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Formal contracting addresses the moral hazard problems inherent in interfirm deals via explicit terms designed to achieve incentive alignment. Alternatively, when firms expect to interact repeatedly, relational mechanisms may achieve similar results without the associated costs. However, as we now know from a growing body of theoretical and empirical work, the resulting intuition—that relational mechanisms will be substituted for formal ones whenever possible—does not generally hold. The extent to which firms substitute relational mechanisms for formal ones in the presence of repeated interaction is an empirical question that forms the basis of this paper. We study a sample of 52 joint technology development contracts in the telecommunications and microelectronics industries and devise a coding scheme to allow empirical comparison of contract terms. Counter to the above intuition (but consistent with recent research), we find that a firm's contracts are more detailed and more likely to include penalties when it engages in frequent deals (whether with the same or different partners). Our results suggest complementarity between formal and relational contracts, and have implications for optimal contracting, particularly in high technology sectors.

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1. Introduction

The governance of interfirm collaboration is the subject of large body of research that spans multiple disciplinary areas. A recurring focus in this work is on the roles played by contracts in these settings, both as project planning tools and as external enforcement devices. To the extent that such agreements facilitate smooth collaboration and avoid costly misunderstandings, they enhance the performance of the interfirm activities they govern.[1] In this sense, contractual content is a managerial choice variable with strategic implications.

Recently, a growing stream of literature has considered the issue of contract design in repeated relationships.[2] Collaborators in repeated partnerships experience shared learning, build trust, establish reputations, and use relational mechanisms to facilitate successful outcomes. Thus, anticipation of an ongoing relationship should influence the design of the formal contract. Although some progress has been made in understanding the individual effects of these factors, little is presently known about their joint, interactive effects.

Our purpose in this paper is to contribute new empirical findings on formal contract design when firms repeatedly interact, exploring in greater depth the specific details of a particular class of contracts and analyzing how these details vary when relational considerations are at play. Specifically, we examine 52 contracts for joint technology development in the telecommunications equipment industry to determine whether and how their content is affected by relational considerations. Three categories of salient terms emerge from our analysis: those that

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[1] This view is consistent with recent empirical work linking organizational form choice and performance (e.g., Sampson 2004, Macher 2006).

[2] Note that we refer to written documents governing exchange as formal contracting, and unwritten mechanisms for governing exchange, such as an interest in preserving the value of ongoing relationships that prevents opportunistic behavior, as relational contracting. Although formal and relational mechanisms are often referred to as explicit or implicit, we do not use this terminology, because relational mechanisms can be quite explicit and known to the exchange parties, but not formalized in a written document.

(i) define the rights and obligations of the parties ("contract detail"), (ii) facilitate observation of performance ("monitoring"), and (iii) provide enforcement prescriptions ("penalties"). We investigate whether the inclusion of term types varies with the relational status and deal experience of the partners. We find that contracts become more detailed and include stronger enforcement terms when at least one of the firms has prior deal experience. These effects are stronger when collaborating firms have prior relationships with each other.

Our study sits at the intersection of two important streams of literature, one in economics and the other in management. On the economics side, an extensive body of formal theory examines various aspects of both relational and formal contracting (Baker et al. 2002, is a central contribution).[3] Recent work on the interplay between these two classes of mechanisms identifies a number of theoretical interactions between them—from substitutes to complements to outright collision (e.g., Bernheim and Whinston 1998, Levin 2003, Kvaloy and Olsen 2005). In contrast, the relevant management literature presents a rich body of empirical findings on contracting in a variety of settings (e.g., Mayer and Argyres 2004, Argyres et al. 2007, Poppo and Zenger 2002).[4] These contributions cover a wide spectrum and, not infrequently, offer alternative explanations to those provided in the economics literature.

Given the breadth and variation in prior findings, both theoretical and empirical, we do not test any specific model, but instead take an inductive approach by providing descriptive results of direct relevance to several of the key ideas put forth in each of these streams. This has implications for how we organize our paper: we lead with our empirical analysis and then follow up with a careful discussion relating our findings to the prominent ideas in both management and economics. It is in this discussion that we review the relevant literatures—both theoretical and empirical—and contrast them against what we deem our most interesting results. We discover both consistencies and gaps between our results and existing theories, with the latter suggesting several potentially fruitful directions for theoretical development. To the best of our knowledge, our examination of monitoring and penalty clauses with respect to prior deal experience is entirely new.

In technical terms, the approach taken here contributes to the existing empirical literature on several dimensions. Our categorization scheme goes beyond the discrete-form analysis that has been a hallmark of the literature examining, for example, alliance structure choices (Gulati 1995, Oxley 1997, Sampson 2004). In this sense, we add to the growing stream analyzing how contract terms vary with deal-specific factors (e.g., Crocker and Reynolds 1993, Lerner and Merges 1998, Mayer and Argyres 2004, Argyres et al. 2007). By proceeding inductively, we generate a broad set of terms that permits more comprehensive comparisons than traditionally available in studies of this kind. Moreover, our approach uncovers several ancillary, previously unreported stylized facts—most notably that the majority of firms in our sample waive their rights to courtroom dispute resolution. This observation suggests that the role of contracts goes beyond the legal function of providing evidence for third party dispute resolution and is further support for the claim that contracts may influence deal performance. In this sense, we take a more holistic approach to examining contracts in our context with a view to providing some empirical regularities that may be used to advance theory development in the area. Our hope is that this broader design may provide a useful guideline in future studies.

This paper proceeds as follows. Section 2 describes our sample and the contracts in detail. In §3, we empirically examine the relationship between contract structure and repeated interactions. In §4, we contrast our results with existing work—both empirical and theoretical—in some detail. Concluding comments are presented in §5.

2. Sample and Description of Contracts

Technology development across firm boundaries is a fertile environment for enforceability problems in formal agreements. Often, research and development (R&D) projects are passed back and forth between firms at various stages, making it difficult to observe the behavior of one's partner. Moreover, project outcomes can be highly uncertain, making it difficult to infer unobserved partner performance (see, e.g., Holmstrom 1989). Unintended leakage of intellectual property may also be an issue in this context. The contracts in our sample capture the attempts of partnering firms to address these issues.

2.1. The Contract Sample

Our source of joint technology development contracts is SEC filings. Public firms, under SEC disclosure requirements, submit "material contracts" as part of their 8K, 10K, 10Q, and S-1 filings, including joint technology development contracts. To obtain the largest sample possible, our contracts are collected for the years 1991 to 2000, inclusive. Because the SEC

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[3] See Baker et al. (2008) for an application to strategic alliances.

[4] See Macher and Richman (2008) for a more thorough discussion of empirical studies on contract terms, at least in the context of empirical transaction cost economics work.

requirement is to file material documents and not joint development contracts specifically, filing of these contracts is somewhat discretionary. Thus, the limitation of this data is that we observe only contracts of public companies and likely only the largest and most important deals for these firms.

We collected contracts in the telecommunications equipment and microelectronics industries. The convergence of the telecommunications equipment with computer and microelectronics markets in the late 1980s substantially accelerated the pace of technological development (e.g., *The Economist* 1997). Product life cycles shortened while the cost of development increased. To gain access to different technologies, realize economies of scale in R&D, and spread the risk and expense of development, firms in these industries frequently collaborated in their R&D activities.[5]

The firms included in our sample range in size from the largest players in each industry, such as Motorola and IBM, to much smaller, more specialized firms like Global Village Communication and Positron Fiber Systems.[6] Collaborations take many forms, including cross-licensing arrangements, joint technology development agreements, and formal joint ventures for development and manufacturing. Projects in our sample focus on end-product- or manufacturing-process-driven R&D.

To collect a sample of contracts, we began with a list of firms with primary operations in SIC 366 or 367 from Compustat (approximately 625 firms). From this list, we downloaded all SEC filings from the EDGAR database and supplemented these filings with those from Disclosure, Inc. (a company that provides SEC filings on request for a fee).[7] From approximately 12,500 filings, we obtained over 120 technology development contracts. Screening for deals involving some form of joint development reduced our sample size to 52 contracts. Thus, we explicitly exclude those deals that are solely licensing arrangements. Licensing arrangements—typically, defined technology transfers or usage agreements with royalties attached—are an interesting class of contracts to consider, but do not involve the same contracting issues as joint development agreements between firms. Because our focus is on the contract heterogeneity that may result from repeated interactions, we try to control for

Table 1 Number of Sample Contracts per Firm

Contracts per firm	Frequency	Percentage (%)
1	28	78
2	4	11
3	1	3
4	2	6
5	1	3
Total	36	100

Note. Firms included are only those with SEC filings.

other sources of heterogeneity by limiting our scope of examination and, thus, excluding licensing contracts. This approach is similar to that taken by earlier research on contract terms (e.g., Robinson and Stuart 2007).

These 52 contracts involve 78 organizations, when we count both parties to the deal. However, the number of firms for which we have the SEC filings is 36; that is, each of these 36 firms represents one party to the contract. The number of sample contracts per firm is set out in Table 1. The majority of firms in the sample (78%) have only one contract. The remaining firms have anywhere from two to five contracts in the sample.

These deals, even when confined to those for joint technological development, cover a broad spectrum of purposes, from development of new microprocessor cores based on existing technology to developing a "next-generation" ferroelectric chip. For more information on these sample deals, see the online supplement (provided in the e-companion).[8]

For data on the frequency of deals between firms, we relied upon the Securities Data Company (SDC) Database on Alliances and Joint Ventures. The SDC database compiles information on a firm's alliance activity from news reports, SEC filings, and industry and trade journals. Ideally, we would measure the full contracting network among firms in our sample to better assess reputational mechanisms that may be at work; unfortunately, a full sample of all contracts and deals for each firm in the sample is not available. Although coverage by SDC is inevitably incomplete, because firms are not required to report alliance activity, this database represents one of the most comprehensive sources of information on interfirm deals. Using SDC data, we captured all repeated deal activity for a firm and broke this information down into two components: (1) prior deals for a firm where the partners are the same as partners in our sample contracts for that firm, and (2) prior deals for a firm where partners differ from those in our sample contracts for the firm.

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[5] According to Gans et al. (2002), firms more likely cooperate in technology development and commercialization the stronger the intellectual property regime, because stronger intellectual property rights imply a greater return to collaboration.

[6] Global Village Communication is a firm that specializes in creating websites for corporate clients, and Positron Fiber Systems is a broadband equipment manufacturer.

[7] The EDGAR database, maintained by the SEC, provides electronic filings from 1996 onward. For filings prior to 1996, we used Disclosure, Inc.

[8] An electronic companion to this paper is available as part of the online version that can be found at http://mansci.journal.informs.org/.

We did not discriminate between the types of prior deals; that is, we did not differentiate among prior deals for manufacturing, marketing, technology licensing, or R&D, because our measure is intended to capture the presence of relational mechanisms, which we expect may develop over prior interactions of different types (i.e., not just R&D). Furthermore, we expect that firms gain experience in contracting or with partnering (either with a specific partner or more generally) from all types of deals. For example, it appears that for R&D collaborations, prior experience of any type is positively correlated with performance (Sampson 2005).

Information on prior deals was collected for the years 1985 to present. Note that our prior deals measures are time variant. We attempt to capture experience at the time the contract was drafted. Thus, we only count those prior deals that occurred prior to the contract signing date. We supplement this data with financial information (including R&D spending) where available from Compustat, collected for the year prior to the contract date.

2.2. Descriptive Overview

Several patterns are revealed in the descriptive summary of the joint technology deals and partner firm characteristics presented in Table 2. Most of the joint development deals involve R&D only (i.e., no manufacturing or marketing). A slight majority are cross-border deals, involving firms headquartered in different countries. The average reported deal value is about $91 M.

Partners do not typically have a history together; we see repeat dealings with a specific partner in only ten contracts in our sample. However, over 80% of our firms do have prior deal experience of some kind with different partners. Colocation of joint development activities occurs in only 11.5% of our contracts. Equity holdings between partners (whether majority, minority, or cross-equity) occur in about one-third of the deals; joint venture formation (i.e., formation of a new firm in which each partner holds equity) occurs in just over 11% of the cases. Intellectual property is typically not shared equally, but is split between partners according to input contributions, each firm's area of technological expertise, and end-product market. Finally, firms tend to set a fixed termination date for the joint development, on average, just over three years from the contract date.

There are several contractual features that appear regularly across the sample. Most contracts contain provisions (1) to ensure confidentiality of partner technologies and to protect against leakage to third parties, (2) to terminate the deal on bankruptcy or change in key management of a partner, (3) to limit liability, and (4) to resolve disputes via arbitration rather than through the courts. These common terms likely reflect the issues shared by most joint technology

Table 2   Deal and Firm Descriptives

	N	Mean	SD	Min	Max
Average deal value (in millions)	17	91.147	178.198	1	700
Technology breadth (0 to 1, with 1 being next generation)	52	0.404	0.495	0	1
Average deal length in years (where specified)	47	3.426	7.711	0	50
Prior deal exists—same partner (dummy variable)	52	0.096	0.298	0	1
Contemporaneous deal exists—same partner (dummy variable)	52	0.173	0.382	0	1
Prior deal exists—different partner (dummy variable)	52	0.808	0.398	0	1
Average prior deal activity for firm, not including same partner (since 1985)	52	31.480	61.454	0	370.5
Average prior deal activity for firm, not including same partner (five years prior to contract date)	52	25.049	54.784	0	362.5
Manufacturing (dummy variable)	52	0.481	0.505	0	1
Marketing (dummy variable)	52	0.192	0.398	0	1
Cross-border (dummy variable)	52	0.558	0.502	0	1
Firms physically colocate for joint development (dummy variable)	52	0.115	0.323	0	1
Development is primarily vertical (one firm for the other) (dummy variable)	52	0.423	0.499	0	1
Equity stake exists (cross, majority, or minority equity) (dummy variable)	52	0.308	0.466	0	1
Intellectual property shared equally (dummy variable)	52	0.212	0.412	0	1
Joint venture formed (dummy variable)	52	0.115	0.323	0	1
Termination date set in contract (dummy variable)	52	0.808	0.398	0	1
Firm size (total assets) (in millions)	64	10,955.84	21,120.97	0.419	81,091.00
Firm size (net sales) (in millions)	64	10,236.11	19,062.16	0.094	75,094.00
R&D spending (in millions)	64	748.95	1,311.00	0.28	5,094.00

Note. Data for 78 organizations involved in 52 joint development deals are shown.

Table 3 **Examples of Common Contract Terms**

Type of common term	Examples
1. Arbitration	"Each party waives any rights to bring any dispute, controversy or claim in any other forum or proceeding, including without limitation, the International Trade Commission of the United States or any other administrative or judicial forum."
	"ABCN and Osicom agree to attempt to resolve any question or dispute that arises regarding or under this Agreement through prompt good faith discussions between their respective officers with decision making authority. . . . Any and all claims . . . which have not been resolved by good faith negotiations between the parties shall be resolve exclusively by final and binding arbitration in Washington, DC, . . . by a three person arbitration panel. ABCN and Osicom shall each have the right to choose one of the arbitrators and the third shall be mutually chosen."
	"The award of arbitration shall be final and binding upon the parties hereto and shall not be subject to appeal to any court, and shall not be entered in any court of competent jurisdiction for execution forthwith."
2. Confidentiality	"The recipient of Confidential Information will not . . . use any portion of the confidential Information for any purpose other than those contemplated by this agreement and will hold the information in the strictest confidence and will exercise the same care with respect thereto as it exercises with respect to its own proprietary and confidential information."
3. Right to terminate	"Both Benchmarq and SGS-Thomson reserve the right to terminate this Agreement at any time by written notice for default, without prejudice of their other legal rights and legal position under the following conditions:
	i. Filing of a petition in bankruptcy . . . by the other party, or the appointment of a receiver for the business of the other party . . . ;
	ii. Material breach of the provisions of this agreement, which breach has not be cured within thirty (30) days after written notice of said breach."
4. Limitation of liability	"Liability of SGS-Thomson to Benchmarq for damages for any cause whatsoever, and regardless of the form of any action, whether in contract or in tort, including but not limited to negligence, shall be limited to the greater of $10,000 or the price specified in the sale contact for the specific product or products that caused the damages. . . . In no event shall SGS-Thomson be liable to Benchmarq or others for a loss of goodwill, loss of profits, loss of use or other special, collateral, incidental or consequential damages, regardless of the form of action therefore."
5. Cross-licensing	"(a) In the event Sanyo Energy or Sanyo Electric incorporate any of their respective existing technology, technical information, proprietary information or know-how ("Existing Sanyo Technology") into [integrated circuits] developed pursuant to this Agreement, Sanyo Energy shall grant . . . to Benchmarq a nonexclusive world-wide, royalty-free license with no right to sublicense . . . for the limited use of Benchmarq . . . solely in applications regarding the design, manufacture and sale of [integrated circuits]." (*An identical provision for licensing by Benchmarq to Sanyo follows.*)
6. Patent indemnity	"Benchmarq will, at its own expense, indemnify and hold SGS-Thomson harmless from and against any expenses or loss resulting from any actual or claimed infringement of any United States Intellectual Property Right, including patent, trademark, copyright, or mask work right to the extent arising from SGS-Thomson's compliance with any of Benchmarq's specifications, designs or instructions."

development deals—concerns over knowledge leakage to third parties, fundamental changes in partner status (such as ownership), and the inefficiency of external dispute resolution. Examples of the contract language used in these common terms are set out in Table 3.

Interestingly, most of the contracts in our sample stipulate arbitration as the sole recourse in events of disputes. Several contracts explicitly waive firm rights to bring disputes before the courts or other administrative bodies. Some provisions also create disincentives for seeking arbitration. For example, in one case of a cross-border joint development agreement, arbitration was required to be conducted in the language and country of the partner firm *not* bringing the dispute.[9]

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[9] The joint development agreement between Ramtron International and ULVAC (Japan) (dated April 9, 1997) requires arbitration to take place in Japan and be conducted in Japanese if Ramtron, a Colorado microelectronics company, initiates the dispute, and in the United States in English if ULVAC initiates the dispute.

Also common, but less frequent, are clauses specifying cross-licensing of all partner patents so as to avoid infringement over the course of the project (whether related to the technology in the agreement or not). In joint ventures, percentage stakes in the venture are usually specified, as are the establishment and composition of a board of directors. When firms are engaged in multiple deals with the same partner, these common terms are identical between contracts.

The terms that vary from contract to contract likely arise out of differences in development goals, environmental uncertainty, and propensity for strategic behavior. Unfortunately, the existing literature provides few guidelines for identifying and categorizing clauses of relevance to our study. Prior work appears to be focused primarily on a few specific terms, such as pricing provisions (e.g., fixed-price versus cost-plus contracts; see Corts and Singh 2004, Kalnins and Mayer 2004). Some property rights studies examine a broader range of terms, but these are constrained by the underlying theoretical focus, typically on control rights (e.g., Lerner and Merges 1998, Robinson and

Stuart 2007, Kaplan and Stromberg 2003, Elfenbein and Lerner 2003) and/or ownership rights (e.g., Elfenbein and Lerner 2003). Other papers look at general categories, such as "task description" or "contingency planning" (e.g., Argyres et al. 2007), but provide limited discussions of the various forms these terms take in the actual contracts. Therefore, our approach is primarily inductive. We conduct an in depth analysis of the contracts of a few firms in the sample to discover the forms taken by terms intended to encourage cooperative behavior—those that set incentives, define obligations, establish monitoring rights, and elaborate performance penalties (see the online supplement for more details).

We find three broad categories that account for a large portion of the variance across contracts: (1) the detail with which firm obligations are specified; (2) how much monitoring is explicitly provided for; and (3) whether penalties exist for noncompliant behavior. Each of these categories is multidimensional. For example, in addition to defining the specific technologies that a firm is obligated to contribute, a contract may also specify time frames for the completion of tasks, the division of intellectual property, and individuals to manage the project. We identify six types of clauses that illustrate the extent to which partner rights and obligations are detailed or specified in the contracts, five types of clauses that outline monitoring rights, and two primary forms that penalties take. Examples are illustrated in Table 4; Table 5 presents frequencies and cross-frequencies.

There is substantive heterogeneity across our contracts. No single term is used in all contracts; the highest percentage of term usage is 51.9% (i.e., time frames for completion of stages specified). A relatively large proportion of the contracts require some sort of periodic reviews (46.2%), whereas penalties, particularly financial penalties, are rarer (11.5%). Terms that more frequently appear together are (1) time frames for completion specified and reviews of development work required (co-occurring in 28.8% of the contracts), (2) time frames for completion specified and right to terminate for underperformance (25%), (3) reviews of development work required and the timing of reviews specified (28.8%), and (4) development output specifications included and specific technologies to be contributed described (23.1%). Given this low incidence of co-occurrence of terms, it does not appear that the contract terms are used in clusters in our sample.

To assess the degree of intrafirm heterogeneity, we produced frequency tables of each contract term by firm (available upon request from the authors.). These frequencies reveal the extent to which firms may favor certain terms over others. Of the 36 firms in the sample, eight have multiple (two to five) contracts. Of these, only three firms have more than 70%

consistency in the types of terms used across their contracts. Our results are robust to the exclusion of these firms from the sample.[10]

Similarities between our term classifications and those used in prior research arise primarily around our "contract detail" clauses. Task description, as Argyres et al. (2007) define it, appears to be similar to a few of our clauses in "contract detail," notably inclusion of development specifications, time frame for completion, and number of employees to be contributed. Similarities with respect to studies on control and ownership rights are more limited, typically to one or two terms in our classification; for example, "intellectual property rights defined" here is similar to, but not the same as, the allocation of control rights over intellectual property in Lerner and Merges (1998). However, these studies do not focus on the inclusion of such terms as a function of repeated interactions. An exception is Robinson and Stuart (2007), who do examine the influence of prior deals (with any partner) on the inclusion of particular control rights. One such right—employment provisions that specify the number and quality of research personnel—is similar to our "number of employees" and "specific persons specified." We compare our findings with this related empirical work in our results discussion below.

3. Contract Structure and Repeated Interactions

As the descriptive overview illustrates, there is considerable variance in the structure of our sample contracts. The three apparent sources of this heterogeneity are (1) the purpose of the deal (e.g., whether the deal involves radical technological development or simple customization of existing technology), (2) firm preferences for contract structure, based on history, prior experience, and relative bargaining power, and (3) the potential availability of relational enforcement mechanisms due to repeated interactions. Our primary interest is the extent to which observed variance in contract structure is systematically related to the presence of repeated interactions.

As a first step, we examine mean frequency differences in contract terms among four groups: (1) the full sample, (2) those observations where firms have

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[10] Unfortunately, we do not have multiple contracts for every firm in the sample, so we cannot estimate a fixed-effects (or similar) model to control explicitly for such effects. However, we do include firm-level variables in some of our regressions (e.g., R&D spending), which may control to some extent for firm-specific effects. We also cluster standard errors by firm to control for the lack of independence between observations for the same firm. As a robustness check, we reestimated Tables 7–9, dropping these firms' contracts from the sample. Results are substantively the same (with no changes in sign or significance on key variables) as those reported below. These results are available from the authors.

Table 4   Examples of Contract Terms

	Examples
Contract detail	
1. Development specifications (such as tolerances) included	"Product Specifications: The Comanche shall include the following elements and functions [confidential specifications follow]…" "The development steps for the Subject Technology related to the 0.5 micron process shall be as follows: (a) The parties shall first compare and evaluate each unit process of both parties' existing 0.5 micron wafer process to assess their applicability to the production of JV products at JV's facility. (b) The parties shall then establish a target process flow for the 0.5 micron wafer process for the JV considering the structural requirements of JV products…"
2. Time frame for completion of each stage specified	"…this phase, lasting nine months from the date of signing this agreement…" "Phase 1 will be considered complete when Ramtron and ULVAC determine through mutual consultations that the ferroelectric stack deposition process has matured to the point where more rapid evaluation results will be beneficial and prototype production can be run." "Major milestones and Project Deliverables: Milestone / Project Deliverable / Completion Date Lab prototype phase / LB units (25) / February 28, 1994 Production prototypes phase / PP units (150) / May 5, 1994…"
3. Number of employees to be contributed specified	"During the term of this Agreement, e-Power will dedicate at least two design engineers in the design and development of high-power adapters for supporting newly-released Products and the development of next-generation Products." "Each party agrees to commit no less than 5 employees to a joint product definition team."
4. Specific persons stipulated for management or other development work	"The parties hereby agree that the Project Leader for Ramtron shall be Mr. Tom Davenport and the Project Leader for ULVAC shall be Mr. Yoshifumi Ota. The responsibilities of the project leaders shall be to coordinate the individual work and/or shared work as set forth in the SOW with respect to the equipment deliverables as described in Attachment 'B' and the cost sharing as described in Attachment 'C'." "The initial project manager for the Comanche project shall be John Lovato. …Hewlett Packard's initial project manager for the Comanche project shall be Jean-Jacques Simon."
5. Specific technologies to be contributed described	"Fujitsu shall provide and make available to the Program Fujitsu's existing 0.50/0.35 micron CMOS process technology as relates to the backend ferroelectric processing." "Phase 2: The SPZ-1000 machine will be transferred to Ramtron, Colorado Springs at the beginning of Phase 2. The work undertaken will include composition, microstructural, electrical, and other optimizations. Specific Phase 2 objectives will be defined by the parties through mutual consultations. A minumum of 50 wafers per month will be supplied by Ramtron for the development. Machine time for joint development work will be shared with customer evaluations, at ULVAC's cost and Ramtron prototype production. ULVAC will provide in-house support during Phase 2 to the extent agreed by the parties."
6. Intellectual property rights defined over specific technologies	"Ramtron shall retain sole ownership to all patents…relating to…ferroelectronic technology." "JABIL will have unlimited rights to use new concepts created or derived during the development of the COMANCHE BIOS to implement other non-HPF products as long as such products will not be based on, or incorporate any part of, the HPF BIOS or COMANCHE BIOS. …HPF will have unlimited rights to use of modify the COMANCHE BIOS source code delivered by JABIL, for the purpose of developing future HPF products."
Monitoring	
7. Reviews of development work required	"Fujitsu and Ramtron shall each conduct by the end of each calendar quarter quarterly reviews of the Development Plan, including review of the progress made in accomplishing development milestones set out in the Development Plan, the allocation of staffing contemplated by the development Plan, the development focus and timetable for development efforts contemplated by the Development Plan, and the development budget."
8. Reviews of outcome only required	"ASKEY will evaluate Centillium's first prototype of the Interface Devices. Centillium will provide evaluation boards to ASKEY for this evaluation." "Once Motorola has customized and/or modified the Equipment, a prototype of the Equipment will be sent to Comdial…for acceptance testing…Comdial…shall test the resulting product to determine whether the Equipment is operating in conformity with the specifications set forth in Appendix A."
9. Discretionary reviews available	"Apple may conduct periodic reviews, including reviews at Global Village's premises, of the Product. At Apple's reasonable request, Global Village will provide Apple with written reports regarding its work on the Product in form and substance acceptable to Apple and with copies of any work in progress and related materials." "With respect to each Milestone, ALI shall have thirty (30) days after the date of receipt of the completed Milestone Deliverables to examine and test them to determine whether they satisfy the applicable Milestone Criteria."
10. Timing of reviews specified	"Benchmarq shall issue a design status report no less frequently than twice per month." "Fujitsu & Ramtron shall conduct by the end of each calendar quarter, quarterly reviews of the Development Plan, including review of the progress made in accomplishing development milestones set out in the development plan."

Table 4   (Continued)

	Examples
Monitoring	
11. Content of reviews specified	"As part of such review, Benchmarq shall provide the following deliverables: (a) Test tape program for Terradyne 386 tester; (b) Source tapes; (c) Hardware documentation; (d) Working hardware; (e) Program Flows…"
	"…including review of the progress made in accomplishing development milestones set out in the Development Plan, the allocation of staffing contemplated by the Development Plan, the development focus and timetable for development efforts contemplated by the Development Plan, and the development budget associated with the various components of the Development Plan."
12. Physical audits of development work permitted	"BENCHMARQ maintains the right to audit the OPTi manufacturing facility for conformance to agreed upon manufacturing flows at any time."
	"In the event that development or design work is performed at one party's facility or facilities, the other party may at all reasonable times visit the facility or facilities, observe the development or design work being performed, and bring back to such other party's facilities all information and results obtained in the course of such work."
13. Reviews required of both (all) firms	"In the event that, during the term of this Agreement, any portion of such work is required to be performed independently by one party, such party shall provide the other party with regular progress reports on the status of such work."
	"AltiGen may accept or reject the end products within thirty (30) days of delivery by Nitsuko. AltiGen may reject the end products if it materially fails to meet the requirements…except normal bugs. …Nitsuko may accept or reject the end products within thirty (30) days of delivery by AltiGen. Nitsuko may reject the end products if it materially fails to meet the requirements…except normal bugs."
Penalties	
14. Financial penalties for under-performance	"For each Deliverable that is delivered more than thirty (30) days late…Fujitsu will reduce the applicable milestone payment by ten percent (10%)."
	"If the JVC fails to pay on due date, any sums payable hereunder, the JVC shall pay to MEMC…interest on the aforesaid sums calculated at a rate equivalent to 2% (two percent) per annum above the prevailing Base Lending Rate of Malayan Banking Berhad."
15. Right to terminate for under-performance (as distinct from "material breach")	"If Ross fails to deliver a Deliverable without errors or otherwise acceptable to Fujitsu after two attempts, Fujitsu may terminate this Agreement."
	"If Ramtron does not cure such defaults and satisfy the Delinquent Milestones within the applicable grace period, then Fujitsu may terminate the Program by providing written notice."
	"In the event that Jabil fails to deliver to HP acceptable Deliverables for any Milestone within sixty (60) calendar days after the original target date therefore, HPF may at its sold option either (i) terminate this Agreement…"

no repeated deals, (3) those observations where partners have repeated deals with the same partner, and (4) those observations where partners have repeated deals, but not with the same partner.[11] These frequencies and mean difference tests are set out in Table 6.

Contracts by firms that have repeat dealings are more likely to include terms specifying the content of reviews, allowing physical audits of joint development work, and requiring reviews of all firms in the deal (rather than just one firm). Furthermore, these contracts are also more likely to include financial penalties, to specify persons for management of the development work and to detail the technologies to be contributed to the joint work. Thus, contracts between firms with repeat dealings (either with each other or with other firms) have more detailed contracts and are more likely to include monitoring and penalty clauses.

[11] Note that we use "repeated interactions" to refer to the theoretical concept of expected future interactions with a firm or group of firms, and "repeated deals" to refer to the empirical proxy in our discussion below.

Although these patterns are interesting, it is difficult to assess whether they are related to the existence of a prior relationship between the firms or other characteristics of the development task (e.g., whether the task represents next-generation technology development or not). Thus, we estimate several simple regressions to better assess the effect of repeated deals on the inclusion of particular contract terms by attempting to control for alternative sources of heterogeneity. We examine several measures, including the number of terms within each of the three broad categories of variance (detail, monitoring, and penalties) and rough classifications based on a threshold number of clauses included in a contract within these groups.

Measures of a firm's prior dealings, both with the same partner as in the contract examined as well as with other firms, are used as independent variables. We note that both the sociology (e.g., Gulati 1995) and economics (e.g., Banerjee and Duflo 2000) literatures use prior deals to measure the presence of relational mechanisms. This is despite the fact that the notion underlying the relational mechanisms differs between the two disciplines: sociologists emphasize

Table 5   Contract Term Frequency and Cross-Frequency

	Frequency (n = 52)		1. Development specifications		2. Time frame		3. Number of employees		4. Manager specified		5. Technology contributions		6. IPR specified	
Contract detail														
1. Development output specifications (such as tolerances) included	22	42.3%			17	32.7%	4	7.7%	8	15.4%	12	23.1%	8	15.4%
2. Time frame for completion of each stage specified	27	51.9%	17	32.7%			6	11.5%	7	13.5%	15	28.8%	8	15.4%
3. Number of employees to be contributed specified	8	15.4%	4	7.7%	6	11.5%			3	5.8%	4	7.7%	3	5.8%
4. Specific persons stipulated for management or other development work	14	26.9%	8	15.4%	7	13.5%	3	5.8%			4	7.7%	5	9.6%
5. Specific technologies to be contributed described	23	44.2%	12	23.1%	15	28.8%	4	7.7%	4	7.7%			7	13.5%
6. Intellectual property rights defined over specific technologies	17	32.7%	8	15.4%	8	15.4%	3	5.8%	5	9.6%	7	13.5%		
Monitoring														
7. Reviews of development work required	24	46.2%	11	21.2%	15	28.8%	3	5.8%	9	17.3%	9	17.3%	10	19.2%
8. Reviews of outcome only required	11	21.2%	3	5.8%	6	11.5%	0	0.0%	1	1.9%	5	9.6%	6	11.5%
9. Discretionary reviews available	8	15.4%	4	7.7%	5	9.6%	1	1.9%	1	1.9%	6	11.5%	2	3.8%
10. Timing of reviews specified	15	28.8%	8	15.4%	10	19.2%	3	5.8%	7	13.5%	7	13.5%	3	5.8%
11. Content of reviews specified	8	15.4%	6	11.5%	7	13.5%	3	5.8%	4	7.7%	7	13.5%	2	3.8%
12. Physical audits of development work permitted	14	26.9%	8	15.4%	11	21.2%	1	1.9%	3	5.8%	10	19.2%	3	5.8%
13. Reviews required of both (all) firms	13	25.0%	8	15.4%	10	19.2%	3	5.8%	3	5.8%	10	19.2%	3	5.8%
Penalties														
14. Financial penalties for underperformance	6	11.5%	4	7.7%	5	9.6%	1	1.9%	1	1.9%	5	9.6%	1	1.9%
15. Right to terminate for underperformance (distinct from "material breach")	17	32.7%	10	19.2%	13	25.0%	5	9.6%	4	7.7%	10	19.2%	5	9.6%

the development of trust or embeddedness from prior interactions that facilitates smoother collaborations in the future (Granovetter 1985, Gulati 1995, Uzzi 1997); economists emphasize the anticipation of valuable future interactions in ensuring cooperation in the present setting (Radner 1986, Fudenberg et al. 1994). Ideally, we would like to distinguish these two mechanisms to isolate their effects. Unfortunately, we lack a precise means to do so given the historical nature of our data. Prior deals are an imperfect measure for both approaches, capturing all prior deals whether positive or not (and therefore not necessarily facilitating trust development) and failing to perfectly capture the expectation of future dealings.

We do, however, distinguish between prior and contemporaneous deals with the same partner based on the starting date for the contract. This allows us to relate our results to economic theories on the use of formal enforcement mechanisms when relational mechanisms are also available; contemporaneous deals may be a better proxy for expectations of future interactions with a specific firm than prior deals (because they are ongoing at the time the sample contract was signed). Thus, we use three proxies for repeated interactions: (1) prior deals with the same

partner firm as in the sample contract, (2) contemporaneous deals with the same firm as in the sample contract, and (3) prior or contemporaneous deals with other firms. We include prior deals with other firms to explore the role of relational mechanisms that may operate via expectations of future deals with any partner (i.e., reputation), rather than future interactions with specific partners (Kreps 1990). The unit of analysis is the sample contract.

We create two dummy variables, *prior deals* and *concurrent deals*, which equal one if there are prior or contemporaneous deals, respectively, between the firms in the sample contract. Ten contracts in the sample have prior or concurrent deals with the same partner. Seven firms that we collected SEC filings for are responsible for these ten contracts. Eight of the ten contracts with prior or concurrent deals with the same partner involve unique pairs of firms. Thus, there are two contracts in this group involving the same pair of firms.

To capture prior deals with other firms, we create an ordered ranking based on the average number of prior deals by partners in the five years prior to the contract date. The distribution of prior deals among firms in our sample is skewed. Most firms have no prior deals (43.6% of sample firms). The next largest group has only one prior deal (14.10%), and

Table 5   (Continued)

	Monitoring							Penalties	
	7. Review required	8. Outcome only	9. Discretionary reviews	10. Timing of reviews	11. Content of reviews	12. Physical audits	13. Reviews for all firms	14. Financial penalties	15. Termination penalties
Contract detail									
1. Development output specifications (such as tolerances) included	11 21.2%	3 5.8%	4 7.7%	8 15.4%	6 11.5%	8 15.4%	8 15.4%	4 7.7%	10 19.2%
2. Time frame for completion of each stage specified	15 28.8%	6 11.5%	5 9.6%	10 19.2%	7 13.5%	11 21.2%	10 19.2%	5 9.6%	13 25.0%
3. Number of employees to be contributed specified	3 5.8%	0 0.0%	1 1.9%	3 5.8%	3 5.8%	1 1.9%	3 5.8%	1 1.9%	5 9.6%
4. Specific persons stipulated for management or other development work	9 17.3%	1 1.9%	1 1.9%	7 13.5%	4 7.7%	3 5.8%	3 5.8%	1 1.9%	4 7.7%
5. Specific technologies to be contributed described	9 17.3%	5 9.6%	6 11.5%	7 13.5%	7 13.5%	10 19.2%	10 19.2%	5 9.6%	10 19.2%
6. Intellectual property rights defined over specific technologies	10 19.2%	6 11.5%	2 3.8%	3 5.8%	2 3.8%	3 5.8%	3 5.8%	1 1.9%	5 9.6%
Monitoring									
7. Reviews of development work required		5 9.6%	1 1.9%	15 28.8%	6 11.5%	6 11.5%	10 19.2%	2 3.8%	6 11.5%
8. Reviews of outcome only required	5 9.6%		0 0.0%	0 0.0%	1 1.9%	1 1.9%	2 3.8%	1 1.9%	4 7.7%
9. Discretionary reviews available	1 1.9%	0 0.0%		0 0.0%	1 1.9%	7 13.5%	1 1.9%	3 5.8%	4 7.7%
10. Timing of reviews specified	15 28.8%	0 0.0%	0 0.0%		6 11.5%	5 9.6%	8 15.4%	2 3.8%	4 7.7%
11. Content of reviews specified	6 11.5%	1 1.9%	1 1.9%	6 11.5%		4 7.7%	4 7.7%	3 5.8%	3 5.8%
12. Physical audits of development work permitted	6 11.5%	1 1.9%	7 13.5%	5 9.6%	4 7.7%		5 9.6%	5 9.6%	6 11.5%
13. Reviews required of both (all) firms	10 19.2%	2 3.8%	1 1.9%	8 15.4%	4 7.7%	5 9.6%		3 5.8%	7 13.5%
Penalties									
14. Financial penalties for underperformance	2 3.8%	1 1.9%	3 5.8%	2 3.8%	3 5.8%	5 9.6%	3 5.8%		2 3.8%
15. Right to terminate for underperformance (distinct from "material breach")	6 11.5%	4 7.7%	4 7.7%	4 7.7%	3 5.8%	6 11.5%	7 13.5%	2 3.8%	

less than 35.9% of sample firms have more than two prior deals. Approximately 23% of sample firms have more than ten prior deals. Given this distribution, we use an ordered ranking to reflect that the difference between one and two prior deals is likely greater than the difference between seven and eight prior deals. "*Prior deal experience*" = 0 if neither partner has any prior deals, 1 if the partners, on average, have one to ten prior deals, and 2 if the partners, on average, have greater than ten prior deals.[12]

In addition to the influence of relational mechanisms, there are several other factors that we expect affect the ease of crafting detailed contracts. Generally, items that increase the uncertainty or complexity associated with a joint project should affect the level of contract detail, monitoring, and penalty provisions, albeit in ambiguous ways. We identify four elements that likely increase the deal's uncertainty and/or complexity: (1) technology breadth, (2) long project or contract duration, (3) manufacturing and/or marketing activities in addition to joint development, (4) cross-border coordination between partners (i.e., an international deal).

To see why these factors have ambiguous effects, consider the specification of development steps and completion times. The marginal cost of specifying an additional step is likely to be higher under conditions of greater complexity. However, greater complexity may also imply a higher marginal benefit to specifying an additional step because firms may have more project-critical contingencies to consider. The effect of complexity on penalties is similarly unclear. Penalties may be less likely under conditions of ambiguity because a penalty may be triggered by poorly assessed contingencies that are unrelated to firm efforts. The converse is also possible, because firms are more likely to attempt to define their own penalties for

[12] Given the strong correlation between *prior deals, concurrent deals*, and *prior deal experience*, we reestimated Tables 7–9 combining all three into a single variable as a robustness check. The results are substantively identical to those presented in Tables 7–9, with the effect of the combined deal variable being very similar both in sign and significance to the *prior deal experience* variable.

Table 6   Contract Term Frequency by Group

	(A) Full sample (*n* = 52)		(B) No repeat deals (*n* = 10)		(C) Repeat deals, same partner (*n* = 10)		(D) Repeat deals, different partners (*n* = 42)	
Contract detail								
1. Development output specifications (such as tolerances) included	22	42.3%	2	20.0%*	4	40.0%	20	47.6%*
2. Time frame for completion of each stage specified	27	51.9%	4	40.0%	4	40.0%	23	54.8%
3. Number of employees to be contributed specified	8	15.4%	2	20.0%	2	20.0%	6	14.3%
4. Specific persons stipulated for management or other development work	14	26.9%	1	10.0%*	1	10.0%*	13	31.0%*
5. Specific technologies to be contributed described	23	44.2%	2	20.0%*	5	50.0%	21	50.0%*
6. Intellectual property rights defined over specific technologies	17	32.7%	3	30.0%	2	20.0%	14	33.3%
Monitoring								
7. Reviews of development work required	24	46.2%	4	40.0%	4	40.0%	20	47.6%
8. Reviews of outcome only required	11	21.2%	3	30.0%	1	10.0%	8	19.0%
9. Discretionary reviews available	8	15.4%	1	10.0%	2	20.0%	7	16.7%
10. Timing of reviews specified	15	28.8%	2	20.0%	3	30.0%	13	31.0%
11. Content of reviews specified	8	15.4%	0	0.0%***	2	20.0%	8	19.0%***
12. Physical audits of development work permitted	14	26.9%	1	10.0%*	3	30.0%	13	31.0%*
13. Reviews required of both (all) firms	13	25.0%	0	0.0%***	5	50.0%*	13	31.0%***
Penalties								
14. Financial penalties for underperformance	6	11.5%	0	0.0%***	2	20.0%	6	14.3%***
15. Right to terminate for underperformance (distinct from "material breach")	17	32.7%	3	30.0%	5	50.0%	14	33.3%

Notes. Contract term frequencies according to whether and what kind of repeat deals exist are shown. Mean difference tests are calculated between the group and its complement. For example, the complement group for (B) is the group of observations with repeat deals of some kind, whether with the same partner or not. Term frequency differs between groups at the ***1%, **5%, and *10% levels.

underperformance when deals are characterized by greater uncertainty, (i.e., given the difficulties of court assessment under these circumstances).

The four sources of uncertainty/complexity described above are measured as follows. *Technology breadth* = 1 if the development is next generation, involving radical changes to existing technology, and 0 if projects are incremental changes to existing technologies. Contract duration is taken from the agreement termination clauses; *long-term deal* = 1 if the joint development activity is expected to last more than one year, 0 otherwise. Approximately one-half of the deals in our sample (46%) operate for one year or less. We set *manufacturing/marketing* = 1 if the deal involves joint manufacturing or marketing in addition to the joint development activities, 0 otherwise. Finally, *cross-border* = 1 if the deal involves firms from different countries, 0 otherwise.

We first estimate the relationship between contract detail and repeated deals in Table 7. Six specifications are estimated: three using an ordered probit based on the number of "detail" clauses a contract contains (zero to six) and three using a simple probit based on a dummy ranking (set to one if the contract contains three or more of the relevant clauses, zero otherwise).[13] Columns 1 and 4 include the prior deal measures and controls discussed above. Columns 2

and 5 add a dummy to capture equity holdings between partners, which equals one if there is any type of equity holding between the partners (whether minority, majority, or cross-equity holdings), zero otherwise. This variable is intended to control for the possibility that partners with equity holdings have alternative means of control and incentive alignment and, possibly, a reduced need for more detailed contracts. Note that our *equity holding* measure does not capture whether a joint venture was formed in the contract, but focuses exclusively on whether partners have some sort of ownership in each other.[14]

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particular manager and firm technology contributions for the joint development project. The equivalence of these contracts may or may not be accurate. At this stage, a defensible means and justification to allocate weights to each of the clauses is not apparent, and we default to an equal weighting of the clauses.

[14] We note that six of our contracts involve joint venture formation (as set out in Table 2). As a robustness check, we reestimate Tables 7–9 with either a joint venture dummy variable or by dropping the joint venture contracts from the sample. It appears that joint venture contracts are less detailed and less likely to contain monitoring or penalty clauses than non-joint venture contracts. This is consistent with what we might expect from Oxley (1997) and Sampson (2004); selecting a more hierarchical form of organization relieves parties from the full contractual specification of rights and obligations, because a characteristic of these more hierarchical forms (i.e., those forms closer to organization within the firm) is more efficient adaptability to unforeseen circumstances (from a joint perspective). The results from this estimation are not reported here in the interest of brevity, but yield substantially the same results as those reported below.

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[13] A limitation of this approach is that it allocates equal weight across the clauses. Thus, for example, partners specifying detailed development steps and the timing for these steps will be coded as having a contract that is similarly detailed to partners specifying a

Table 7   Contractual Detail and Repeated Deals

	Ordered probit, Detail = 0 to 6			Simple probit, Detail = 0, 1		
	(1)	(2)	(3)	(4)	(5)	(6)
Prior deals (partner specific)	1.417	1.608**	1.072*	1.290*	1.781*	1.270**
	(0.875)	(0.660)	(0.569)	(0.698)	(0.587)	(0.645)
Concurrent deals (partner specific)	−1.267**	−1.002	−0.937	−1.425**	−1.649***	−1.594***
	(0.630)	(0.719)	(0.689)	(0.596)	(0.630)	(0.617)
Prior deal experience (any partner)	0.442**	0.552***	0.359*	0.733**	0.883***	0.634**
	(0.183)	(0.202)	(0.192)	(0.307)	(0.318)	(0.282)
Technology breadth (=1 if "next generation," 0 otherwise)	0.050	0.002	0.139	−0.820*	−0.928*	−0.741
	(0.304)	(0.326)	(0.340)	(0.437)	(0.548)	(0.565)
Long-term deal (=1 if >1 year, 0 otherwise)	−0.097	−0.308	−0.300	−0.486	−0.705	−0.760
	(0.354)	(0.388)	(0.404)	(0.426)	(0.500)	(0.523)
Manufacturing and/or marketing	−0.098	0.066	−0.053	0.027	0.275	0.128
	(0.322)	(0.333)	(0.323)	(0.435)	(0.431)	(0.435)
Cross-border deal	0.194	0.199	0.173	0.900*	1.063*	1.038*
	(0.329)	(0.327)	(0.340)	(0.490)	(0.532)	(0.532)
Equity holding		−1.191**	−0.969*		−1.177*	−0.918
		(0.497)	(0.497)		(0.604)	(0.633)
R&D spending			2.637***			2.218
			(0.909)			(1.420)
Constant				−1.244**	−1.204*	−1.105*
				(0.576)	(0.657)	(0.630)
n	52	52	49	52	52	49
Log likelihood	−81.16	−75.98	−69.59	−24.07	−21.66	−20.15
Chi-square	10.47	26.30***	35.37***	24.68***	36.52***	42.13***
d.o.f.	7	8	9	7	8	9

Notes. Ordered probit and probit models of the effect of prior deals on the level of contract detail are shown. Columns (1)–(3) use an ordered ranking of a contract's detail based on how many of the six clauses the contract contains (i.e., *detail* = 0 if no detail clauses, 1 if 1 clause, 2 if 2 clauses, etc.). Columns (4)–(6) use a dummy ranking of a contract's detail (i.e., *detail* = 1 if the contract contains three or more detail clauses, zero otherwise). d.o.f., Degrees of freedom.

   *, **, ***Significant at the 10%, 5%, and 1% levels, respectively, for two-tailed tests. Standard errors are in parentheses.

Finally, columns 3 and 6 add a scaled measure for R&D spending by the partner firms. R&D spending proxies for firm size and the size of a firm's R&D program, which likely influences the extent of resources available to the firm for such joint R&D projects, such as in-house counsel. The marginal cost of drafting a more detailed contract is likely less for firms with in-house legal departments than for firms without such resources. These firms (i.e., those with greater resources and larger R&D programs) are more likely to have greater experience with technology development projects and may be more influential in the contract drafting process. We report scaled R&D spending (i.e., divided by 10,000) for the partner with the largest R&D expense in the deal in the year prior to the contract date, because it is likely the maximum size of any partner's R&D program (rather than the average among partners) that drives the marginal cost of additional details or provisions in a deal contract.

We also control for the fact that some firms have more than one contract in the sample. Contracts that involve the same firms, even if all partners are not the same, may not be independent. Firms may use a similar contract structure in their deals with different partners (as noted above). We correct for this possible lack of independence by clustering observations by firm for the purposes of calculating standard errors (Huber 1967). If a contract can be assigned to more than one firm group (i.e., because both partner firms have multiple contracts in the sample), then the contract is assigned to the firm with the greater number of contracts in the sample for the purposes of correcting standard errors. Fixed effects are not used, because most of our firms are involved only in one contract.

Across specifications, two patterns emerge. First, prior deals with the same partner as in the sample contract appear to be correlated with more detailed contracts.[15] The probability of a more detailed contract increases by 48% if firms in the current deal

[15] Parameter estimates are less significant for the effect of prior deals with the same partner than for the effect of prior deals with any firm. However, given the small number of observations and the fact that these estimates are on the margin of significance for a two-tailed test, this lowered significance may be explained by the lack

have a prior deal with the same partner.[16] Interestingly, concurrent deals decrease the probability of a more detailed contract by 33%. Prior deals (i.e., with any partner, excluding the firm(s) in the sample contract) are positively correlated with the detail of joint development contracts; this result is consistent across specifications. The likelihood of a more detailed contract is increased by 24% when firms have prior deals with any partner other than the partner in the sample contract.

These results contrast with those obtained in other studies. For example, Argyres et al. (2007) do not find a significant relationship between task description (similar to elements of our contract detail) and prior relationships with a specific partner. Robinson and Stuart (2007) find that greater centrality (i.e., a weighted measure of prior deals with any partner) significantly lowers the probability that employment provisions are included in the contract. These employment provisions, where the number and quality of research personnel are specified, are similar to elements of our contract detail.

Control variables suggest that the effects of deal complexity on contract detail depend on the source of the added complexity. Equity holdings between partners appear to be correlated with less detailed contracts, whereas cross-border deals and partners with relatively larger R&D programs tend to include more details in their deal contracts. These control variables, however, are not consistently significant across specifications.

Next-generation projects are less likely to be governed by detailed contracts. This appears to be consistent with Kalnins and Mayer (2004), who find that, as project complexity increases, firms are less likely to use high-powered incentives that require greater efforts to spell out details in advance. Our finding may also reflect technology life-cycle effects in the sense that, as technologies mature, detailed

contract specification may become easier. The negative and significant coefficient on *technology breadth* is consistent with this effect. Unfortunately, we lack adequately detailed information on the deal technologies to more precisely estimate the effect of maturing technology on contract structure. However, we ran a robustness check adding year dummies to Tables 7–9 to see whether there is an effect of maturing technology that is industry wide. Although these year controls do not capture the maturity of the underlying technology in specific deals, they will capture overall industry maturity to the extent that there are some homogenous factors affecting all of the underlying technologies in the industry. These year controls are positive and significant in some specifications in later years, suggesting that technology maturity may lead to greater contract detail and inclusion of penalty clauses. (There is no effect of year controls on monitoring.) Results on our main variables (i.e., *prior deals concurrent deals*, and *prior deal experience*) remain largely unchanged.

To investigate whether repeated deals are correlated with monitoring and penalty provisions, we repeat the analysis above with monitoring and penalties as dependent variables in Tables 8 and 9, respectively. *Monitor* is constructed both as an ordered variable (0 to 5), based on the number of possible monitoring clauses included in a contract, and a binary variable, taking the value of 1 if the contract contains three or more monitoring clauses, 0 otherwise. Similarly, *penalty* is an ordered variable (0 to 2) based on the number of penalties included in the contract as well as a binary variable (1 if the contract includes any penalty clauses, 0 otherwise).

The effects of prior and concurrent deals on the probability that the contract includes monitoring provisions are not statistically significant, with the exception of prior deal experience with any partner in specifications (4) and (5). Firms having prior deals with any partner are 11% more likely to include monitoring provisions in their current deals.[17] No other variables are significantly correlated with monitoring provisions. In contrast, prior deals are highly correlated with the inclusion of penalty clauses. Prior deal experience with any partner increases the probability that penalty clauses are included in the sample contract by 25%. Similarly, prior deals with a specific partner increase the likelihood that penalty provisions are included in the sample contract by 51%.[18]

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of power in the test. Lowered significance may also arise out of the use of asymptotic results to compute the standard errors in maximum likelihood estimation; conventional significance levels may be too restrictive, because the asymptotic calculation of standard errors does not take into account the greater variability inherent in small samples. Given the small number of observations, the magnitude of the effects is quite large. Furthermore, the marginal effects of these results, which are discussed below, are highly significant. Thanks to Bill Greene for helpful comments on this point.

[16] Marginal effects for Table 7 are reported on specifications (4)–(6) and represent the change in probability that a contract is more detailed given a categorical change in the independent variable discussed (i.e., the independent variable changes from zero to one). The marginal effects discussed are consistent across specifications (4)–(6) and are statistically significant at the 0.01 level. Because marginal effects are calculated as a function of all coefficients, it is possible for marginal effects to be significant even while some coefficient estimates are not.

[17] This marginal effect is calculated for specifications (4) and (5) from Table 8.

[18] The marginal effects discussed here are calculated based on the probit estimates in Table 9, columns (4)–(6), and are statistically significant at the 0.05 level. Note that although the parameter estimates for prior deals with a specific partner are not statistically

Table 8   Monitoring and Repeated Deals

	Ordered probit, Monitor = 0 to 5			Simple probit, Monitor = 0, 1		
	(1)	(2)	(3)	(4)	(5)	(6)
Prior deals (partner specific)	−0.112	−0.120	−0.609	0.000	0.005	−0.168
	(0.654)	(0.658)	(0.688)	(0.542)	(0.538)	(0.659)
Concurrent deals (partner specific)	0.348	0.432	0.422	1.041	1.095	1.045
	(0.546)	(0.671)	(0.657)	(0.670)	(0.774)	(0.784)
Prior deal experience (any partner)	0.278	0.287	0.124	0.419**	0.427**	0.346
	(0.188)	(0.189)	(0.248)	(0.212)	(0.205)	(0.221)
Technology breadth	0.564	0.554	0.559	0.352	0.337	0.396
(=1 if "next generation," 0 otherwise)	(0.345)	(0.345)	(0.351)	(0.419)	(0.411)	(0.411)
Long-term deal	0.156	0.120	0.275	0.508	0.500	0.552
(=1 if >1 year, 0 otherwise)	(0.378)	(0.420)	(0.439)	(0.469)	(0.487)	(0.497)
Manufacturing and/or marketing	0.177	0.204	0.230	0.065	0.088	0.119
	(0.308)	(0.304)	(0.311)	(0.422)	(0.411)	(0.417)
Cross-border deal	−0.202	−0.204	−0.160	−0.772	−0.768	−0.677
	(0.351)	(0.349)	(0.353)	(0.511)	(0.509)	(0.510)
Equity holding		−0.200	−0.057		−0.141	−0.110
		(0.471)	(0.474)		(0.570)	(0.589)
R&D spending			2.260			0.755
			(1.432)			(1.599)
Constant				−1.560**	−1.541**	−1.582**
				(0.629)	(0.668)	(0.682)
n	52	52	49	52	52	49
Log likelihood	−77.51	−77.36	−72.44	−22.90	−22.86	−22.35
Chi-square	7.18	7.77	11.97	9.60	9.56	7.78
d.o.f.	7	8	9	7	8	9

Notes. Ordered probit and probit models of the effect of prior deals on inclusion of monitoring clauses are shown. Columns (1)–(3) use an ordered ranking of monitoring clauses in a contract based on how many of the five clauses the contract contains (i.e., *monitor* = 0 if no monitoring clauses, 1 if 1 clause, 2 if 2 clauses, etc.). Columns (4)–(6) use a dummy ranking of a contract's monitoring clauses (i.e., *monitor* = 1 if the contract contains three or more monitoring clauses, zero otherwise). d.o.f., Degrees of freedom.

    *, **, ***Significant at the 10%, 5%, and 1% levels, respectively, for two-tailed tests. Standard errors are in parentheses.

Further investigation of the data suggests that the firms including penalty clauses in their contracts are those with a greater number of prior deals. For example, 85% of the contracts with penalty clauses are written by firms with prior deals and 57% of the contracts with penalty clauses involve firms with extensive prior deals (i.e., greater than ten prior deals). Of the 21 contracts with penalty clauses, 8 have bilateral penalties (i.e., where either party may exercise the penalty), and 13 have unilateral penalties (i.e., where only one party to the contract may exercise the penalty). In the case of these unilateral penalty clauses, the party penalized is usually the party with fewer prior deals. Penalty clauses also seem to be correlated with vertical agreements; most deals with unilateral penalties involve more vertical development arrangements, where one firm is developing a technology at the direction and often with the funding of the other firm.

Of the control variables, only one is consistently significant. Next-generation development projects are characterized by fewer penalty clauses; the probability of including penalties in the deal contract decreases by 34% when the technology developed is next generation or a radical change over existing technology. In specifications (4)–(6), cross-border deals appear to decrease the probability of penalties; assessing contingencies that would trigger a penalty is likely difficult when the distance between partners is great.

As a robustness check, we also estimate contract detail, monitoring, and penalties as a seemingly unrelated set of equations, which allows for contemporaneous correlation among the error terms across equations. Controlling for this correlation may be important if the same set of latent variables affects whether firms include contract detail, monitoring, and penalty clauses. Results from this estimation are very similar to those reported in Tables 7–9 and are available on request.

Before proceeding to the next section, in which we contrast these empirical findings against the relevant

significant in specifications (4)–(6), the marginal effects are highly significant, both statistically and in terms of magnitude. See Footnote 15 for more detail on significant marginal effects when coefficient estimates are insignificant.

Table 9   Penalties and Repeated Deals

	Ordered probit, Penalty = 0 to 2			Simple probit, Penalty = 0, 1		
	(1)	(2)	(3)	(4)	(5)	(6)
Prior deals (partner specific)	1.354**	1.361**	1.031*	1.428	1.451	1.219
	(0.599)	(0.587)	(0.566)	(0.920)	(0.944)	(0.877)
Concurrent deals (partner specific)	−0.095	−0.176	−0.232	−0.094	−0.126	−0.175
	(0.550)	(0.564)	(0.564)	(0.630)	(0.668)	(0.664)
Prior deal experience (any partner)	0.728**	0.707**	0.583*	0.666**	0.659**	0.586**
	(0.321)	(0.313)	(0.303)	(0.317)	(0.312)	(0.315)
Technology breadth	−1.041***	−1.017***	−0.985***	−0.972**	−0.966**	−0.929**
(=1 if "next generation," 0 otherwise)	(0.327)	(0.315)	(0.334)	(0.397)	(0.393)	(0.406)
Long-term deal	0.020	0.038	0.146	0.151	0.160	0.238
(=1 if >1 year, 0 otherwise)	(0.381)	(0.385)	(0.402)	(0.445)	(0.446)	(0.473)
Manufacturing and/or marketing	0.532	0.481	0.482	0.550	0.534	0.577
	(0.410)	(0.425)	(0.426)	(0.446)	(0.455)	(0.452)
Cross-border deal	−0.692	−0.702	−0.619	−0.963*	−0.965**	−0.857*
	(0.427)	(0.428)	(0.429)	(0.439)	(0.442)	(0.453)
Equity holding		0.259	0.377		0.076	0.088
		(0.442)	(0.500)		(0.494)	(0.504)
R&D spending			1.630			0.840
			(1.717)			(1.762)
Constant				−0.711	−0.718	−0.790
				(0.580)	(0.567)	(0.567)
n	52	52	49	52	52	49
Log likelihood	−32.72	−32.53	−31.39	−26.78	−22.86	−25.98
Chi-square	19.73***	19.18**	16.19*	12.81*	9.56	11.79
d.o.f.	7	8	9	7	8	9

Notes. Ordered probit and probit models of the effect of prior deals on inclusion of penalty clauses are shown. Columns (1)–(3) use an ordered ranking of penalty clauses in a contract based on how many of the two clauses the contract contains (i.e., *penalty* = 0 if no penalty clauses, 1 if 1 clause, 2 if 2 clauses). Columns (4)–(6) use a dummy ranking of contract penalties (i.e., *penalty* = 1 if the contract contains one or more penalty clauses, zero otherwise). d.o.f., Degrees of freedom.

  *, **, ***Significant at the 10%, 5%, and 1% levels, respectively, for two-tailed tests. Standard errors are in parentheses.

theories, it is worth considering how empirical measurement of the link between formal and relational mechanisms might be strengthened in future work. For one thing, data on *revisions* to the contracts associated with specific deals would provide a sharper distinction between terms arising from experience and those included in anticipation of future dealings. For example, our result that the likelihood of monitoring clauses increases under repeated dealings is consistent both with learning that these clauses are useful per se as well as knowing that they are needed in later periods of waning relational effectiveness (i.e., when relationships are ongoing for a finite period). Evidence that such clauses appear later in an ongoing relationship seems to favor the learning explanation. Information on the network structure that the firms are a part of could also yield deeper insights. For example, we might then discover more precisely how the availability of indirect relational mechanisms influences contract structure. Finally, to rule out other

competing explanations, such as technological maturity (i.e., more mature technology makes a more detailed contract easier to specify), information on the specific technologies covered in each deal and the relative maturity of these technologies is required. This type of information may be more available in the single-firm type studies similar to Mayer and Argyres (2004).

4. Discussion
To discuss the broader implications of our work relative to the present state of understanding on this topic, we link our findings to a number of related papers—both theoretical and empirical—that span two, often disparate, literatures. We organize our discussion around what we judge to be a few of our more interesting findings and take these findings at face value, because the empirical issues concerning the significance and validity of our analysis are discussed in detail above.

As a starting point, consider our finding that the probability of a more detailed contract increases with prior deals. This effect is greater when the contracting parties have had prior experience with each other than when their earlier dealings were with others (i.e., exclusive of the current partner). The conventional explanation for this is learning by doing: as a firm learns, its ability to write more complete contracts for similar projects improves. If experience with a given partner is more valuable for future deals with that same partner, then this logic may also explain why the likelihood of more detail is greater when firms' prior experiences are with each other.

This argument appears consistent with related findings in the management literature. For example, survey evidence from Poppo and Zenger (2002), in the context of data entry outsourcing relationships, shows that prior relationships between firms lead to more detailed or customized contracts. Thus, Poppo and Zenger (2002) argue that prior relationships allow parties to learn more about each other and draft more complete, customized contracts. Mayer and Argyres (2004) find that firms add terms as unforeseen issues or contingencies arise, which supports the learning explanation. Simiarly, Argyres et al. (2007) demonstrate that a more extensive relationship history leads to greater efforts at contingency planning in the contracting process.

Surely, learning by doing influences the evolution of contract design, particularly in these complex project domains. Yet, examining the fine details of our results raises some puzzles that are not neatly explained by this rationale. Moreover, although certain alternative, formal theories appear to offer important, supplemental insights, they do not provide a complete explanation for our results. Let us elaborate.

We find that greater experience implies a greater likelihood of partners including more terms in their contracts (as noted above). However, although we find that *overall* contract detail appears to be greater in the presence of repeated deals, the learning-by-doing rationale does not offer precise guidance on the inclusion of specific terms. For example, Table 6 reveals that the likelihood of output specifications increases under repeated deals with the same partner, but the likelihood of those allocating intellectual property rights over specific technologies actually *decreases*. This latter effect is consistent with prior research showing that formal mechanisms are less likely with repeated deals (e.g., Gulati 1995).

If learning is the driving force behind these contradictory effects, the implication is that contractual effectiveness is not simply increasing in contract detail. This view is supported by various theoretical findings. For example, Holmstrom and Milgrom (1987) find that the optimal contract in a complex environment involves only linear terms. Levin (2003) demonstrates, for a very general class of agency settings, that the optimal contract in a dynamic relationship is stationary, with a fixed wage and unenforceable, performance-contingent bonus. In other words, learning may cause parties to write more effective, less detailed contracts. Unfortunately, the available theory is not sufficiently specific to be applied at the level of our data (i.e., inclusion of specific terms), thereby making it difficult to distinguish learning from other (e.g., relational) effects.

Momentarily setting aside situations in which efficient contracts are simple, suppose partners experience an unforeseen event with significant, unanticipated consequences for performance. How does this affect their next round of contracting? For example, our finding of a positive correlation between the likelihood of a timing clause and repeat deals may be simply due to the fact that, sometimes, firms discover that timing is important and, as a result, add an appropriate term in later contracts. However, from a learning perspective, the "unforeseen" event should cause firms to update their beliefs—presumably with some events viewed as less likely than before. If so, it should not be surprising to find some of the original terms reassessed as unnecessary and dropped. Unfortunately again, how agents react to unforeseen events is an open theoretical question, the answer to which is central to conclusions regarding the relationship between experience and contract detail.

Other questions arise when we realize that "experience" in a deal is actually some composite of the experiences of two or more firms. What happens to contractual form when firms have significantly different levels of experience? We find that an experienced firm dealing with a new partner is 24% more likely to have a more detailed contract. This is substantially lower than the 48% increase when firms have prior dealings with each other. It seems plausible that, faced with a more experienced partner, an inexperienced firm might compensate for the information asymmetry through the design of the contract—but how? Might inexperienced firms attempt to "insure" against poorly understood downsides with overly detailed contracts? At issue is how information asymmetries affect contract detail; we are not aware of any theoretical results on this specific topic.

This brings us to the central themes in economics on the interaction between relational and formal mechanisms. The earliest work in this line demonstrates the ways in which relational mechanisms substitute for formal ones in the attainment of efficient outcomes. Today, we know that the interplay between formal and relational mechanisms is subtle. The two can act as complements in the sense that efficiency is sometimes only attainable using mechanisms of

both types.[19] Conversely, formal and relational mechanisms can inhibit one another such that efficiency is unattainable when both mechanisms are available; in such settings, restraining access to one mechanism or the other is more effective.

Thus, the anticipated effect of repeated interaction on contract form is ambiguous, even when learning by doing works according to the conventional wisdom.[20] For example, substitution effects are consistent with our finding that the likelihood of formal property rights specification is less under repeated interaction with the same partner than in one-off deals. In one-off deals, it may be that the formal specification creates a credible punishment option for noncompliance via established legal institutions, whereas in the repeated situation, informal punishments (e.g., terminating the relationship altogether) may be equally if not more effective performance inducements. This substitution effect is consistent with the empirical results of Gulati (1995), Gulati and Singh (1998), and Uzzi (1997), who find that firms with prior ties are less likely to choose more hierarchical controls for their collaborative activities, suggesting that prior ties may alleviate concerns of opportunism.

In contrast, our finding of overall contract detail increasing with repeated interaction is consistent with work demonstrating complementarities between relational and formal mechanisms. Bull (1987) and MacLeod and Malcomson (1993) are among the first to study settings in which agents rely on formal *and* relational inducements to achieve outcomes that are impossible using one or the other exclusively. Baker et al. (1994) show that certain formal contracts cannot be sustained without a supporting relational mechanism. This suggests that the type of project a firm places under formal governance may evolve as its reputational capital increases over time: a project guarded in-house due to its importance in maintaining a firm's competitive advantage may be viable for collaboration once the firm's partner establishes a reputation for honoring confidentiality agreements. At the same time, once such projects do move into the realm of outside collaboration, they may yet require stringent formal controls. Thus, as reputational mechanisms become available, we may observe a shift in the project mix to those requiring more detailed formal contracts.[21]

Substitution and complementarities are not the whole story, however. As Bernheim and Whinston (1998) demonstrate, tightening up the formal contract has two offsetting effects upon overall efficiency when relational mechanisms are also at play: (1) the (obvious) positive effect of limiting noncompliance due to the addition of refined legal punishment options, and (2) the (less obvious) negative effect of reducing the efficacy of relational enforcement due to the implicit constraints on informal punishment options introduced by more restrictive formal terms.[22] Following this line of reasoning, Kvaloy and Olsen (2005) develop a model in which degree of verifiability is a choice variable, the equilibrium value of which depends on trade-offs between the cost of verification and the benefit of improved compliance over relational mechanisms alone. The closest empirical studies on the issue of verifiability and contract design examine the choice between fixed-price and cost-plus contracts; both Kalnins and Mayer (2004) and Corts and Singh (2004) argue that as verifiability becomes more difficult, cost-plus contracts become more attractive. Both studies find that difficulties with verifiability lead to less restrictive formal terms. This brings our discussion of contract detail full circle because the "cost of verification" is, presumably, affected by experiential learning, reputation, issues of trust, communication, properly aligned expectations, etc.

Our finding that termination rights for underperformance are more likely in repeated settings is significant, counterintuitive, and worthy of further discussion.[23] Although this result parallels those for other types of contract detail, penalty clauses are special in the sense that their inclusion seems difficult to interpret as stemming from anything other than their role in formal enforcement. Yet, as MacLeod (2006,

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[19] Note our discussion at the start of this section of the relevant empirical work suggesting complementary effects, including Poppo and Zenger (2002), Mayer and Argyres (2004), and Argyres et al. (2007).

[20] For example, Macaulay (1963) makes the point that firms with access to relational sanctions do not need contract planning and contract law. Early developments in the theory of infinitely repeated games focused on the use of relational mechanisms to achieve efficient outcomes (i.e., games in which behavior is "self-enforced" in the sense of being a Nash equilibrium of the repeated game). Well known is the work of Radner (1986), who demonstrates conditions under which a partnership constrained by imperfect monitoring can sustain efficiency. Fudenberg et al. (1994) establish general, sufficient conditions for efficiency to be attained in repeated games with imperfect monitoring.

[21] We thank the anonymous associate editor for bringing this point to our attention.

[22] Deliberately incomplete, or "strategically ambiguous," contracts are optimal when greater flexibility in response to observable but nonverifiable information is needed. Most recently, Itoh and Morita (2005) show that, in an infinitely repeated transaction between a buyer and seller, optimal relation-specific investments can be implemented in certain circumstances only if a fixed-price contract is written and combined with a relational contract (i.e., when agents are too impatient to satisfy the self-enforceability requirements).

[23] This is in contrast to termination for material breach, a higher threshold for termination and a term universally included in our sample contracts.

p. 21) points out, this may not be the whole story when relational contracts are also in play:

> Hence,…even with informal enforcement, one may wish to have an explicit contract with clear terms. In this case, the role of the contract is to clarify the conditions under which it is legitimate for one party to terminate a relationship or to impose informal sanctions.

In other words, partners who deal with each other repeatedly may find it worthwhile to write a detailed agreement, including performance terms and related penalty clauses, not due to their usefulness in court, but instead, their usefulness in maintaining a smoothly functioning relational contract.[24]

To see the general idea, suppose a firm's reputation for high-quality performance is valuable in acquiring and maintaining ongoing business relationships. Then, the public failure of such a relationship may lead the market to draw negative inferences about the firm's trustworthiness, thereby inhibiting its ability to conduct future business with others. By permitting firms to mitigate performance shortfalls privately via prespecified side payments rather than seeking redress publically via the courts, contracts effectively regulate the conditions under which more substantive reputational costs can be imposed.[25] Mayer (2006) tests for the link between reputation and contract structure more directly; he finds that the relationship between the importance of reputation and contract detail is positive but statistically insignificant.[26]

Of course, for the threat of contractual dissolution to have its desired effect, the market must be able to identity *whose* reputation should suffer in the event of a public breakup. For example, the dissolution of a buyer-seller relationship in which the seller agrees to provide high-quality goods, the market may naturally damage the reputation of the seller (Klein and Leffler 1981). Alternatively, the dismissal of an employee who receives an above-market wage may be construed as the result of shirking (Shapiro and Stiglitz 1984). Success in technology development alliances, however, depends jointly upon the quality of effort and resources contributed by *both* parties. This suggests a role for formal contracts that, to the best of our knowledge, has yet to receive theoretical attention: to complement relational enforcement by regulating the conditions under which performance disputes go public *and by publicly identifying the party*

at fault. Court-mediated lawsuits are a matter of public record and, thus, help markets determine which party should bear the reputation costs.

Viewed in this light, penalties provide a means by which to prevent certain types of underperformance from being used as triggers for the ultimate option of a public lawsuit. This is consistent with increased use of such terms under repeat dealing. When reputations are at risk from lawsuits over relatively minor performance failures, the perceived costs may be so great as to result in the failure of the alliance to form at all. This problem is solved by including an appropriate penalty in the contract, the payment of which neutralizes the damaged party's right to sue. Similarly, termination clauses allow partners to quietly dissolve their relationship without further consequence when contractually specified performance is not met. This logic seems relevant to an interesting qualitative observation arising from our data: some contracts are entirely unenforceable in a court of law because the partners waive their rights to court adjudication of disputes. If ambiguity exists regarding the ways in which performance can fail, then reputational concerns may lead the parties to eschew court-mediated disputes altogether.[27]

5. Conclusions

In this paper, we examine the relationship between contracts for interfirm technology development and prior deal experience. We find that contracts between firms with prior deal experience tend to be more detailed and are more likely to invoke penalty clauses than contracts between firms with no such prior deal experience. These effects are stronger when the prior deals are between the same partners.

We see several contributions from this work. First, we provide new empirical findings on how contracts vary across multiple dimensions, adding to the growing body of literature that examines contract terms in more detail (e.g., Mayer and Argyres 2004, Argyres et al. 2007). Furthermore, our analysis of how these terms link with prior experience (our proxy for repeated interactions) suggests that, consistent with Poppo and Zenger (2002) and Mayer and Argyres (2004), formal and relational mechanisms may well be complementary. Although learning must certainly

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[24] This is loosely consistent with the findings by Llewellyn (1931), who views contracts as planning devices, as well as with the findings by Mayer and Argyres (2004).

[25] A firm is, typically, not even required to reveal its private history of penalty payments on past deals to new prospective partners.

[26] This finding is consistent, as Mayer (2006) suggests, with learning effects dominating reputational ones in his setting.

[27] Crocker and Masten (1991, p. 71) note, "The legal system does not costlessly and unerringly assess remedies. On the contrary, there are reasons to believe that courts systematically deviate from efficient awards. Claims for damages, for example, are subject to a requirement of 'proof with reasonable certainty.' In cases where lost profits cannot be adequately established, recovery is likely to be limited to the cost of reliance, implying lower than optimal awards on average. And even if court-determined damages were not systematically biased, the cost of adjudicating damage awards would diminish the attractiveness of litigated enforcement."

reduce the overall cost of writing effective contracts, our specific findings imply this effect is more subtle than the one suggested by a straightforward application of learning-by-doing logic (i.e., with experience, firms include more detail because it is less costly to do so). Where learning is involved, there are theoretical subtleties that require further thought.

The fact that some terms are less likely to occur under prior experience, even though the overall relationship is positive, also has implications for the present theoretical debate over the relationship between formal and informal governance mechanisms. Care must be taken in making broad generalities about complementarity or substitutability from empirical results examining one or two contract clauses.

To the extent that our findings do reinforce the idea that formal and relational mechanisms are complements, we offer suggestions as to why firms may include additional terms and penalties when relational mechanisms are available. By defining when a party is outside the bounds of the agreement, relational mechanisms can be triggered and used to reinforce the terms of the agreement. The reduction of uncertainty as to when behavior falls outside the bounds of an agreement may induce alliances that, otherwise, would be too risky (reputation-wise) to implement.

Naturally, there are important limitations to our work. First, the substantial heterogeneity makes true comparison between contracts difficult at best. Although we attempt to control for sources of heterogeneity, our measures are blunt instruments that do not perfectly capture, for example, the breadth of the underlying technologies developed. Similarly, though our results are suggestive of the complementarity between relational and formal mechanisms, we cannot measure or test this complementarity directly. For example, our measure of repeated interactions, prior deal experience, measures relational governance only to the extent that past experience captures the likelihood of a valuable relationship or reputation to maintain. Furthermore, although access to actual contracts permits more detailed analysis, the difficulty in accessing these contracts prevents collection of large samples and a more sophisticated econometric analysis. We may also experience sample selection, in the sense that we only observe contracts for public firms and only those contracts that the firms choose to file with the SEC. Although some of this selectivity works in our favor (e.g., we more likely observe contracts on more important deals that actually took place), we acknowledge that our results may be impacted by some form of sample selection that we have not yet considered.

Notwithstanding these limitations, our results provide some potentially provocative evidence on the link between repeated interactions and contract structure. Furthermore, the richness of the data we present facilitates a greater understanding of industrial organization in R&D; we observe the details of how firms organize their joint development activities and respond to challenging coordination issues. As an initial exploration that provides both stylized facts and more formal empirical analysis, we believe this study complements existing theory and suggests some promising directions for its extension. Hopefully, our analysis will lead to a better understanding of how firms can more effectively coordinate and, ultimately, the role of contracts in economic exchange.

6. Electronic Companion

An electronic companion to this paper is available as part of the online version that can be found at http://mansci.journal.informs.org/.

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