

FORMAL CONTRACTS IN THE PRESENCE OF RELATIONAL  
ENFORCEMENT MECHANISMS: EVIDENCE FROM TECHNOLOGY  
DEVELOPMENT PROJECTS\*

Michael D. Ryall  
*Melbourne Business  
School*

Rachelle C. Sampson  
*University of Maryland*

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ABSTRACT

Formal contracting addresses the moral hazard problems inherent in inter-firm 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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\*Corresponding author: Rachelle Sampson, Smith School of Business, University of Maryland, Van Munching Hall 3301, College Park, MD 20742-1815; rsampson@rhsmith.umd.edu. We thank Juan Alcacer, Adam Brandenburger, Gary Dushnitsky, Joshua Gans, Robert Gibbons, Michelle Gittelman, Bill Greene, Andy King, Josh Lerner, Scott Masten, Joanne Oxley, Per Strömberg and Bernard Yeung for valuable feedback and comments; seminar participants at the US Department of Justice (Antitrust), Wharton School, Ohio State University, the Strategy Research Forum at Washington University and the University of Maryland for thoughtful suggestions; and participants at the NBER Conference on Corporate Alliances for helpful suggestions that led to the development of this paper. Ryall thanks IPREA for its financial support.



## I. INTRODUCTION

Interfirm collaboration continues to grow apace, despite difficulties in coordinating complex activities across firm boundaries. How firms govern these relationships is the subject of large body of research that spans multiple disciplinary areas. The breadth of this literature reflects that, as a means to plan the collaboration and set partner expectations, contracts may fill multiple roles, both as planning documents and evidence of agreed terms should external enforcement be necessary. To the extent that such agreements can facilitate smoother collaborations and avoid costly misunderstandings and missteps, it follows that careful crafting of such agreements may enhance the performance of these inter-firm activities.<sup>1</sup> In this sense, the organization of firm activities, contracts being a part of a broader group of organizational tools, can be thought of as a strategic choice variable with direct performance implications.

In recognition of the fact that contract structure is an endogenous function of the firms involved, we see an increasing focus in the literature on the issue of contract design in repeated relationships.<sup>2</sup> As transacting parties develop a history of shared experiences, they build trust, establish reputations and learn how to construct better formal governance mechanisms. When firms expect their relationship to be on-going, then relational, or informal, governance mechanisms become relevant. The effects of learning, trust, reputation-building and relational mechanisms may simultaneously exert their influences on the design of a formal contract. While 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 with respect to formal contract design when firms repeatedly interact, with an emphasis on 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 describe and examine contracts for joint technology development (i.e., development of new technologies by two or more firms) in detail in an attempt to identify whether and how these agreements are correlated with repeated interactions among firms. Through an in-depth analysis of joint technology contracts in the telecommunications equipment industry, we develop a coding scheme to capture how firms attempt to resolve various coordination challenges in their formal agreements. Three categories of contract terms emerge from our analysis: contract detail, monitoring provisions and penalties. We investigate whether the existence of these terms varies according to whether firms have prior deal experience and whether this experience is with the same partners. Broadly, 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 deals with each other.

Our study sits in 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. 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). As we show, each of these effects appear to be broadly relevant to our findings. However, their high level of abstraction and tendency to focus on only one or two substantive issues at a time make direct comparisons difficult. 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, Bercovitz and Mayer, 2007; Poppo and Zenger, 2002).<sup>3</sup> These contributions cover a wide spectrum and, not infrequently, offer alternative explanations to those provided in the economics literature. While our findings appear consistent with these alternative hypotheses on some dimensions, they differ in important ways on others.

Because of the breadth and variation in prior findings, both theoretical and empirical, we do not test any specific model in this growing set of possibilities but instead take an inductive approach and attempt to provide descriptive results of direct relevance to several of the key ideas put forth in these streams. This has implications for how we organize our paper. Rather than attempting to formulate formal hypotheses from disparate theories that are often at odds with one another and then testing them empirically, we begin by presenting our empirical analysis and then follow up with a careful discussion of our results in relation to the relevant 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 feel are our most salient results. We discover both consistencies and gaps between our results and existing theories, with the latter suggesting several potentially fruitful directions for theoretical development.

Our setting is a group of 52 contracts for joint technology development in the telecommunications equipment industry. We begin by identifying terms that define the rights and obligations of firms (‘contract detail’), facilitate observation of whether firms uphold their promises (‘monitoring’) and provide means for enforcement of these obligations (‘penalties’). Within each category of terms, we identify several specific contract terms, so that we are able to code the extent of, for example, contract detail in a contract. With each

contract coded on these three dimensions, we then empirically analyze how these terms vary with prior deal experience by the participating firms, explicitly detailing when the prior experience is between the same partners or not. Since our proxy for repeated interactions is prior experience rather than an explicit measure of the availability of relational mechanisms, we cannot directly measure whether formal and relational governance mechanisms are complements or substitutes, but our results are suggestive of a complementary relationship. As mentioned above, we find that contracts are more detailed and use penalty clauses more frequently when firms have prior experience of any kind, but these effects are stronger when firms have interacted with the same partner previously.

This approach represents several key contributions over the existing empirical literature in the area. Our detailed categorization of deal structure goes beyond the discrete form analysis that has been the hallmark of much of the literature examining, for example, alliance structure choices (Gulati, 1995; Oxley, 1997; Sampson, 2004). In this sense, our work adds to the growing body of literature analyzing specific contract terms and how these vary with several different deal specific factors (eg, Lerner and Merges, 1998; Mayer and Argyres, 2004; Argyres et al, 2007). However, our study differs from these papers in several important ways. First, our inductive approach to developing a coding scheme for these contracts led to identification of a broad group of contract terms that allows a more comprehensive description and comparison of agreements than has been traditionally conducted in these studies. For example, while Argyres et al (2007) examine specific contract terms, their analysis is focused primarily on two groups of terms – deal description and contingency planning - and how these terms interact. Part of our contribution is to provide a broader coding scheme that hopefully will be useful as a guideline in future studies. Second, we analyze terms that, to the best of our knowledge, have neither been empirically examined nor linked with prior deal experience, specifically, monitoring and penalties. 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. This approach in part addresses issues raised with past studies on selection of contract terms; namely that many studies focus on a single contract term to the exclusion of others, even when terms may well have important interactions (Macher and Richman, 2007). Finally, given our initial inductive approach identifying contract terms, we also uncover several patterns that have been previously unexplored in prior empirical work, most notably that the majority of firms in our sample explicitly waive their rights to go to court for dispute resolution in their contracts. 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.

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

## II. SAMPLE & DESCRIPTION OF CONTRACTS

Technology development across firm boundaries is a fertile environment for enforceability problems in formal agreements. Often, R&D projects are passed back and forth between firms at various stages, making it difficult to observe the behavior of one's partner. The inherent nature of these projects makes it challenging to infer partner behavior based upon what one actually does observe; R&D projects are idiosyncratic with uncertain outcomes (Holmstrom, 1989). Often, firms are concerned about unintended leakage of intellectual property, since joint technology development often requires some exposure of a firm's intellectual property to its partners. Project-specific investments are not uncommon. The contracts in our sample capture the attempts of partnering firms to address these issues.

### A. 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. In order to obtain the largest sample possible, our contracts are collected for the years 1991 to 2000, inclusive. Since the SEC requirement is to file material documents and not joint development contracts specifically, filing of these contracts is somewhat discretionary. As a result, firms tend to file contracts for their most substantial or important deals. The natural limitation of this data is obvious – we observe only contracts of public companies and likely only the largest and most important deals for these firms. Small firms do appear, but only when they partner with public companies who file with the SEC.

We collected contracts in the telecommunications equipment and microelectronics industries. The convergence of the telecommunications equipment with computer and microelectronics markets in the late 1980's substantially accelerated the pace of technological development (e.g., *The Economist* 9/13/97). 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.<sup>4</sup>

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.<sup>5</sup> Collaborations take many forms, including cross-licensing arrangements, joint technology development agreements and formal joint ventures for development and manufacturing. There are no cases of basic research in our sample. Rather, projects in our sample focus on end-product or manufacturing process driven R&D. This appears consistent with broader trend in industrial R&D, where applied research makes up roughly 77% of industrial spending on R&D (NSF, 2002).

To collect a sample of representative 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).<sup>6</sup> From roughly 12,500 filings, we obtained over 120 technology development contracts. Screening for deals involving some form of joint development, reduces 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 do. Since our focus is on the contract heterogeneity that may result from repeated interactions, we try to control for other sources of heterogeneity by limiting our scope of examination and, thus, excluding licensing contracts. By limiting our sample in this way, we have greater confidence that any variation in contract terms we observe arises not out of differences in the types of contracts that we include in our sample, but rather from the variance in either repeated interactions and/or how firms respond to the various moral hazard problems that joint development deals entail. This approach is similar to that taken by earlier research on contract terms (e.g., Robinson and Stuart, 2002).

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, Panel A. 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.

[Table 1, Panel A, here.]

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 (‘supporting document’).

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, industry and trade journals. Ideally, we would be able to 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. While coverage by SDC is inevitably incomplete, since firms are not required to report alliance activity, this database represents one of the most comprehensive sources of information on inter-firm 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.

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, since 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). Further, we expect that firms gain experience in contracting or with partnering (either with a specific partner or more generally) from all types of deals. Prior research suggests that prior collaborative experience itself may be more important than the type of collaborative experience. Whether the prior collaboration is for marketing, manufacturing or R&D, it appears that, at least 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 are attempting to capture either relational mechanisms or experience *at the time the contract was drafted*. Thus, in crafting our prior deals measures, we only count those prior deals that occurred prior to the contract signing date. We supplemented this data with financial information (including R&D spending) where available from Compustat, collected for the year prior to the contract date.

## **B. Descriptive Overview**

First, consider the descriptive summary of the joint technology deals and partner firm characteristics presented in Table 1, Panel B. Several patterns are revealed. 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 deal value is quite large, about \$91M; however, we only have deal value for seventeen of the fifty two deals. Note, though, that since we only observe contracts for the most important deals a firm enters into, this large size may well be representative. While value is not a perfect indicator of deal importance, we expect that value is positively correlated with deal importance to the firm. If firms invest more in the design of their more important deals, then contract terms are less likely to be random in such deals.

Partners do not typically have a history together; i.e., most firms do not have prior alliances with the same partner as in the current deal. 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. Co-location 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 a third of the deals, while joint venture formation (i.e., formation of a new firm for joint activities, where each partner holds equity in the new firm) is infrequent, occurring in just over 11% of the cases. Intellectual property is typically not shared equally among partners, 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.

[Table 1, Panel B, here.]

Next, 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 development deals – concerns over knowledge leakage to third parties, fundamental changes in partner status (such as ownership), and the inefficiency of external dispute resolution.

While not the primary focus of our study, the common reliance upon arbitration is interesting. Most of the contracts in our sample stipulate arbitration as the sole recourse in the event of disputes. Several contracts

explicitly waive firm rights to bring disputes before the courts or other administrative bodies, such as the US International Trade Commission. Some arbitration provisions also create disincentives for seeking arbitration. For example, in the 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.<sup>7</sup> These provisions likely reflect the inefficiency of courts in resolving disputes of a highly complex, technical nature. Courts often have difficulty inferring the intentions of the respective parties and, as a result, may produce sub-optimal remedies in comparison to arbitration.<sup>8</sup>

Still 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. Examples of the contract language used in these common terms are set out in Table 2.

[Table 2 here.]

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. While prior studies have examined contract terms, these studies have focused on a few specific provisions, such as pricing provisions (e.g., fixed price versus cost-plus contracts, Corts and Singh, 2004; Kalnins and Mayer, 2004). Where some studies on contract terms have examined a broader range of terms this range has been necessarily constrained by the underlying theoretical focus (i.e., property rights theory) that has typically lead to an examination of control rights (e.g., Lerner and Merges, 1998; Robinson and Stuart, 2002; Kaplan and Stromberg, 2003, Elfenbein and Lerner, 2003) and/or ownership rights (e.g., Elfenbein and Lerner, 2003). In prior work that has looked more broadly at contract terms such as ‘task description’ or ‘contingency planning’ (e.g., Argyres et al, 2007), there is very limited discussion of what these terms look like or the various forms these terms take in the actual contracts. Therefore, our approach was primarily inductive. We conducted an in depth analysis of the contracts of a few firms in the sample to discover the forms taken by their governance mechanisms (i.e., those intended to ensure or encourage cooperative behavior). We focused on terms that set incentives, defined the obligations of

the parties, established monitoring rights, and elaborated penalties for non-compliance. For a more detailed discussion, see the online supplement.

We found three broad categories that account for a large portion of the variance across contracts: (1) the extent to which firm obligations are precisely specified ('contract detail'); (2) how much monitoring is explicitly provided for; and (3) whether penalties exist for non-compliant behavior. Each of these categories is multidimensional. For example, in addition to defining the specific technologies a firm is obligated to contribute, a contract may also specify time frames for 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. These terms capture the three key areas of contract variance analyzed and are illustrated in Table 3, Panel A, below.

[Table 3, Panel A, here.]

The frequency and cross frequency of these terms across our sample contracts are set out in Table 3, Panel B.

[Table 3, Panel B, here.]

Table 3, Panel B, reveals the heterogeneity of the contracts. No single term is used in all contracts in the sample; the highest percentage of term usage is 51.9% or twenty seven contracts (i.e., time frames for completion of stages specified). A relatively large proportion of the contracts require some sort of periodic reviews (46.2% or twenty four contracts), while penalties, particularly financial penalties, are somewhat rare, occurring in only 11.5% (six) of the sample contracts. Co-occurrence of terms is relatively low; the terms that more frequently appear together are: (1) time frames for completion specified and reviews of development work required (co-occurring in 28.8% or fifteen contracts); (2) time frames for completion specified and right to terminate for underperformance (co-occurring in 25% or thirteen contracts); (3) reviews of development work required and the timing of reviews specified (28.8% or fifteen contracts); and (4) development output specifications included and specific technologies to be contributed described (23.1% or twelve contracts). Given this low incidence of co-occurrence of terms, it does not appear that the contract terms are used in clusters in our sample.

Note that this is true even when considering the percentage of terms used by *firms* in the sample (i.e., out of thirty six firms, rather than fifty two contracts); no terms are universally used by all firms (or no firms) in the

sample. To assess this degree of intra-firm variation, we produced frequency tables of each contract term by firm (as opposed to by contact, reported in Table 3, panels A and B). By examining intra-firm variation, we can better assess the extent to which one firm versus another uses a particular contract term. (In the interests of brevity, these frequency tables are set out in the online supplement.) Of the thirty six firms in the sample, eight firms have multiple contracts, anywhere from two to five contracts. Of these eight firms, most display substantial heterogeneity in the terms used in their contracts (i.e., intra-firm heterogeneity), with a few exceptions. Three firms have more than 70% consistency in the types of terms used across their multiple contracts in the sample: Centillum Technology Corp., 3M and Summa Four Inc. Centillum Technology Corp. (5 contracts in the sample) has the least amount of variation in the usage of contract terms. Fourteen of the fifteen coded terms are either universally used or not used in all of this firm's contracts in our sample. Two other firms also have less intra-firm heterogeneity in their contracts – 3M and Summa Four Inc. However, both of these firms have only two contracts in the sample, so it is more difficult to conclude that these firms use terms consistently across all of their contracts. We note that our results are robust to the exclusion of these firms from the sample.<sup>9</sup>

Note that similarities between our contract term classifications and those used in prior research primarily surround our 'contract detail' clauses. Task description, as Argyres et al (2007) define it, is 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. However, it is difficult to precisely assess how similar 'task description' according to Argyres et al (2007) is to our contract detail, since detailed information on how these clauses are coded is not provided (i.e., the clauses are coded by engineers).

Similarities between our classifications and those terms used in prior research examining control and ownership rights are more limited. Most of these studies focus on a few well defined control rights (most commonly board seats, voting rights and equity stakes: e.g., Kaplan and Stromberg, 2003; Lerner and Merges, 1998) but these control rights have minimal overlap with the terms we coded. Where similarities exist between these studies and ours, they are typically limited to one or two terms in our classification; for example 'intellectual property rights defined' in our contract detail is similar to, but not the same as, the allocation of control rights over intellectual property in Lerner and Merges, 1998 and 'right to terminate without cause' appears similar to our 'right to terminate for underperformance' in penalties. However, these studies do not focus on the inclusion of such terms as a function of repeated interactions. An exception to this is Robinson and Stuart (2002), who do examine the influence of prior deals (though with any partner, not a specific partner) and the

effect on inclusion of particular control rights. One control right in Robinson and Stuart (2002), employment provisions that specify the number and quality of research personnel, is similar to terms in our contract detail coding, ‘number of employees’ and ‘specific persons specified’. However, again, it is difficult to assess how similar these employment provisions are to elements of our contract detail classification since detailed information on how these clauses are coded is not provided. Notwithstanding this, we do compare our findings with Robinson and Stuart (2002) in our results discussion below. Note that our monitoring clauses do not appear to overlap with any terms in these studies.

### III. CONTRACT STRUCTURE & 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 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.<sup>10</sup> These frequencies and mean difference tests are set out in Table 4 below.

[Table 4 here.]

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). Further, these contracts are also more likely to include financial penalties, to specify specific persons for management of the development work and to detail the specific 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.

While these patterns are interesting, it is difficult to assess whether the patterns here 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 in a contract 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 have used 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 the development of trust or embeddedness from prior interactions that facilitates smoother collaborations in future (Granovetter, 1985; Gulati, 1995; Uzzi, 1997), while economists emphasize the anticipation of valuable future interactions in ensuring cooperation in the present setting (Radner, 1986; Fudenberg, 1994). Ideally, we would be able to empirically distinguish between these two mechanisms in order to better isolate notions of trust from expectations of future interactions. Unfortunately, we lack a precise means to directly measure trust or the expectation of future interactions, given the historical nature of our data. Prior deals is 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 likelihood of future dealings between partners.

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 better relate our results to the economic theoretic results 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 (since they are ongoing at the time the sample contract was signed) while prior deals may reflect embeddedness or trust, as well as the potential for future interactions to the extent that concurrent deals does not fully capture this expectation. 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. Note that there are ten contracts in the sample that have prior or concurrent deals with the same partner. Seven firms (that is, 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 upon 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 less than 35.9% of sample firms have more than 2 prior deals. Approximately 23% of sample firms have more than 10 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” equals zero if neither partner has any prior deals with other firms, one if the partners on average have between one and ten prior deals, and two if the partners on average have greater than ten prior deals.<sup>11</sup>

In addition to the influence of relational mechanisms, there are several other factors that we expect affect the ease (and, hence, cost) 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 uncertainty and/or complexity associated with the deal: (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 since 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 since a penalty may be triggered by poorly assessed contingencies that are unrelated to firm efforts. The converse is also possible, since

firms are more likely to attempt to define their own penalties for 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 is classified as *incremental* if the project involves customization of existing technologies for new uses and *next generation* if it involves radical changes to the existing technology. “Technology breadth” equals one if the development is next generation, zero otherwise. Contract duration is taken from the agreement termination clauses; “Long term deal” equals one if the joint development activity is expected to last more than one year, zero otherwise. Approximately one half of the deals in our sample (46%) operate for one year or less. We set the “Manufacturing &/or marketing” variable to one if the deal involves joint manufacturing or marketing in addition to the joint development activities, zero otherwise. Finally, “Cross border” equals one if the deal involves firms from in different countries, zero otherwise. While these measures imperfectly capture all deal specific factors that may influence contract structure, they go some length towards isolating the effect of prior deals.

[Table 5 here.]

We first estimate the relationship between contract detail and repeated deals in Table 5. 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).<sup>12</sup> 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. In this sense we are relaxing the constraint that there is a distinction between equity joint venture and other types of joint development contracts. We note that six of our contracts involve joint venture formation (as set out in Table 1, Panel B). As a robustness check, we re-estimate Tables 5-7 below 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 full contractual specification of rights and obligations, since 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 interests of brevity, but yield substantially the same results as those reported below.

Finally, columns 3 and 6 add a scaled measure for R&D spending by the partner firms. R&D spending is the R&D expense reported by the partner firm with the largest R&D program in the year prior to the contract date, scaled (i.e., we divide R&D by 10,000). 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 for the partner with the largest R&D expense in the deal, since 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 detail 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 similar contract structure in their deals with different partners. 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, since most firms in our sample contracts are involved only in one contract.

Across specifications, two patterns emerge. First, prior deals with the same partner as in the current contract appear to be correlated with more detailed contracts.<sup>13</sup> The probability of a more detailed contract increases by 0.48 (i.e., 48%) if firms in the current deal have a prior deal with the same partner.<sup>14</sup> Interestingly, concurrent deals (i.e., occurring at the same time as the deal represented by the sample contract) decrease the probability of a more detailed contract by 33% (i.e., the marginal effect is -0.33). 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 probability 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 directly contrast with those obtained in other studies, such as Argyres, Bercovitz and Mayer (2007) and Robinson and Stuart (2002). 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 (2002) 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.) A more detailed comparison of our results to related papers appears in our discussion section below.

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, while cross border deals and partners with relatively larger R&D programs tend to include more detail in their deal contracts. These control variables, however, are not consistently significant across specifications.

Broad technology deals are less likely to have detailed contracts; detailed specification is likely more difficult when joint development is for more embryonic technologies. This is consistent with Kalnins and Mayer (2004) who find that, as project complexity increases, firms are less likely to use high powered incentives that may require greater efforts to spell out details in advance. Our technology breadth measure may also be capturing the technology life cycle to some extent. As technologies mature, detailed contract specification likely becomes easier. The negative and significant coefficient on technology breadth is consistent with this effect. Unfortunately, we lack adequately detailed information on the deal technologies as well as the relevant expertise to evaluate how mature a technology is at a particular point in time and thus to more precisely estimate the potential effect of maturing technology on contract structure. However, in addition to our technology breadth measure, we ran a robustness check adding year dummies to Tables 5-7 to see if there is an effect of maturing technology that is industry wide. While 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.) Note that

results on our main variables of interest (i.e., prior and concurrent deals and prior deal experience) remain largely unchanged.

To investigate whether repeated deals are correlated with the usage of monitoring and penalty provisions, we repeat the analysis above with monitoring and penalties as dependent variables in Tables 6 and 7, respectively. The Monitoring and Penalty dependent variables are similar in construction to Contract Detail. Monitoring 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 one if the contract contains three or more monitoring clauses, zero 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 that takes the value of one if the contract includes one or more penalty clauses, zero otherwise.

[Table 6 here.]

[Table 7 here.]

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 with prior deals with any partner are 11% more likely to include monitoring provisions in their current deal contracts.<sup>15</sup> No other independent variables appear to be significantly correlated with inclusion of monitoring provisions.

In contrast, prior deals do appear to be 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%.<sup>16</sup>

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 twenty one contracts with penalty clauses, eight have bilateral penalties (i.e., where either party may exercise the penalty) and thirteen 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 (e.g., 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. Broad technology 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) through (6), cross border deals appear to decrease the probability of penalties, which may be explained by the difficulty of assessing contingencies that would trigger a penalty 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. While we do not include these tables here in the interests of brevity, we note that results from this estimation yield very similar results to those reported in Tables 5-7 below and are available on request.

As a final thought, we note that we may be able to better define the link between formal and relational mechanisms with additional data. With a more comprehensive sample of contracts, we may be able to identify the extent to which our observed relationships can be explained by different theoretical arguments. (These theoretical arguments are discussed in greater detail in our discussion below.) For example, observing the changes in multiple contracts over time – in particular, the revisions to individual contracts associated with a specific deal or relationship – would provide a sharper set of facts regarding contract formulation under learning and/or reputational effects. In this context, we can imagine situations in which learning occurs in the presence of progressively weakening relational mechanisms and, hence, the possibility of distinguishing between the two (e.g., in a long, but finite-length relationship). For example, increasing likelihood of monitoring clauses is consistent both with learning that these clauses are useful per se and knowing that they are needed in later periods of waning relational effectiveness - hence, no greater ability to differentiate between these explanations. On the other hand, in finite-length relationships, finding that monitoring clauses tend to be removed would be more consistent with simply learning that they are not useful since, if anything, the relational need for such clauses should be increasing in this setting.

Combining this depth of contracts with more complete information on the network structure that the firms are a part of (by measuring all relevant ties, not just alliances) could also yield deeper insights. Then, we might then discover how the availability of relational mechanisms that do not involve a partner firm (i.e., by virtue of a dense network surrounding the firms involved in a deal) influences contract structure. Note that this approach would also require the contracts of multiple firms, not just a single firm, in order to have variation in the network structure.

It would also be useful to combine this data with more precise information on the relative bargaining power of partner firms involved in the deals in order to see whether and how bargaining power differences affect contract structure. Prior research has suggested that selection of organizational form may not be consistent with theory when bargaining power differences between transacting parties are acute (Shervani, Frazier and Challagalla, 2007). If collecting data by survey, one could then measure the types of terms that specific firms prefer. With this information, we could see whether these firms more frequently include these terms in their contracts when they have relatively greater bargaining power in a specific deal.

Finally, in order 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).

#### IV. DISCUSSION

In order to discuss the 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. The empirical issues concerning the significance and validity of our analysis are discussed in detail above. Hence, we now proceed to consider the broader implications of our findings when taken at face value.

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). At first glance, there is a simple, rather obvious explanation consistent with this result: namely, each deal yields valuable lessons with respect to contract design. This knowledge is both general (i.e., applies to deals with any firm) and specific (i.e., applies to another deal with the same firm); as a result, the ability to write a more complete contract is greater for a firm

with more deals under its belt. Hence, a positive correlation arises between number of previous deals and contract detail (a proxy for contractual completeness). Essentially, this is a learning-by-doing story in which the “quality” of a contract is increasing in completeness and the “marginal cost” of quality is decreasing in experience. If experience with a given partner is more valuable for future deals with that same partner, then this logic also seems to 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 and, in some cases, is raised explicitly as a likely explanation. 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, apparently as they learn to contract over time. Similarly, Argyres, Bercovitz and Mayer (2007) demonstrate that a more extensive relationship history leads to greater efforts at contingency planning in the contracting process.

While the empirical facts both from this study and earlier work indicate a nontrivial relationship between experience and contract design, we are less sanguine with broad, learning-by-doing reasoning along the lines suggested above. When the finer details of our results are considered, several puzzles emerge that are not neatly explained by this rationale. Further, while certain alternative, formal theories appear to offer important, supplemental insights, neither do they provide a complete explanation for our results.

We find that greater experience implies a greater likelihood of partners including more terms in their contracts (as noted above). However, while 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. This is true for prior empirical work as well; while Poppo and Zenger (2002:717) indicate when a “formal contract is highly customized and required considerable legal work,” they do not identify which terms, specifically, are more or less likely to be included with prior deals. Similarly, Mayer and Argyres (2004) examine a myriad of terms in eleven contracts, but do not have systematic findings relating the likelihood of inclusion with experience. Argyres et al (2007) consider contingency plans and find that they are more likely to occur with prior experience, but do not link other terms with prior experience.<sup>17</sup>

Delving more deeply into our analysis in Table 4, note that the likelihood of output specifications increases under repeated deals with the same partner while the likelihood of those allocating intellectual property rights over specific technologies decreases. Thus, not all terms are more likely to be included with prior deals – some appear less likely. These conflicting effects are also raised by prior research showing that formal mechanisms are less likely with repeated deals (e.g., Gulati, 1995). If experience-based learning induces multiple, sometimes contradictory effects, then we cannot conclude that optimal contracts are inherently more detailed. This view is supported by various theoretical findings showing that optimal contracts may actually be quite simple. 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. When optimal contracts are relatively simple, it makes sense that learning allows parties to write equally effective, less detailed contracts. Thus, in complex transaction environments such as ours, it is likely that different learning effects are at play on different dimensions of the same contract. Joint exploration of these effects in a general setting would represent a very useful extension of current theory.

Our results also highlight the need for additional theory on how firms react to unforeseen contingencies. Momentarily setting aside situations in which efficient contracts are simple, suppose partnering firms experience an unforeseen event with significant, unanticipated consequences for performance. How does this affect their next round of contracting? For example, is our finding of a positive correlation between the likelihood of a timing clause and repeat deals simply due to the fact that, sometimes, firms discover that timing is important and, as a result, add an appropriate term in later contracts (as suggested by Mayer and Argyres, 2004)? Alternatively, placing a positive posterior on the “unforeseen” event (i.e., one to which the firms assigned zero probability at the time of writing their contract) as a result of experience requires that firms update their priors on other events such that some events are no longer viewed as likely as they originally were. If so, it should not be surprising to find some of the original terms reassessed as unnecessary and dropped. Unfortunately, how agents reassess their priors following unforeseen events is an open theoretical question, the answer to which is central to determining the validity of any conclusions regarding the relationship between experience and contract detail.

Other questions arise when we consider that experience in a deal is some composite of the experience of two or more firms. For example, how does the asymmetry of partners come into play and which firm’s

experience drives contractual form, particularly if one has more experience than the other? 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. 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 by demanding overly detailed contracts? Would inexperienced firms include terms that, ex-post, are found to be useless and hence dropped from future contracts? These are also learning-by-doing rationales, but ones that go in the opposite direction to what our overall results suggest in this study. We are not aware of any theoretical results that shed light on these potentially conflicting effects.

This brings us to the central themes of the economics literature analyzing the interactions between relational and formal contract 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.<sup>18</sup> 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.

This means that the net effect on contracts can be ambiguous, even if learning-by-doing works according to the conventional wisdom discussed above.<sup>19</sup> 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 while, 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) and Gulati and Singh (1998) who find that firms with prior ties are less likely to choose more hierarchical controls for their alliance activities and suggest that trust developed over these prior ties may alleviate concerns of opportunism. Similarly, Uzzi (1997:52), finds that parties in embedded ties (typically formed during prior interactions), “said that they signed no contracts because of their expectations of long-term fair play.”

In contrast, our finding of overall contract detail increasing in situations of repeated interaction is consistent with work demonstrating complementarities between relational and formal mechanisms. Bull (1987) and

MacLeod & Malcolmson (1993) are among the first to study settings in which agents engaged in repeated arms-length transactions rely upon formal *and* relational terms to achieve outcomes that are impossible using either one element or the other exclusively. Baker, Gibbons & Murphy (1994) show that certain formal contracts cannot be sustained without a supporting relational mechanism. This suggests that the type of project a firm chooses to place under formal governance may evolve as its reputational capital and that of its partners increase over time. In particular, a project traditionally guarded in-house due to its importance in establishing or maintaining a firm's competitive advantage may become a viable candidate for collaboration once the firm's partner establishes a reputation in such areas as performance and honoring its confidentiality agreements. If so, the following dynamic may be at work. Projects central to a firm's performance require strong formal controls if they are to move into the realm of collaboration with outsiders. Such contracts are not viable without relational mechanisms. Thus, precisely as reputational mechanisms become available, we observe a shift in collaboration to projects associated with more refined formal contracts. In this sense, we may observe that contracts become more detailed with experience. While we may attribute this effect to the development of relational mechanisms, it is also attributable to the type of project that a firm is willing to undertake with a partner. Further work in identifying the relative importance of deal projects to a firm over time may help tease out these effects and demonstrate whether this phenomenon is at work.<sup>20</sup>

As mentioned above, substitution and complementarity effects are not the whole story. 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.<sup>21</sup> Following this latter line of reasoning, observed variations in contract detail could be viewed as the endogenous result of optimizing behavior on the part of the partnering firms. This is the direction taken by Kvaloy and Olsen (2005), who include degree-of-verifiability as a choice variable, the equilibrium value of which depends upon tradeoffs between the cost of verification and the benefit of improved compliance over relational mechanisms alone.<sup>22</sup> 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. Thus, Kvaloy and Olsen (2005), combined with the ideas highlighted above, provide the seeds of a more complete theory of contract design, one capable of providing fuller and more satisfactory explanations of our results and others in the literature.

The other important set of results presented above surrounds the inclusion of penalty clauses. Since this finding is similar to our results on other types of contract detail, most of our earlier comments and citations continue to apply. However, penalty clauses are a special type of contract detail in the sense that their inclusion seems difficult to interpret as stemming from anything other than their value in performance enforcement. If, as has been suggested in the management literature (e.g., Mayer and Argyres, 2004), certain types of clauses may be included for purposes that go beyond the purely legal (e.g., to enrich communication and align expectations), penalties would not seem to be one of them. However, as MacLeod (2006: 21) points out, this is not necessarily true when relational contracts are also in play:

*Hence, as Richard Posner (2003) observes, 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 commit a detailed understanding of their agreement to writing, 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.<sup>23</sup>

Suppose, for example, that a firm's reputation for high quality performance is valuable in acquiring and maintaining on-going business relationships. Then, the public failure of such a relationship not only eliminates the net present value of benefits accruing to that relationship but, in addition, may lead the market to draw negative inferences about the firm's trustworthiness, thereby inhibiting its ability to conduct future business with others. Thus, a contract can amplify the effectiveness of relational mechanisms when reputations are at stake. Simultaneously, it provides a means by which to regulate the conditions under which reputation-related costs can be imposed. This suggests, following the reasoning of MacLeod (2006), that the increased use of specific penalty clauses (not to mention the more refined terms discussed in the previous section) is also to be expected – not as a substitute for relational enforcement, but as a roadmap for it.

That these effects may be at work in our data is suggested by our finding that termination rights for underperformance are more likely in repeated settings.<sup>24</sup> If public termination of an on-going relationship is an effective relational enforcement mechanism, our results appear to support the view that formal contracts facilitate the use of relational mechanisms by providing specific guidance as to when such enforcement is allowed. This view also seems consistent with our finding of increased use of specific penalty clauses in the presence of repeated interaction; it is sometimes efficient for a firm's reputation to be associated with making remedial payments, such as penalties, rather than quality of services per se (as explained in MacLeod, 2006:35). In this case, the firm gains a reputation for upholding the overall contract, even when it fails on some performance dimensions (e.g., by making the requisite remedial payment after providing an input of lower-than-specified quality). Mayer (2006), in a sample of contracts involving one supplier and numerous customers, similarly finds that extensive prior relationships are correlated with greater degree of detail.<sup>25</sup>

Note that the application of this idea is complicated in our setting. In order for the threat of contractual dissolution to have its desired effect, the market must be able to identify *whose* reputation must suffer should dissolution occur. Sometimes, this is implicit in the type of transaction under consideration. For example, when observing the breakup of a buyer-seller relationship in which the seller agrees to provide high-quality goods, the market may naturally assume performance failure on the part of the seller (e.g., Klein and Leffler, 1981). Similarly, the dismissal of an employee who receives an above-market wage may be viewed as the result of shirking on the employee's part (e.g., Shapiro and Stiglitz, 1984). More generally, the agent holding the reputation for performance should be the one whose behavior is easiest to observe (Bull, 1987).

Making such inferences in technology development alliances is more challenging. Successful partnerships depend jointly upon the quality of effort and resources contributed by *both* parties. Further, performance is complex and difficult to observe by outsiders. Even when penalty payments are made for underperformance, firms are not typically required to reveal such information to new prospective partners. Our results suggest a possible explanation that, to the best of our knowledge, has yet to receive theoretical attention: a formal contract can complement relational enforcement in a strategic alliance simply *by creating the vehicle both by which to take a performance dispute public and to publicly identify the party at fault* (i.e., determine whose reputation is damaged). While it is true that out-of-court transfer payments such as penalties and settlements are not typically observed by outsiders, court-mediated lawsuits and their outcomes are a matter of public record. It is this threat of court enforcement that makes even private contracts effective as relational mechanisms and facilitates the

complementarity of relational and formal mechanisms. The existence of a contract, with its specified rights and obligations, gives each partner the ability to take a dispute public via the court system, thereby invoking relational punishments.

Viewed in this light, penalties and rights of termination 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 (where reputation concerns are more likely at play) because, in such situations, it may be efficient to identify only a subset of performance issues as worthy of court enforcement. For example, leaving the reputation-holder open to a lawsuit over relatively minor performance failures may result in no alliance formation because the reputational downside exceeds the potential gains from cooperation. This problem is solved by including an appropriate penalty in the contract, the payment of which neutralizes the damaged party's right to sue. 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. Notice that this does not preclude third-party enforcement (e.g., via private mediation), only the possibility of court enforcement in deals where such external enforcement is inefficient.

## V. CONCLUSIONS

In this paper, we examine the relationship between contracts for inter-firm technology development and prior deal experience, whether with the same firm or not. To empirically analyze these agreements, we first construct a coding scheme to categorize the contracts along three dimensions - contract detail, monitoring and penalties – and then link the extent of these provisions in a contract to prior deal experience by the partner firms. While these contracts are highly heterogeneous, they exhibit some consistent patterns. 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 two firms. Moreover, not only are many of the terms in these agreements not verifiable or easily enforceable in a court of law, the majority of contracts in our sample waive rights to court access for disputes.

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, Bercovitz and Mayer, 2007). Further, our analysis of how these terms link with prior experience (our proxy for repeated interactions) suggests, consistent with Poppo and Zenger (2002) and Mayer and Argyres (2004), that formal and relational mechanisms may well be complementary. While learning must certainly 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 since it is less costly to do so). For example, we find that some terms are less likely to occur with prior experience. Clearly, where learning is involved, there are theoretical subtleties that continue to 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. Apparently, some contract terms may be complementary to relational governance, while others may be substitutes. That all formal mechanisms do not bear the same relationship with proxies for relational governance means that care must be taken in making broad generalities about complementarity or substitutability from empirical results examining one or two contract clauses. Further, this suggests that theory development needs to be more holistic in its approach to considering contract structure, via consideration of different types of formal mechanisms and how these mechanisms are more or less likely to occur with repeated interactions, with explicit reference to the fact that formal mechanisms may be simultaneously more and less likely depending on which formal mechanism is considered.

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 terms such as increased contract detail or 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 the agreement, coupled with the potential damage to the relationship should the behavior continue, may deter firms from engaging in opportunistic practices. This is particularly the case in situations where terms are verifiable but not easily enforced through external means (e.g., when individuals are specified for managerial or development tasks by the contract). This is consistent with the survey-based evidence of Poppo and Zenger (2002:708), who argue that, "Relational governance may heighten the probability that trust and cooperation will safeguard against hazards poorly protected by contract." Increased use of formal mechanisms such as contract detail may also be

useful in defining threat points for renegotiation to occur. Detailed contracts may allow firms to more efficiently determine when the project has deviated from the original intent (e.g., perhaps because conditions have changed from the time the agreement was entered). Similarly, inclusion of penalty clauses may clarify triggers for invoking punishments; these formal punishments may well complement the relational punishments anticipated in theories of repeated interactions.

More broadly, these findings, combined with the fact that most parties in our sample waive their rights to external dispute resolution, suggest that contracts facilitate greater efficiency in subtle ways that go beyond providing legal constraints to curtail opportunistic behavior. For example, contracts may also serve as ‘blueprints’ for exchange. As a means to plan the collaboration and set partner expectations, a key value of contracts may be in their ability to force firms to consider the details at the outset of their exchange; by defining expectations, firms may be able to avoid costly misunderstandings and missteps. If formal contracts are indeed such a blueprint, they are particularly important for technology alliances, given the substantial coordination that development across firm boundaries requires. This interpretation suggests yet another potentially fruitful area for further theory development. Whether enforcement is left to an outside arbitrator or a court, a contract is fundamentally a legal device. The alternative is for firms to create distinct, non-contractual planning documents if need be. Why then would parties opt to align expectations using planning documents that may have the force of law behind them? This question is especially relevant under bounded rationality and information asymmetry where managers may worry that today’s innocuous planning term may be tomorrow’s costly lawsuit. It may be that the inclusion of such terms in a legal document can, in addition to facilitating coordination, allow firms to terminate without consequence if formally defined expectations are not met. Thus, even if such terms cannot be easily enforced by third parties, they may facilitate private remedies such as termination without consequence (i.e., one firm cannot sue the other, since agreed upon terms were not met). We know of no theoretical treatment, however, for terms that may be used for planning and also to facilitate some type of private remedies.

Naturally, there are important limitations to our work. First, the substantial heterogeneity makes true comparison between contracts difficult at best. While we attempt to control for sources of heterogeneity, our measures are blunt instruments which 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. Further, while access to actual contracts permits more detailed analysis, the difficulty in accessing these contracts prevents collection of large samples. The relatively low number of observations is a barrier to 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. While 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. Further, 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.

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## ENDNOTES

**Table 1, Panel A: Number of Contracts per Firm**

Number of sample contracts per firm  
 Firms included are only those with SEC filings.

<i>Contracts per firm</i>	<i>Frequency</i>	<i>Percentage</i>
1	28	78%
2	4	11%
3	1	3%
4	2	6%
5	1	3%
Total	36	100%

**Table 1, Panel B: Deal & Firm Descriptives**

*78 organizations involved in 52 joint development deals*

	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Average deal value (\$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 (5 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 co-locate 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) (\$millions)	64	10,955.84	21,120.97	0.419	81,091.00
Firm size (net sales) (\$millions)	64	10,236.11	19,062.16	0.094	75,094.00
R&D spending (\$millions)	64	748.95	1,311.00	0.28	5,094.00



**Table 2: Examples of Common Contract Terms**

TYPE OF COMMON TERM		EXAMPLES
1.	Arbitration	<ul style="list-style-type: none"> <li>· ‘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.’</li> <li>· ‘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...’</li> <li>· ‘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.’</li> </ul>
2.	Confidentiality	<ul style="list-style-type: none"> <li>· ‘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....’</li> </ul>
3.	Right to Terminate:	<ul style="list-style-type: none"> <li>· ‘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:               <ul style="list-style-type: none"> <li>i. Filing of a petition in bankruptcy...by the other party, or the appointment of a receiver for the business of the other party...;</li> <li>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.’</li> </ul> </li> </ul>
4.	Limitation of Liability:	<ul style="list-style-type: none"> <li>· ‘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...’</li> </ul>
5.	Cross Licensing:	<ul style="list-style-type: none"> <li>· ‘(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 non-exclusive 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]...’ <i>(An identical provision for licensing by Benchmarq to Sanyo follows.)</i></li> </ul>
6.	Patent Indemnity:	<ul style="list-style-type: none"> <li>· ‘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...’</li> </ul>

**Table 3, Panel A: Examples of Contract Terms**

CONTRACT DETAIL	EXAMPLES									
1. Development specifications (such as tolerances) included	<ul style="list-style-type: none"> <li>Product Specifications: The Comanche shall include the following elements and functions [confidential specifications follow]...</li> <li>The development steps for the Subject Technology related to the 0.5 micron process shall be as follows:                             <ul style="list-style-type: none"> <li>(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.</li> <li>(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...</li> </ul> </li> <li>... this phase, lasting nine months from the date of signing this agreement</li> <li>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.</li> <li>Major milestones and Project Deliverables:                             <table border="1"> <tr> <td>Milestone</td> <td>Project Deliverable</td> <td>Completion Date</td> </tr> <tr> <td>Lab Prototype phase</td> <td>LB units (25)</td> <td>February 28, 94</td> </tr> <tr> <td>Production Prototypes phase</td> <td>PP units (150)</td> <td>May 05, 94</td> </tr> </table> </li> </ul>	Milestone	Project Deliverable	Completion Date	Lab Prototype phase	LB units (25)	February 28, 94	Production Prototypes phase	PP units (150)	May 05, 94
Milestone	Project Deliverable	Completion Date								
Lab Prototype phase	LB units (25)	February 28, 94								
Production Prototypes phase	PP units (150)	May 05, 94								
2. Time frame for completion of each stage specified	<ul style="list-style-type: none"> <li>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.</li> <li>Each party agrees to commit no less than 5 employees to a joint product definition team...</li> </ul>									
3. Number of employees to be contributed specified	<ul style="list-style-type: none"> <li>The parties hereby agree that the Project Leader for Ramtron shall be Mr. Tom Davenport and the Project Leader for ULVAC shall be Mr. Yoshihumi 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"...</li> <li>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...</li> </ul>									
4. Specific persons stipulated for management or other development work	<ul style="list-style-type: none"> <li>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...</li> <li>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 minimum 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...</li> </ul>									
5. Specific technologies to be contributed described	<ul style="list-style-type: none"> <li>Ramtron shall retain sole ownership to all patents... relating to... ferroelectric technology</li> <li>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...</li> </ul>									
6. Intellectual property rights defined over specific technologies	<ul style="list-style-type: none"> <li>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...</li> </ul>									
7. Reviews of development work required	<ul style="list-style-type: none"> <li>ASKEY will evaluate Centillum's first prototype of the Interface Devices. Centillum will provide evaluation boards to ASKEY for this evaluation.</li> <li>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...</li> <li>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.</li> <li>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...</li> <li>Benchmark shall issue a design status report no less frequently than twice per month.</li> <li>Fujitsu &amp; 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...</li> <li>As part of such review, Benchmark 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...</li> <li>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.</li> <li>BENCHMARK maintains the right to audit the OPTI manufacturing facility for conformance to agreed upon manufacturing flows at any time.</li> <li>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...</li> <li>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...</li> <li>AliGen may accept or reject the end products within thirty (30) days of delivery by Nitsuko. AliGen 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 AliGen. Nitsuko may reject the end products if it materially fails to meet the requirements... except normal bugs...</li> </ul>									

Reviews of outcome only required	Reviews of outcome only required
Discretionary reviews available	<ul style="list-style-type: none"> <li>ASKEY will evaluate Centillum's first prototype of the Interface Devices. Centillum will provide evaluation boards to ASKEY for this evaluation.</li> <li>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...</li> </ul>
3. Timing of reviews specified	<ul style="list-style-type: none"> <li>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.</li> <li>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...</li> <li>Benchmark shall issue a design status report no less frequently than twice per month.</li> <li>Fujitsu &amp; 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...</li> </ul>
1. Content of reviews specified	<ul style="list-style-type: none"> <li>As part of such review, Benchmark 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...</li> <li>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.</li> <li>BENCHMARK maintains the right to audit the OPTI manufacturing facility for conformance to agreed upon manufacturing flows at any time.</li> <li>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...</li> <li>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...</li> <li>AliGen may accept or reject the end products within thirty (30) days of delivery by Nitsuko. AliGen 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 AliGen. Nitsuko may reject the end products if it materially fails to meet the requirements... except normal bugs...</li> </ul>
2. Physical audits of development work permitted	<ul style="list-style-type: none"> <li>BENCHMARK maintains the right to audit the OPTI manufacturing facility for conformance to agreed upon manufacturing flows at any time.</li> <li>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...</li> <li>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...</li> <li>AliGen may accept or reject the end products within thirty (30) days of delivery by Nitsuko. AliGen 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 AliGen. Nitsuko may reject the end products if it materially fails to meet the requirements... except normal bugs...</li> </ul>
3. Reviews required of both (all) firms	<ul style="list-style-type: none"> <li>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...</li> <li>AliGen may accept or reject the end products within thirty (30) days of delivery by Nitsuko. AliGen 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 AliGen. Nitsuko may reject the end products if it materially fails to meet the requirements... except normal bugs...</li> </ul>
ENALTIES	<p>EXAMPLES</p> <ul style="list-style-type: none"> <li>For each Deliverable that is delivered more than thirty (30) days late... Fujitsu will reduce the applicable milestone payment by ten percent (10%)...</li> <li>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 Malaysian Banking Berhad...</li> <li>If Ross fails to deliver a Deliverable without errors or otherwise acceptable to Fujitsu after two attempts, Fujitsu may terminate this Agreement.</li> <li>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...</li> <li>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, HPP may at its sole option either (i) terminate this Agreement...</li> </ul>
4. Financial penalties for underperformance	<p>EXAMPLES</p> <ul style="list-style-type: none"> <li>For each Deliverable that is delivered more than thirty (30) days late... Fujitsu will reduce the applicable milestone payment by ten percent (10%)...</li> <li>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 Malaysian Banking Berhad...</li> </ul>
5. Right to terminate for underperformance (as distinct from material breach)	<p>EXAMPLES</p> <ul style="list-style-type: none"> <li>If Ross fails to deliver a Deliverable without errors or otherwise acceptable to Fujitsu after two attempts, Fujitsu may terminate this Agreement.</li> <li>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...</li> <li>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, HPP may at its sole option either (i) terminate this Agreement...</li> </ul>

**Table 3, Panel B: Contract Term Frequency & Cross-Frequency**

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

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

**Table 4: Contract Term Frequency by Group**

Contract term frequencies according to whether and what kind of repeat deals exist. Mean difference tests 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.

	(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)
<b>Contract Detail:</b>				
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 wor	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%
<b>Monitoring:</b>				
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% ***
<b>Penalties:</b>				
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 breac	17 32.7%	3 30.0%	5 50.0%	14 33.3%

**Table 5: Contractual Detail and Repeated Deals**

Ordered probit and probit models of the effect of prior deals on the level of contract detail. 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.)

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

\*, \*\*, \*\*\* significant at 10%, 5%, and 1% level for 2-tailed tests  
standard errors in parentheses

**Table 6: Monitoring and Repeated Deals**

Ordered probit and probit models of the effect of prior deals on inclusion of monitoring clauses. 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.)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ordered Probit Monitor = 0 to 5			Simple Probit Monitor = 0,1		
Prior deals (partner specific)	-0.112 (0.654)	-0.120 (0.658)	-0.609 (0.688)	0.000 (0.542)	0.005 (0.538)	-0.168 (0.689)
Concurrent deals (partner specific)	0.348 (0.546)	0.432 (0.671)	0.422 (0.657)	1.041 (0.670)	1.095 (0.774)	1.045 (0.784)
Prior deal experience (any partner)	0.278 (0.188)	0.287 (0.189)	0.124 (0.248)	0.419 ** (0.212)	0.427 ** (0.205)	0.346 (0.221)
Technology breadth (=1 if 'next generation', 0 otherwise)	0.564 (0.345)	0.554 (0.345)	0.559 (0.351)	0.352 (0.419)	0.337 (0.411)	0.396 (0.411)
Long term deal (=1 if >1 year, 0 otherwise)	0.156 (0.378)	0.120 (0.420)	0.275 (0.439)	0.508 (0.469)	0.500 (0.487)	0.562 (0.497)
Manufacturing &/or marketing	0.177 (0.308)	0.204 (0.304)	0.230 (0.311)	0.065 (0.422)	0.088 (0.411)	0.119 (0.417)
Cross border deal	-0.202 (0.351)	-0.204 (0.349)	-0.160 (0.353)	-0.772 (0.511)	-0.768 (0.509)	-0.677 (0.510)
Equity holding		-0.200 (0.471)	-0.057 (0.474)		-0.141 (0.570)	-0.110 (0.589)
R&D spending		2.260 (1.432)				0.755 (1.599)
Constant				-1.560 ** (0.629)	-1.541 ** (0.688)	-1.582 ** (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

\*, \*\*, \*\*\* significant at 10%, 5%, and 1% level for 2-tailed tests  
standard errors in parentheses

**Table 7: Penalties and Repeated Deals**

Ordered probit and probit models of the effect of prior deals on inclusion of penalty clauses. 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.)

	<i>Ordered Probit Penalty = 0 to 2</i>			<i>Simple Probit Penalty = 0,1</i>		
	(1)	(2)	(3)	(4)	(5)	(6)
Prior deals (partner specific)	1.354 ** (0.599)	1.361 ** (0.587)	1.031 * (0.566)	1.428 (0.920)	1.451 (0.944)	1.219 (0.877)
Concurrent deals (partner specific)	-0.095 (0.550)	-0.176 (0.564)	-0.232 (0.564)	-0.094 (0.630)	-0.126 (0.668)	-0.175 (0.664)
Prior deal experience (any partner)	0.728 ** (0.321)	0.707 ** (0.313)	0.583 * (0.303)	0.666 ** (0.317)	0.659 ** (0.312)	0.586 * (0.315)
Technology breadth (=1 if 'next generation', 0 otherwise)	-1.041 *** (0.327)	-1.017 *** (0.315)	-0.985 *** (0.334)	-0.972 ** (0.397)	-0.966 ** (0.393)	-0.929 ** (0.406)
Long term deal (=1 if >1 year, 0 otherwise)	0.020 (0.381)	0.038 (0.385)	0.146 (0.402)	0.151 (0.445)	0.160 (0.466)	0.238 (0.473)
Manufacturing &/or marketing	0.532 (0.410)	0.481 (0.425)	0.482 (0.426)	0.550 (0.446)	0.534 (0.455)	0.577 (0.452)
Cross border deal	-0.692 (0.427)	-0.702 (0.428)	-0.619 (0.429)	-0.963 ** (0.439)	-0.965 ** (0.442)	-0.857 * (0.453)
Equity holding		0.259 (0.442)	0.377 (0.500)		0.076 (0.494)	0.088 (0.504)
R&D spending			1.630 (1.717)			0.840 (1.762)
Constant				-0.711 (0.580)	-0.718 (0.587)	-0.790 (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

\*, \*\*, \*\*\* significant at 10%, 5%, and 1% level for 2-tailed tests  
standard errors in parentheses