease, allowing the buyer to write a more complete contract. This effect should be most pronounced if output observability and verifiability are initially low, as contracting costs are then particularly high. Contracts can also become stricter if the buyer observes moral hazard. On the other hand, relational-contracting models imply that contracts can become more relaxed as trust and reputational capital accumulate and substitute formal contracting (Baker, Gibbons, & Murphy, 2002).

We find that contracts with the same supplier become stricter over time. Repeat contracts contain, in particular, additional clauses that allocate monitoring rights to the buyer, but also clauses that allow the measurement and evaluation of supplier performance. Output verifiability matters significantly for contract dynamics, as the increase in contract strictness is driven by service contracts. As services are initially more difficult to observe and verify than goods (Hart, 1995), repeated contracting can help to specify better monitoring technologies and reduce contractual incompleteness. As predicted, moral hazard, measured as quality problems, also explains why contracts become stricter, and it is addressed by the addition of clauses that provide effort incentives. Our evidence on contract dynamics is consistent with the view that contracting costs go down over time as the buyer learns how to address monitoring needs. One can consider this as a form of adaptive learning through contractual interaction. Compared to other environments, trust and reputation may be less important in our sample, as the underlying legal regime is well developed and contract enforcement well functioning. This may explain why contracts do not get more relaxed. In summary, the key finding of our dynamic analysis is that contracts become more complete over time.

Next, we study the prediction that buyer protection against holdups should decrease if the supplier does not renegotiate. We document that the control-right allocation to the buyer is less likely in a second contract if the supplier does not renegotiate, consistent with PRT. With regard to TCE, we do not find that subsequent contracts have shorter durations, though the estimated coefficients indicate a small decrease (not statistically significant).

Our findings indicate support for several theories, but also that contracts are multidimensional, covering different types of clauses that address both moral hazard and holdups. Thus, contracts seem to contain a complex set of terms that interact and work together as a group. We therefore also study which clauses are substitutes or complements and how different clauses within a broader set of terms interact.

We first study substitutability and complementarity across different contract groups that address moral hazard and holdups. We find that monitoring and incentives clauses generally coincide, acting as complements. One interpretation of this finding is that the buyer may be better able to incentivize a supplier if she has more information due to her monitoring activities (Milgrom & Roberts, 1992). Moral-hazard and holdup clauses tend to be used as substitutes, as transfers of control rights and long-term contracts are less likely if contracts contain many monitoring terms. Mechanisms that address holdup concerns from a PRT or TCE perspective usually coincide, as control-right allocations and long durations tend to be used simultaneously.

We then study how contract clauses within a given group of clauses interact. The general pattern that emerges is that most monitoring clauses are used as complements. Three clauses in particular tend to coincide: supplier audits, financial reporting requirements, and a KPI monitoring system.[4] This is plausible as a monitoring system requires availability of information. Moreover, for audits to be on time, the buyer needs to have access to performance indicators. We also document that the exclusion of preferred supplier status works as a substitute for other monitoring devices. A possible explanation is that "nonpreferred suppliers" are already subject to extra monitoring, which makes it less necessary to add other monitoring terms. Within the set of incentive clauses we find that penalties and bonuses work as complements, leading to symmetric incentive schedules for suppliers. Product warranties and availability guarantees usually coincide, possibly reflecting the importance of a product to the buyer. Finally, bonuses are less likely if a contract stipulates large liability obligations in case of damage or loss of life, probably to avoid excessive risk taking if safety-sensitive products are supplied.

Our data allow us to mitigate several concerns that challenge the empirical analysis of contracts. One concern is that contracts are endogenous to unobserved characteristics of the contracting parties. We mitigate this concern by studying how variation across suppliers in terms of product characteristics (rather than, for example, more endogenous financial characteristics) affects contracts; this variation is largely exogenous, as it is mostly driven by predetermined industry characteristics. Another concern is the endogeneity of contract design and product prices; suppliers may ask for higher prices in exchange for accepting more stringent terms. Our data have the advantage that they allow us to measure and control for prices.

[3] We measure contract strictness by counting the number of provisions that address moral hazard.

[4] A KPI monitoring system is a mechanism by which the buyer defines, measures, and frequently evaluates a set of key performance indicators (KPI) that the supplier has to meet.

We contribute to the literature that empirically studies contracts between firms (see Lafontaine & Slade, 2013, for a review). Our results on static contracting are most closely related to Costello (2013), who studies how contract duration and financial covenants address opportunism. Related also is Joskow (1987), who shows that concerns over holdups lead to longer contract durations. We provide new insights into the contractual clauses that parties use to protect themselves against opportunistic behavior. The clauses are likely to affect economic behavior, as contract enforcement in the underlying jurisdiction is high.

Few papers study contract dynamics. An exception is Lafontaine and Shaw (1999), who show that price clauses in franchise contracts are stable over time and mostly driven by differences across contracting parties. Another exception is Roberts (2015) who studies how loan terms evolve over time. We provide novel evidence on how contracting costs shape the evolution of nonprice clauses that address moral hazard. Other studies of real-world contracts between firms focus on contractual incompleteness and contractibility (Kaplan & Stromberg, 2003; Baker & Hubbard, 2004; Crocker & Reynolds, 1993; Lerner & Malmendier, 2010) or on trust and reputation when contract enforcement is low (McMillan & Woodruff, 1999; Banerjee & Duflo, 2000; Ryall & Sampson, 2009).

II. Data

A. Data Sources

Our analysis builds on a data set that contains contracts signed between a buyer and her suppliers. To obtain these data, we were granted access to the buyer's electronic contract database, which she uses for her day-to-day contract management. The database was introduced in 2002 and contains electronic copies of contracts signed between 1996 and 2010. We have access to all 185 contracts that were in this database. The contracts were signed with 89 suppliers. We have few contracts from prior to 2002, the year in which the database was introduced, and from the last two sample years.[5] (The sample construction and distribution of contracts across years is reported in online appendix table A1.) Based on a manual developed with the buyer's purchase and legal departments, we coded all contracts to identify and describe clauses that have the potential to address moral-hazard problems and holdups.

We complement the data with information from a survey of 35 purchase managers of the buyer to collect data on product and supplier characteristics. Each of these managers is responsible for a set of suppliers and an expert when it comes to describing and evaluating suppliers and their products. We performed the surveys in September and October 2009 in person at the buyer's headquarters. The managers were encouraged by the head of the purchasing department to participate in the survey. Not all questions were answered by all managers.

We can match 131 contracts for 55 suppliers with the survey data. We miss data on 34 suppliers because no purchase manager was assigned (25 suppliers) or the assigned manager did not participate in the survey (9 suppliers). We complement these data with information on financial characteristics from Amadeus and on product supplier criticality and spending volume from the buyer.

[5] The reason is that we got access to the data in 2009–2010 and several contracts that were negotiated and signed in those years were not yet scanned and added to the electronic database.

TABLE 1.—SUMMARY STATISTICS

A. Supplier Characteristics

	Mean	Median	SD	Observartions
Critical product supplier	0.34			131
Goods	0.29			185
Alternative buyers	4.52	5.00	0.95	124
Switching time	0.84	0.00	1.13	95
Switching costs	1.79	2.00	1.18	95
Domestic firm	0.62			174
Privately held firm	0.62			177
Date	2005	2005	2	177
Above market price	0.26			117
Spending volume (th euros)	4,572	2,496	4,437	160
Total assets (m EUR)	12,400	555	33,300	117
Quality problems with supplier	0.56			131
Supplier renegotiates	0.30			131

B. Contract Characteristics

	Mean	Observations
Moral-hazard clauses (maximum 10)	4.07	185
Monitoring clauses (maximum 5)	2.02	185
Incentive clauses (maximum 5)	2.05	185
Supplier audit	42%	185
Financial information	15%	185
Evaluation meetings	18%	185
KPI monitoring system	46%	185
No preferred supplier	81%	185
Liability	66%	185
Product warranty	43%	185
Availability guarantee	27%	185
Penalty	59%	185
Bonus	10%	185
Transfer IP rights	23%	185
Duration (years)	5.34	175
Open duration	16%	175

This table reports statistics of supplier characteristics (panel A) and contract clauses (panel B) at the supplier-contract level. Our sample consists of 185 contracts between 89 suppliers and the buyer. The sample period is 1996 to 2010. Variables are defined in online appendix table A2.

B. The Buyer and Suppliers

The buyer is a large European company in the transportation industry with revenues on the order of several billion euros. The jurisdiction of the buyer's country applies to all except for three contracts. The suppliers provide a wide range of products, from transportation vehicles to management accounting software. Table 1, panel A provides statistics on the suppliers, reported at the supplier-contract level. The buyer spends each year on average 4.5 million euros per supplier. We have only limited supplier financial data as 62% are private, nonpublicly listed firms.

C. Measuring Product Characteristics

To measure the potential consequences of moral hazard, we exploit an internal classification scheme that the buyer used to categorize suppliers as critical or noncritical. In this way, the buyer assesses the potential overall impact that may result from supplier nonperformance. Nonperformance can manifest itself in contract breach, a situation where the supplier does not perform at all, or in delayed deliveries and quality problems. The buyer defines this measure at the supplier level, as there is little variation in the importance of products within the supplied product portfolio of a given supplier. Thirty-four percent of the suppliers are classified as critical. We assume that the consequences of moral hazard are more severe for critical suppliers.

We use the survey to create two measures that capture relationship-specific investments made by the buyer: we ask the purchase managers to estimate the hypothetical costs and time needed to switch from a current to a new supplier. We assume that both time and costs are higher if the buyer incurred more relationship-specific investments (Monteverde & Teece, 1982).

D. Measuring Contract Design

We study ten provisions that have the potential to mitigate moral hazard. Five provisions capture the buyer's rights to monitor suppliers. *Supplier audit* equals 1 if the buyer has the right to perform audits of a supplier's factories or products. *Financial information* equals 1 if the supplier has to provide financial performance data during the contract duration. *Evaluation meetings* is 1 if the supplier and buyer have joint meetings at least quarterly to evaluate contract performance. *KPI monitoring system* is 1 if a contract stipulates a key performance indicator (KPI) monitoring system by which the buyer can measure and evaluate supplier performance. *No preferred supplier* takes the value 1 if a contract does not stipulate that the supplier has preferred supplier status. Preferred supplier status implies that the buyer waives monitoring and performance evaluations during the contract duration.

Five provisions speak to the monetary incentives of suppliers. *Liability* takes the value 1 if the supplier has to indemnify the buyer for liabilities from loss of life or injuries related to the supplied products.[6] *Product warranty* equals 1 if a warranty is specified. *Availability guarantee* is 1 if the supplier guarantees the availability of the supplied products for a future period.[7] *Penalty* equals 1 if the supplier has to pay a fine in case of poor performance, and *Bonus* equals 1 if the supplier gets a bonus for good performance. We also create measures that count contract terms, by adding the number of monitoring clauses (0 to 5), incentive clauses (0 to 5), and the sum of the two (0 to 10). Counting the presence of different clauses follows Lerner and Malmendier (2010). Like them, we interpret these measures as proxies for contract strictness. For example, all else equal, a contract with more monitoring clauses can be considered as stricter vis-à-vis a supplier.

We study one clause that speaks to predictions derived from PRT. *Transfer IP rights* equals 1 if the intellectual property rights of the products are allocated to the buyer. We study two related variables to test predictions derived from TCE. *Duration* is the length of a contract in years, and *Open duration* equals 1 if a contract has an unspecified length. We set the length of open-ended contracts equal to twenty years, the maximum duration in the sample. Online appendix table A2 provides definitions of variables, and online appendix table A3 provides examples for different contract terms from our sample.

Summary statistics of all contract terms are in table 1, panel B. We find that 42% of the contracts specify supplier audits, 46% specify a KPI monitoring system, 81% exclude preferred supplier status, and 59% contain penalties. Bonuses are present in 10% of the contracts. Almost a fifth of the contracts stipulate a transfer of IP rights, the average duration is 5.3 years, and 16% have an open duration.

III. Static Contracting

A. Moral-Hazard Problems

Theoretical predictions. The relationship between a buyer and a supplier can be characterized as a principal-agent relationship. As in standard agency theory, a concern of the buyer is that the supplier provides insufficient effort when producing and supplying her products, leading to no performance at all, delayed deliveries, or quality problems. Such moral hazard is of concern to the buyer as it may have a negative effect on her own performance. The consequences of moral hazard are most severe if the supplied products are important (critical) inputs to the buyer.

The buyer can use two contractual channels to mitigate moral hazard. First, she can ask for contractual rights to monitor the actions of the supplier (Holmstrom & Tirole, 1993; Aghion & Bolton, 1992; Dewatripont & Tirole, 1994). This allows the buyer to intervene ex ante to reduce the risk that the supplier does not perform. Second, the buyer can provide monetary incentives that make the ex post compensation dependent on the outcome of a signal that is informative about supplier effort (Holmstrom, 1979). Contingent compensation may be a fine (e.g., a penalty or warranty) in case of poor performance or a bonus in case of good performance. We expect these provisions to be more likely if a supplier is critical.

[6] If no liability, product warranty, or penalty clause is included in the contract, the general purchasing conditions (GPC) of the buyer apply. In all three cases, the addition of a specific contractual clause implies that the level of liability, warranty, or penalty exceeds that of the GPC.

[7] Availability of spare parts can be important. Suppose a supplier delivers a vehicle with vehicle-specific wheels that show material fatigue. Then it is important for the buyer to replace these wheels quickly; otherwise, the vehicle creates costs because it is unavailable for operations. Thus, the potential consequences of moral hazard (poor wheels) are lower if the supplier has to keep a stock of replacement wheels. This problem is most severe if the supplier is critical.

TABLE 2.—DETERMINANTS OF CONTRACT DESIGN: MORAL-HAZARD PROBLEMS

	Monitoring Clauses					Incentive Clauses				
	Supplier audit	Financial information	Evaluation meetings	KPI Monitoring system	No preferred supplier	Liability	Product warranty	Available guarantee	Penalty	Bonus
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Critical product supplier	0.19*	0.08	0.46***	−0.01	0.24***	−0.02	−0.16*	0.27***	0.12	0.06
	(1.87)	(0.97)	(5.92)	(−0.11)	(2.97)	(−0.15)	(−1.67)	(3.06)	(1.14)	(0.84)
Goods	0.01	0.16**	0.10	0.02	0.13	0.29***	0.42***	0.27***	0.31***	−0.04
	(0.10)	(1.96)	(1.23)	(0.16)	(1.47)	(2.71)	(4.10)	(2.89)	(2.81)	(−0.56)
Domestic firm	−0.04	0.26***	0.28***	−0.05	0.13	0.07	−0.16	−0.13	−0.07	0.16**
	(−0.35)	(2.94)	(3.20)	(−0.38)	(1.39)	(0.61)	(−1.45)	(−1.26)	(−0.59)	(2.04)
Privately held firm	0.20**	0.30***	0.12	0.13	0.23***	0.26***	−0.09	0.05	0.02	−0.06
	(2.03)	(4.04)	(1.64)	(1.20)	(2.95)	(2.73)	(−0.96)	(0.57)	(0.17)	(−0.89)
Log(Spending volume)	0.18***	0.16***	0.08**	0.15***	0.14***	0.18***	−0.06	0.04	0.03	0.02
	(3.38)	(3.88)	(1.97)	(2.61)	(3.33)	(3.46)	(−1.22)	(0.93)	(0.47)	(0.53)
Constant	−2.46***	−2.58***	−1.44**	−1.74*	−1.61**	−2.29***	1.36*	−0.47	0.16	−0.26
	(−2.77)	(−3.88)	(−2.17)	(−1.87)	(−2.32)	(−2.68)	(1.68)	(−0.63)	(0.18)	(−0.44)
Observations	120	120	120	120	120	120	120	120	120	120
R^2	0.1355	0.1823	0.2419	0.0688	0.1429	0.1315	0.2309	0.2337	0.115	0.0599

This table provides OLS regressions at the supplier-contract level to explain the presence of different contract terms that address moral-hazard problems. To allow error terms to be correlated across regressions, we estimate a seemingly unrelated regression model. Variables are defined in online appendix table A2. *t*-statistics in parentheses. Significant at *10%, **5%, and ***1%.

Note that supplier criticality does not necessarily imply relationship-specific investments (RSI) by either party. For example, a supplier of trucks is critical for a logistics firm in the sense that there is a negative performance impact if the trucks are delivered late. However, ordering trucks does not necessarily require large RSI. Hence, holdup problems are mostly about ex post renegotiation, while moral hazard is more about effort provision and can arise even if a supplier does not renegotiate. (Indeed, our proxies for RSI and criticality are far from perfectly correlated, with a correlation of only between 36% and 58%, depending on the RSI proxy.)

Empirical results. We test these predictions by relating the presence of monitoring and incentive clauses to supplier criticality, the product characteristic that reflects concerns over moral hazard. We assume that criticality is primarily determined by industry structure and that unobserved supplier characteristics are unlikely to be correlated with it. All regressions control for other drivers of contract design: information asymmetry (dummy that is 1 if a supplier is a private, nonpublicly listed firm), supplier location (dummy that is 1 if she originates from the buyer's country), the money spent on a supplier's products, and general contractibility (dummy that equals 1 if a product is a good). We assume that contractibility is higher for goods than for services, as services are more difficult to observe and verify (Hart, 1995). As contract terms are chosen simultaneously, we allow error terms to be correlated across different regressions that explain individual contract terms.

The results in table 2 show that moral-hazard concerns are primarily addressed through monitoring: contracts with critical suppliers are more likely to contain audits and evaluation meetings, and they are more likely to exclude preferred supplier status. All three mechanisms allow the buyer to intervene ex ante to reduce the risk that the buyer does not perform. The possibility for intervention is achieved through a combination of information provision (evaluation meetings, exclusion of preferred supplier status) and the transfer of actual intervention rights (audits), as predicted by Holmstrom and Tirole (1993), Aghion and Bolton (1992), and Dewatripont and Tirole (1994). Incentives are also important but to a lesser extent; contracts with critical suppliers are more likely to guarantee future availability of the products.

We find that contracts over goods tend to contain more incentive provisions (and, to a smaller degree, more monitoring clauses). This is surprising at first glance as one may argue that moral hazard is more of an issue for services, where concerns over effort provision may be larger. However, our finding may be explained by incomplete-contracting models. As Hart (1995) pointed out, contractibility is an important determinant of contract design. At the end, judges or arbitration courts will need to be able to verify product quality if conflicts arise. It is likely that contractibility is better for goods, which are generally easier to define and verify, and therefore also easier to contract on and enforce. This may explain why we find that clauses that rely on contractibility (e.g., penalties) are more prevalent in goods contracts.

Table 3 reports regressions that explain aggregate contract design using different OLS specifications (results are also robust to using logit models, not reported). Across all specifications, we find that contracts with critical suppliers contain more clauses that address moral hazard. Consistent with table 2, this effect is driven by more monitoring clauses. While supplier criticality is also positively related to the number of incentive clauses, this relation is statistically insignificant in most specifications. In terms of economic significance, column 1 suggests that contracts with critical suppliers have 1.2 more clauses that can mitigate moral hazard, which equals about 30% of the variable's mean of 4.1. For monitoring clauses, the estimates in column 4 suggest that contracts with critical suppliers have

TABLE 3.—DETERMINANTS OF AGGREGATE CONTRACT DESIGN: MORAL-HAZARD PROBLEMS

	Moral-hazard clauses			Monitoring clauses			Incentive clauses		
	OLS	OLS, SE Clustered by Supplier	OLS	OLS	OLS, SE Clustered by Supplier	OLS	OLS	OLS, SE Clustered by Supplier	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Critical product supplier	1.23***	1.23***	1.66***	0.96***	0.96***	1.08***	0.27	0.27	0.57**
	(2.82)	(2.72)	(3.86)	(3.15)	(2.77)	(3.60)	(1.12)	(0.91)	(2.43)
Goods	1.67***	1.67***	1.19***	0.42	0.42	0.42	1.25***	1.25***	0.77***
	(4.05)	(3.17)	(2.69)	(1.51)	(1.31)	(1.38)	(4.95)	(3.38)	(2.99)
Domestic firm	0.46	0.46	0.24	0.58*	0.58	0.50	−0.12	−0.12	−0.27
	(0.93)	(0.74)	(0.50)	(1.81)	(1.48)	(1.57)	(−0.44)	(−0.31)	(−1.04)
Privately held firm	1.17***	1.17**	1.37***	0.99***	0.99***	1.27***	0.18	0.18	0.10
	(3.05)	(2.54)	(3.38)	(4.35)	(3.19)	(5.20)	(0.67)	(0.47)	(0.35)
Log(Spending volume)	0.91***	0.91***	0.85***	0.70***	0.70***	0.79***	0.21	0.21	0.07
	(4.72)	(3.59)	(3.97)	(5.63)	(3.78)	(5.40)	(1.58)	(1.09)	(0.48)
Above market price			0.91**			0.84***			0.07
			(2.29)			(3.67)			(0.25)
Duration			0.03			−0.02			0.05**
			(1.05)			(−0.92)			(2.41)
Constant	−11.34***	−11.34**	−10.78***	−9.84***	−9.84***	−11.39***	−1.50	−1.50	0.61
	(−3.48)	(−2.63)	(−3.03)	(−4.71)	(−3.23)	(−4.67)	(−0.69)	(−0.47)	(0.27)
Observations	120	120	102	120	120	102	120	120	102
R^2	0.255	0.255	0.333	0.273	0.273	0.369	0.215	0.215	0.290

This table provides regressions at the supplier-contract level to explain aggregate measures of contract design. The table looks at the total number of clauses that address moral-hazard problems, the number of monitoring clauses, and the number of incentive clauses. *t*-statistics in parentheses (based on robust standard errors, unless indicated differently). Significant at *10%, **5%, and ***1%.

one additional monitoring term, which is about 50% of the number of monitoring clauses in a typical contract.

A concern with our analysis is the potential endogeneity of contract design and prices. It could be the case that suppliers ask for higher prices for accepting more stringent contracts. Alternatively, contracts could be less strict if prices are higher, as suppliers then have intrinsic incentives to provide effort (or to not renegotiate) to extract future rents through repeated transactions. A challenge to controlling for prices is that it is difficult to assess whether observed prices are high or low. To circumvent this problem, we asked the purchase managers to judge the prices paid to suppliers.[8] Table 3 shows that our results are unaffected once we control for this price measure.

B. Holdup Problems: Property Rights Theory

Theoretical predictions. We next analyze how the buyer uses contracts to protect herself against the risk of holdups. We do not study implications of theories for the decision to vertically integrate but take the firm's boundaries as given. We study predictions derived from either PRT or TCE. A common theme underlying both theories is that of contractual incompleteness—the impossibility of writing a contract that covers all future contingencies that arise in a transaction and affect the sharing of the investments made by the two parties. We exploit that PRT and TCE make different predictions regarding contract design, though both share that contractual incompleteness may lead to ex-post renegotiation and holdups (Holmstrom & Roberts, 1998, compare PRT and TCE).

PRT, introduced by Grossmann and Hart (1986) and Hart and Moore (1990), focuses on ex ante incentives and ex ante investments in situations where parties make noncontractible RSI. PRT assumes that output is observable but not verifiable (i.e., not contractible), implying that not all contingencies can be specified ex ante. This implies imperfect contract enforcement, leading to ex post opportunistic behavior (holdup).[9] For example, a supplier may be tempted to hold up the buyer to obtain better terms if she knows that the buyer made RSI to cater to the ordered products. PRT shows that this ex post opportunism distorts incentives to invest initially, leading to underinvestment. Naturally, concerns about holdups are larger if RSI are bigger.

As parties are aware of this problem, contract design should anticipate opportunistic ex post behavior. PRT predicts that the allocation of control rights, determining who can choose which action during the contract phase, is an important contractual solution to holdup concerns. The reason is that the allocation of control rights allows the controlling party to decide on the use of the assets underlying a contract, which increases her investment incentives ex ante. We test the specific prediction that the allocation of control rights to the buyer is more likely if her RSI (relative to the supplier) are larger. Measuring the extent to which the buyer makes RSI is difficult, but we assume that if these noncontractible investments are larger, it takes more time and is more costly to switch suppliers (Monteverde & Teece, 1982).

[8] We asked the managers whether prices are above the market. This measure is created at the supplier level, as pricing is homogeneous across products of a supplier. It is unlikely that the managers reported this untruthfully, as we did not share their responses with the management.

[9] PRT predicts that renegotiations over surplus distributions are ex post efficient.

TABLE 4.—DETERMINANTS OF CONTRACT DESIGN: HOLDUP PROBLEMS

	Property Rights Theory				Transaction Cost Economics			
	Transfer IP rights				Duration		Open duration	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Switching time	0.12***		0.15***		0.57		0.03	
	(3.08)		(3.38)		(0.74)		(0.74)	
Switching costs		0.06*		0.08*		0.01		0.00
		(1.68)		(1.91)		(0.02)		(0.11)
Goods	0.08	0.05	0.08	0.04	4.64**	4.47**	0.25**	0.24**
	(1.00)	(0.47)	(1.00)	(0.40)	(2.29)	(2.09)	(2.21)	(2.00)
Domestic firm	0.00	−0.15*	0.01	−0.17*	0.91	0.09	0.06	0.02
	(0.06)	(−1.69)	(0.12)	(−1.86)	(0.57)	(0.06)	(0.74)	(0.22)
Privately held firm	0.01	−0.01	−0.01	−0.03	1.50	1.39	0.07	0.07
	(0.07)	(−0.13)	(−0.12)	(−0.28)	(0.96)	(0.90)	(0.81)	(0.75)
Log(Spending volume)	0.13**	0.09	0.12**	0.08	1.69	1.54*	0.07	0.07
	(2.49)	(1.54)	(2.23)	(1.25)	(1.64)	(1.70)	(1.27)	(1.26)
Alternative buyers			0.06**	0.05				
			(2.13)	(1.39)				
Constant	−1.86**	−1.15	−2.00**	−1.14	−23.90	−20.60	−1.16	−0.97
	(−2.24)	(−1.28)	(−2.36)	(−1.26)	(−1.34)	(−1.32)	(−1.20)	(−1.14)
Observations	91	91	91	91	84	84	84	84
R^2	0.208	0.159	0.231	0.171	0.114	0.106	0.095	0.087

This table provides OLS regressions at the supplier-contract level to explain the presence of different contract terms that address holdup problems. *t*-statistics in parentheses (based on robust standard errors). Significant at *10%, **5%, and ***1%.

Empirical results. The regressions in table 4 report in columns 1 to 4 the relation between the buyer's switching time (costs) and whether intellectual property rights are allocated to the buyer. Getting IP rights allocated can be crucial as it allows the controlling party, if necessary, to continue production herself or reallocate it to a third party, without interference by the other party. We first test whether a control rights allocation to the buyer is more likely if her absolute RSI is higher, and then the effect of relative RSI by conditioning on the number of alternative buyers. If a supplier has more alternatives, her RSI are likely to be less important.

Consistent with PRT, we find in columns 1 and 2 that holdup concerns by the buyer are addressed in contracts, as suppliers are more likely to transfer IP rights if supplier switching takes longer or is more costly. Columns 3 and 4 show that this effect holds after controlling for a supplier's RSI. In fact, we even see an increase in the magnitude of the effect when controlling for supplier RSI. Additionally, we find that the buyer is more likely to obtain IP rights if the supplier has many alternative buyers, indicating a situation where supplier vulnerability is probably low. However, this effect is significant only in one of the two regressions. Taken together, our results are consistent with PRT as they show that the buyer asks for more ex ante protection if her (relative) holdup concerns are larger.

C. Holdup Problems: Transaction Cost Economics

Theoretical predictions. Holdup concerns are an important element also in TCE, pioneered by Williamson (1975, 1979, 1985) and Klein et al. (1978). TCE has important predictions on the integration decision, but it can also be used to test predictions on contract design. Similar to PRT, TCE analyzes contractual incompleteness, but there is less focus on how control rights are allocated through contracts. A key difference to PRT is that ex post opportunism (holdup) is inefficient due to transaction costs and costly renegotiations about surplus distribution, and investments are contractible. An implication following from TCE is to focus on long-term contracting as a solution to protect parties against holdups. TCE predicts that if RSI are more important, contracts should be more long term, implying less repeated bargaining (Joskow, 1987). RSI are important as they generate switching costs, a form of a transaction cost, in case of renegotiation.[10] This implies that contracts should be longer if switching costs and time are larger.

Empirical results. The regressions in table 4, columns 5 to 8, link the two measures of contract duration to switching costs and time. As explained above, we measure both the length of a contract (in years) and whether it has an unspecified open duration. While we find that both switching time and costs are, as predicted, positively related to both measures of duration, we cannot detect statistically significant effects. This indicates that parties may use other contractual mechanisms or that concerns about transaction costs are less important in our setup.

IV. Dynamic Contracting

A. Theoretical Predictions

Contracts often result from repeated interaction, and our data allow us to investigate how contracts evolve over time. As in most of the literature, we start by looking at dynamic

[10] Our measures reflect the way Tadelis and Williamson (2013) model asset specificity, namely, as the probability that a supplier cannot be replaced when problems occur.

TABLE 5.—DYNAMIC CONTRACTING: MORAL-HAZARD PROBLEMS

	Moral-hazard clauses		Monitoring clauses		Incentive clauses	
	OLS	Supplier Fixed Effects	OLS	Supplier Fixed Effects	OLS	Supplier Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)
Second contract	1.16**	1.60**	0.60**	0.83**	0.56*	0.77*
	(2.58)	(2.66)	(2.12)	(2.12)	(1.79)	(1.99)
Third or later contract	0.61	1.57***	0.39	0.85*	0.21	0.71*
	(1.28)	(2.73)	(1.47)	(1.84)	(0.63)	(1.70)
Critical product supplier	1.17**		0.73**		0.44	
	(2.59)		(2.52)		(1.58)	
Goods	1.46***	2.53***	0.57*	1.04***	0.89***	1.49***
	(2.96)	(5.14)	(1.69)	(4.74)	(2.86)	(3.76)
Domestic firm	0.18		0.62**		−0.44	
	(0.39)		(2.09)		(−1.62)	
Privately held firm	1.10***		1.10***		−0.00	
	(3.01)		(4.72)		(−0.00)	
Log(Spending volume)	0.54**		0.59***		−0.04	
	(2.61)		(4.33)		(−0.34)	
Date	0.10	−0.17	0.15***	−0.02	−0.05	−0.15*
	(1.00)	(−1.12)	(2.80)	(−0.18)	(−0.73)	(−1.71)
Constant	−196.60	345.52	−299.66***	42.16	103.05	303.35*
	(−1.03)	(1.13)	(−2.88)	(0.18)	(0.75)	(1.72)
Observations	100	100	100	100	100	100
R^2	0.345	0.315	0.417	0.255	0.264	0.248

This table provides OLS regressions at the supplier-contract level to study changes in contract design over time. We exploit that we can observe for 39 suppliers more than one contract during the sample period. We exclude 28 open-ended contracts, which are contracts with a signing date but without an end date, and 5 contracts for which we do not observe the signing date. We use information on the signing dates of the contracts to create for each supplier a time line of the signed contracts. This leaves us with 77 first, 42 second, and 33 third or later contracts. *t*-statistics in parentheses (based on robust standard errors). Significant at *10%, **5%, and ***1%.

agency problems and contract terms that relate to moral hazard (Sannikov, 2012). Theory predicts two opposing effects once we allow for dynamics.

On the one hand, incomplete-contracting models predict that contracts with the same supplier become stricter over time, containing more clauses that address moral hazard. The reason is that contracting parties trade off ex ante costs of drafting a complex but complete contract against ex post inefficiencies associated with unspecified contract conditions (Dye, 1985; Posner, 1986; Tirole, 1999). If contracting costs become smaller as time passes, the buyer may be able to write at lower cost a more complete contract that addresses more contingencies (Battigalli & Maggi, 2002; Bolton & Faure-Grimaud, 2010). Contracting costs may go down over time because the buyer learns from prior transactions how to best design a contract that describes contingent actions. This should enable the buyer to specify monitor rights more easily and provide incentives more effectively. For example, the buyer may learn how to best monitor as she learns about the supplier, the production process, the supplied products, and potential problems. If changes in contract design are due to lower contracting costs and learning about the supplier, we expect that these changes are stronger for services than for goods, as contracting costs for services are probably larger initially (services are initially more difficult to observe and verify; see Hart, 1995). Contracts may also get stricter as shirking by the supplier is observed.

On the other hand, relational-contracting models predict that contract terms may become fewer over time and contracts more relaxed. The reason is that trust and reputational capital may accumulate so that relational contracts may partially substitute formal contracts (Baker et al., 2002). This effect should be independent of the type of product that is provided.

We also study contract dynamics with respect to PRT and TCE.[11] Both theories imply that if a supplier does not behave opportunistically, protection against holdups should decrease over time, as Holmstrom and Roberts (1998) pointed out. This would imply fewer transfers of property rights to the buyer in subsequent contracts from a PRT perspective and shorter-term contracts according to TCE.

B. Empirical Results

We exploit that we observe for 39 suppliers more than one contract during the sample period. We use information on the signing dates to create for each supplier a time line of contracts to identify the first, second, third, and so on contract. Using the first contract in our database as the benchmark, we then test how the second contract (and third or later ones) differs from the first one.[12] When studying dynamics, we exclude 28 open-ended contracts as dynamics are less relevant for infinite contracts. We further exclude five contracts for which we miss signing dates. This leaves us with 77 first, 42 second, and 33 third or later contracts.

Table 5 reports results on the evolution of contracts, both with and without supplier-fixed effects. We control for the

[11] Che and Sakovics (2004) studied dynamic holdup problems.

[12] Though we do not know when the first contract prior to our sample period was signed, this will affect only the starting level of the contract design rather than changes in the second or third contract relative to the first sample contract.

TABLE 6.—DYNAMIC CONTRACTING AND MORAL-HAZARD PROBLEMS: CONTRACTIBILITY AND SUPPLIER QUALITY PROBLEMS

	A. Contractibility: Goods versus Services					
	Moral-hazard clauses		Monitoring clauses		Incentive clauses	
	Contracts over Goods	Contracts over Services	Contracts over Goods	Contracts over Services	Contracts over Goods	Contracts over Services
	(1)	(2)	(3)	(4)	(5)	(6)
Second contract	0.04	1.35**	−0.39	0.78**	0.43	0.58
	(0.05)	(2.63)	(−0.63)	(2.39)	(1.37)	(1.57)
Third or later contract	0.03	0.58	−0.73	0.50*	0.76	0.08
	(0.02)	(1.13)	(−1.01)	(1.69)	(1.32)	(0.21)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	21	79	21	79	21	79
R^2 square	0.306	0.348	0.329	0.497	0.574	0.190
	B. Quality Problems with Suppliers					
	Moral-hazard clauses		Monitoring clauses		Incentive clauses	
	Quality Problems with Supplier	No Quality Problems with Supplier	Quality Problems with Supplier	No Quality Problems with Supplier	Quality Problems with Supplier	No Quality Problems with Supplier
	(1)	(2)	(3)	(4)	(5)	(6)
Second contract	1.79***	0.77	0.64	0.53	1.15***	0.24
	(2.77)	(1.22)	(1.58)	(1.19)	(2.86)	(0.44)
Third or later contract	1.54**	0.87	0.68*	0.09	0.86*	0.79
	(2.46)	(0.88)	(1.77)	(0.14)	(1.98)	(1.23)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57	43	57	43	57	43
R^2	0.417	0.386	0.411	0.466	0.464	0.228

This table provides OLS regressions at the supplier-contract level to study changes in contract design over time. Panel A separates the sample based on whether a contract is over goods or services, and panel B is based on whether there were problems with the quality of the products of a supplier. The regressions control for (not reported) *Critical product supplier, Goods* (not in panel A), *Domestic firm, Privately held firm, Log(Spending volume), Date*, and a constant. *t*-statistic in parentheses (based on robust standard errors). Significant at *10%, **5%, and ***1%.

same determinants of contract design as in table 2 and, in addition, for general time trends by including a variable that measures the year in which a contract was signed (as in Lerner & Malmendier, 2010). The regressions show strong evidence for dynamic adjustment in contract design. In particular, columns 1 and 2 show that second contracts with a supplier are generally stricter relative to the first ones. Column 1 indicates that a second contract contains 1.16 extra clauses that address moral hazard, which compares to 4.1 clauses in the average contract. Results are even stronger once we account for supplier-fixed effects. The regressions suggest that the increase in contract strictness is driven by a rise in the number of both monitoring and incentive clauses. For example, the estimates in column 3 and 5 suggest that a second contract contains about 0.6 extra monitoring and incentive clauses, which is large relative to the respective average numbers (two in both cases).

Incomplete-contracting models predict that the documented change in contract design is due to lower contracting costs in subsequent transactions. Therefore, table 6 looks more directly into the drivers of dynamic contract adjustment. We first separate the sample based on whether contracts are over goods or services. We use this separation to test whether the change in contract design is related to contractibility. We assume that contractibility problems, especially contracting costs, are larger for services than for goods, as services are initially more difficult to observe and verify (Hart, 1995). If the changes in contract design over time are indeed due to lower contracting costs (e.g., learning about how to best address monitoring needs), we expect that the previously documented changes are stronger for services.

Indeed, we find in table 6, panel A much stronger effects for services. Columns 3 and 4 show that especially the increase in monitoring clauses is driven by service contracts—transactions where output observability and verifiability are initially low. Our finding suggests that repeated contracting over the same services may help to write contracts that allow the specification of monitoring terms at lower cost. We cannot detect any differences between goods and services for the additional of new incentive provisions.

Table 6, panel B suggests that contracts also change in response to information about supplier problems. Based on our survey, we know whether quality problems with the products of a supplier occurred. We use this information to test whether and how contract design reacts as a result. A caveat to this analysis is that we lack information on when exactly the problems did arise. With this in mind, we separate the sample between suppliers with and without quality problems. We find in columns 1 and 2 that the increase in contract strictness is also concentrated among suppliers where information about quality problems did become available. Contracts do not seem to respond with more monitoring clauses, but we find that the buyer adds more incentives clauses to new contracts with problematic suppliers.

TABLE 7.—DYNAMIC CONTRACTING AND HOLDUP PROBLEMS

	A. Property Rights Theory					
	Transfer IP rights					
	Full Sample		Supplier Renegotiates		Supplies Does Not Renegotiate	
	(1)	(2)	(3)	(4)	(5)	(6)
Second contract	−0.23*	−0.24**	0.05	0.12	−0.25*	−0.26*
	(−1.99)	(−2.15)	(0.45)	(0.67)	(−1.74)	(−1.86)
Third or later contract	−0.28**	−0.29**	0.40*	0.40	−0.39	−0.36
	(−2.02)	(−2.06)	(1.95)	(1.46)	(−1.54)	(−1.53)
Switching time	0.08*		0.35*		−0.02	
	(1.72)		(2.09)		(−0.37)	
Switching costs		0.07*		0.23		0.08
		(1.74)		(0.98)		(1.53)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	76	76	20	20	56	56
R^2	0.161	0.159	0.812	0.751	0.124	0.174
	B. Transaction Cost Economics					
	Duration					
	Full Sample		Supplier Renegotiates		Supplies Does Not Renegotiate	
	(1)	(2)	(3)	(4)	(5)	(6)
Second contract	−0.18	−0.14	−0.82	−0.91	−0.35	−0.29
	(−0.49)	(−0.39)	(−0.74)	(−0.86)	(−0.81)	(−0.66)
Third or later contract	0.68	0.73	0.78	0.69	−0.41	−0.37
	(1.33)	(1.41)	(0.70)	(0.61)	(−0.70)	(−0.61)
Switching time	0.07		0.52		−0.14	
	(0.29)		(0.43)		(−0.75)	
Switching costs		−0.03		1.05		−0.17
		(−0.19)		(0.70)		(−1.43)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	73	73	19	19	54	54
R^2	0.136	0.135	0.625	0.634	0.334	0.348

This table provides OLS regressions at the supplier-contract level to study changes in contract design over time. The regressions control for (not reported): *Goods, Domestic firm, Privately held firm, Log(Spending volume), Date*, and a constant. *t*-statistic in parentheses (based on robust standard errors). Significant at *10%, **5%, and ***1%.

Online appendix table A4 illustrates the changes in contract design separately by clause. It shows that the initial increase in monitoring terms is driven by a higher incidence of terms related to supplier audits (57% versus 34%) and KPI systems (57% versus 35%). Financial disclosure requirements also increase relative to the first contract. The addition of clauses on supplier audits and KPI monitoring systems is plausible, as both are probably specifiable at cheaper cost once the buyer has learned from a prior transaction how to monitor most effectively. Subsequent contracts also contain more liability terms, but this increase is reversed in the third contract (this is the only clause that shows a statistically significant decrease in the third contract). The number of penalty clauses rise from the first to the second contract, though the increase is only marginally significant. Overall, our results on dynamic contracting support incomplete-contracting models that argue that contracts become more complete over time as contracting costs go down.

Next, we study the prediction that buyer protection against holdups decreases if a supplier does not misbehave. In particular, we use information from the buyer on whether a supplier has renegotiated, which was the case in 30% of the cases. As with our proxy for supplier problems, a caveat is that we do not know when exactly these renegotiations took place. Nevertheless, we can make the interesting observation in table 7, panel A that the allocation of property rights to the buyer is less likely in a second contract if the supplier did not renegotiate, consistent with PRT. We find no such effect among contracts with suppliers that renegotiated. Here, however, we find a positive coefficient for the second and third (or later) contract, indicating an increase in the probability of an IP rights transfer. This effect seems particularly strong for the third contract, where the coefficient is also significant in one of the two regressions. An interpretation of this finding is that good behavior is immediately reflected in the terms of a new contract, while bad behavior manifests itself only after it has occurred twice. With regard to TCE, we do not find in table 7, panel B that later contracts are shorter, though coefficients for the second contracts are generally negative.

V. Substitutability and Complementarity of Contract Clauses

We have so far studied contracts by testing specific predictions derived from contracting theories. Our findings indicate support for several theories, but also that contracts are multidimensional and cover different types of clauses addressing both moral hazard and holdups. Thus, contracts contain a complex set of clauses that interact and work

TABLE 8.—SUBSTITUTABILITY AND COMPLEMENTARITY IN CONTRACTING

	A. Contract Clauses across Groups			
	Monitoring clauses	Incentive clauses	Transfer IP rights	Duration
	(1)	(2)	(3)	(4)
Monitoring clauses		0.28***	0.06	−1.28**
		(2.80)	(1.54)	(−2.38)
Incentive clauses	0.32***		−0.06	2.59***
	(2.80)		(−1.61)	(4.84)
Transfer IP rights	−0.56*	0.48		4.95***
	(−1.69)	(1.53)		(3.02)
Duration	−0.05**	0.09***	0.02***	
	(−2.40)	(4.84)	(3.01)	
Control variables	Yes	Yes	Yes	Yes
Observations	84	84	84	84
R^2	0.2774	0.3341	0.2912	0.1698

	B. Contract Clauses within Groups: Monitoring Clauses				
	Supplier audit	Financial information	Evaluation meetings	KPI monitoring system	No preferred supplier
	(1)	(2)	(3)	(4)	(5)
Supplier audit		0.26***	0.28***	0.47***	−0.18**
		(3.78)	(3.92)	(5.22)	(−2.39)
Financial information	0.42***			0.34***	0.26***
	(3.78)			(2.83)	(2.76)
Evaluation meetings	0.43***	−0.06		−0.10	0.26***
	(3.92)	(−0.69)		(−0.82)	(2.78)
KPI monitoring system	0.41***	0.18***	−0.06		−0.17**
	(5.22)	(2.83)	(−0.82)		(−2.48)
No preferred supplier	−0.26**	0.23***	0.24***	−0.29**	
	(−2.39)	(2.76)	(2.78)	(−2.48)	
Control variables	Yes	Yes	Yes	Yes	Yes
Observations	120	120	120	120	120
R^2	0.2111	0.2191	0.2447	0.1475	0.1485

	C. Contract Clauses Within Groups: Incentive Clauses				
	Liability	Product warranty	Availability guarantee	Penalty	Bonus
	(1)	(2)	(3)	(4)	(5)
Liability		0.11	−0.19**	0.60***	−0.19***
		(1.22)	(−2.45)	(7.59)	(−3.14)
Product warranty	0.12		0.54***	−0.00	−0.06
	(1.22)		(7.28)	(−0.02)	(−0.93)
Availability guarantee	−0.26**	0.65***		0.30***	−0.01
	(−2.45)	(7.28)		(2.99)	(−0.19)
Penalty	0.63***	−0.00	0.24***		0.40***
	(7.59)	(−0.02)	(2.99)		(6.89)
Bonus	−0.41***	−0.12	−0.02	0.81***	
	(−3.14)	(−0.93)	(−0.19)	(6.89)	
Control variables	Yes	Yes	Yes	Yes	Yes
Observations	120	120	120	120	120
R^2	0.158	0.2698	0.2734	0.1887	0.0889

This table provides OLS regressions at the supplier-contract level. We estimate seemingly unrelated regression models. The regressions control for (not reported) *Critical product supplier, Goods, Domestic firm, Privately held firm, Log(Spending volume), Switching time* (only in panel A, columns 3 and 4) and a constant. *t*-statistics in parentheses. Significant at *10%, **5%, and ***1%.

together as a group. This raises the question of whether these clauses are generally understood to be substitutes or complements, but also how different clauses within a broader set of terms interact. While we have treated individual contract terms in isolation in previous tests, we now study their interactions.

Table 8, panel A provides regressions to explain substitutability and complementarity across different contract groups that address moral-hazard and holdup problems. The first interesting observation that emerges from columns 1 and 2 is that monitoring and incentives clauses generally coincide—that is, act as complements. In other words, incentive clauses tend to be more frequent if a contract also contains more monitoring clauses. One interpretation of this positive relation is that the buyer may be better able to incentivize a supplier if she has more information due to her monitoring activities. Thus, we have no evidence that monitoring and incentives are used as separate ways to address moral hazard (this could be the case if some suppliers are very risk averse, strongly preferring monitoring over incentives). This indicates that it may be interesting for future theoretical work to

integrate both mechanisms by modeling them as complementary devices (as in Allgulin & Ellingson, 2002, for labor markets).

We also find that moral-hazard and holdup clauses are used as substitutes, as column 1 suggests that transfers of control rights and long-term contracts are less likely if many monitoring clauses are present. One interpretation of this finding is that monitoring may serve as an alternative way to mitigate opportunistic holdup behavior, though we note that we cannot find such substitutability for incentive clauses. Additionally, columns 3 and 4 show that mechanisms that address holdup concerns from a PRT or TCE perspective are positively related, implying that control right allocations and long-term contracts tend to be used simultaneously.

Next, we study how contract clauses within a given group of clauses interact. While table 8, panel B focuses on interactions within the set of monitoring clauses, table 8, panel C looks at the set of incentive clauses. We now use regressions that regress each individual contract term within a group on the remaining ones, plus a set of control variables. The general pattern that emerges from panel B is that most monitoring clauses, with two exceptions, are used as complements. A group of three clauses in particular tends to coincide—namely, audits, financial reporting, and KPI monitoring systems. This is plausible, as a monitoring system requires availability of information, obtained from financial documents. Moreover, for audits to be feasible and on time, the buyer needs to have financial documentation and be able to track buyer performance through a KPI system. One clause that tends to work as a substitute is the exclusion of preferred supplier status, which is negatively related to supplier audits and KPI systems. One possible explanation is that suppliers that are not granted preferred status are already subject to further monitoring, making it less necessary to include other monitoring terms in a contract.

Finally, in panel C for incentive clauses, we find a slightly more mixed picture. One pattern that emerges is that penalty and bonus payments seem to work as complements, leading to symmetric incentive schedules for suppliers. Product warranties and availability guarantees also tend to coincide, possibly reflecting that a certain product is important to the buyer; if problems arise and a warranty requires replacement, the warranty is of value only if the supplier still has replacements on hand. Finally, bonuses and product liabilities tend to be substitutes, possibly to avoid excessive risk taking in case of safety relevant products (such products likely come with large liability obligations in case of injury or loss of life).

VI. Conclusion

We study how the possibility of opportunistic behavior between suppliers and buyers affects contracting. We find that contract clauses that address moral hazard are more likely if a supplier's products are critical to the buyer. Moral-hazard concerns are addressed primarily through clauses that allow the monitoring of sellers and, to a lesser degree, also through incentives. We then analyze holdup problems and test specific predictions derived from property rights theory (PRT) and transaction cost economics (TCE). Consistent with PRT we find that buyers ask for more ex ante contractual protection through the allocation of control rights if their holdup concerns are larger. We also test the TCE prediction that contracts should be more long term if holdup concerns are larger, but find only weak evidence for this in our data.

Contracts with the same supplier become stricter over time. The increase in contract strictness is driven by additions of monitoring clauses in service contracts. As services are initially more difficult to observe and verify than goods (Hart, 1995), repeated contracting helps to specify better monitoring technologies and reduce contractual incompleteness. Our evidence on dynamic contracting is consistent with incomplete-contracting models that predict that contracting costs go down over time as the buyer learns where and how to best address monitoring needs. We further find that the allocation of control rights to the buyer is less likely in a second contract if the supplier did not renegotiate, consistent with PRT.

We then study substitutability and complementarity across and within different contract groups. Monitoring and incentive clauses generally coincide, acting as complements. Moral-hazard and holdup clauses are used as substitutes, as transfers of control rights and long contracts are less likely if a contract contains many monitoring clauses. When studying contract terms within groups, we find that most monitoring clauses are used as complements.

Our results point to interesting dynamics in the evolution of contracts. The results suggest that contracts become more complete over time as contracting costs come down. The results also point to the importance of studying the use of different contractual clauses together to understand their role in overcoming contracting frictions. Understanding the dynamics of contracting using a larger set of contracts across different settings is an important avenue for future work.

REFERENCES

Aghion, Philippe, and Patrick Bolton, "An Incomplete Contracts Approach to Financial Contracting," *Review of Economic Studies* 59 (1992), 473–494.

Allgulin, Magnus, and Tore Ellingsen, "Monitoring and Pay," *Journal of Labor Economics* 20 (2002), 201–216.

Baker, George, Robert Gibbons, and Kevin J. Murphy, "Relational Contracts and the Theory of the Firm," *Quarterly Journal of Economics* 117 (2002), 39–84.

Baker, George, and Thomas N. Hubbard, "Contractibility and Asset Ownership: On-Board Computers and Governance in U.S. Trucking," *Quarterly Journal of Economics* 119 (2004), 1443–1479.

Banerjee, Abhijit V., and Esther Duflo, "Reputation Effects and the Limits of Contracting: A Study of the Indian Software Industry," *Quarterly Journal of Economics* 115 (2000), 989–1017.

Battigalli, Pierpaolo, and Giovanni Maggi, "Rigidity, Discretion, and the Costs of Writing Contracts," *American Economic Review* 92 (2002), 798–817.

Bolton, Patrick, and Antoine Faure-Grimaud, "Satisficing Contracts," *Review of Economic Studies* 77 (2010), 937–971.

Che, Yeon-Koo, and Jozsef Sakovic, "A Theory of Dynamic Holdup," *Econometrica* 72 (2004), 1063–1103.

Coase, Ronald, "The Conduct of Economics: The Example of Fisher Body and General Motors," *Journal of Management and Strategy* 15 (2006), 255–278.

Costello, Anna M., "Mitigating Incentive Conflicts in Inter-Firm Relationships: Evidence from Long-Term Supply Contracts," *Journal of Accounting and Economics* 56 (2013), 19–39.

Crocker, Keith J., and Kenneth J. Reynolds, "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement," *Rand Journal of Economics* 2 (1993), 126–146.

Dewatripont, Mathias, and Jean Tirole, "A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence," *Quarterly Journal of Economics* 109 (1994), 1027–1054.

Dye, Ronald A., "Costly Contract Contingencies," *International Economic Review* 2 (1985), 233–255.

Grossman, Sanford J., and Oliver Hart, "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy* 94 (1986), 691–719.

Hart, Oliver, *Firms, Contracts, and Financial Structure* (Oxford: Clarendon Press, 1995).

Hart, Oliver, and John Moore, "Property Rights and the Nature of the Firm," *Journal of Political Economy* 98 (1990), 1119–1158.

Holmstrom, Bengt, "Moral Hazard and Observability," *Bell Journal of Economics* 10 (1979), 74–91.

Holmstrom, Bengt, and John Roberts, "The Boundaries of the Firm Revisited," *Journal of Economic Perspectives* 12 (1998), 73–94.

Holmstrom, Bengt, and Jean Tirole, "Market Liquidity and Performance Monitoring," *Journal of Political Economy* 101 (1993), 678–709.

Joskow, Paul, L., "Contract Duration and Relationship-Specific Investments: Empirical Evidence from Coal Markets," *American Economic Review* 77 (1987), 168–185.

Kaplan, Steven N., and Per Stromberg, "Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts," *Review of Economic Studies* 70 (2003), 281–315.

Klein, Benjamin, Robert G. Crawford, and Armen A. Alchian, "Vertical Integration, Appropriate Rents, and the Competitive Contracting Process," *Journal of Law and Economics* 21 (1978), 297–326.

Lafontaine, Francine, and Margaret E. Slade, "Inter-Firm Contracts: The Evidence," in R. Gibbons and J. Roberts, eds., *Handbook of Organizational Economics* (Princeton, NJ: Princeton University Press, 2013).

Lafontaine, Francine, and Kathryn L. Shaw, "The Dynamics of Franchise Contracting: Evidence from Panel Data," *Journal of Political Economy* 107 (1999), 1041–1080.

Lerner, Josh, and Ulrike Malmendier, "Contractibility and the Design of Research Agreements," *American Economic Review* 100 (2010), 214–246.

Lerner, Josh, and Antoinette Schoar, "Does Legal Enforcement Affect Financial Transactions? The Contractual Channel in Private Equity," *Quarterly Journal of Economics* 120 (2005), 223–246.

McMillan, John, and Christopher Woodruff, "Interfirm Relationships and Informal Credit in Vietnam," *Quarterly Journal of Economics* 114 (1999), 1285–1320.

Milgrom, Paul, and John Roberts, *Economics, Organization and Management* (Englewood Cliffs, NJ: Prentice Hall, 1992).

Monteverde, Kirk, and David J. Teece, "Supplier Switching Costs and Vertical Integration in the Automobile Industry," *Bell Journal of Economics* 13 (1982), 206–213.

Posner, Richard, *Economic Analysis of Law* (Boston: Little, Brown, 1986).

Roberts, Michael, "The Role of Dynamic Renegotiation and Asymmetric Information in Financial Contracting," *Journal of Financial Economics* 116 (2015), 61–81.

Ryall, Michael D., and Rachelle C. Sampson, "Formal Contracts in the Presence of Relational Enforcement Mechanisms: Evidence from Technology Development Projects," *Management Science* 55 (2009), 906–925.

Sannikov, Yuliy, "Contracts: The Theory of Dynamic Principal-Agent Relationships and the Continuous Time Approach," Stanford University working paper (2012).

Tadelis, Steven, and Oliver Williamson, "Transaction Cost Economics," in R. Gibbons and J. Roberts, eds., *Handbook of Organizational Economics*, (Princeton, NJ: Princeton University Press, 2013).

Tirole, Jean, "Incomplete Contracts: Where Do We Stand?" *Econometrica* 67 (1999), 741–781.

Williamson, Oliver, *Markets and Hierarchies: Analysis and Antitrust Implications* (New York: Free Press, 1975).

——— "Transaction-Cost Economics: The Governance of Contractual Relations," *Journal of Law and Economics* 22 (1979), 233–271.

——— *The Economic Institutions of Capitalism* (New York: Free Press, 1985).