FORMAL AND INFORMAL GOVERNANCE IN TECHNOLOGY ALLIANCE CONTRACTS

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ABSTRACT

We examine technology alliance contracts in detail, to explore if and how formal contract terms vary with the availability of informal governance. Traditionally, formal governance has been viewed as the means to address the moral hazard problem, via explicit contractual mechanisms. Via the contract, partner obligations are explicitly specified and uncertainty is dealt with by inclusion of contingent claims. Formal contracting, however, is costly and not the only solution to the moral hazard problem inherent in alliances. Informal governance, or discipline mechanisms outside the contract itself, can encourage cooperative behavior between partners. More specifically, repeated interactions can, through implicit mechanisms, serve to mitigate moral hazard. We use a case study approach to explore the contract mechanisms that reveal a possible interaction between formal and informal governance. By examining actual contracts, we can see first hand the variety of processes that contracting parties have invented and whether these processes are complementary or substitutable for one another. While we conjecture here as to the source of discovered contract variation, this exploration is intended primarily to facilitate later empirical analyses to test whether contract regularities are consistent with theoretical predictions.

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1. INTRODUCTION

As the cost and risk of technological development grows, firms continue to look for alternatives to purely in-house R&D. R&D alliances represent one such alternative - a means by which firms can spread the risk and cost of new development and gain access to unique technologies. While such alliances are increasingly attractive to firms in technologically intensive industries, the attendant risks can be substantial. Firms entering into R&D alliances face considerable moral hazard problems, since partner behavior is often unobservable and the costs of opportunism are potentially high. Allying firms often cannot be sure that their partners are contributing equitably to the alliance activities. Partners may, for example, contribute fewer or lesser quality inputs to the alliance than originally agreed. Allying firms also risk unintended transfer of valuable technologies to their partners, given imperfect intellectual property rights protection. Firms, of course, recognize these issues and often develop/adapt alliance governance mechanisms as a response to these problems.

Recognizing this, researchers argue that the governance mechanisms we observe reflect a rational attempt to induce either efficient ex ante investments (i.e., property rights theory)[1] or to reduce ex post bargaining and hold up threats (i.e., transaction cost economics)[2]. For example, Lerner and Merges (1998) examine the allocation of control rights in biotechnology alliances as a function of the financial resources and technology endowment of a partner, while Oxley (1997) uses a transaction cost approach to examine

[1] That is, property rights theory ('PRT') as developed initially by Grossman and Hart (1986). Under PRT, contracts are necessarily incomplete – required investments are not fully contractible. Thus, organizational form is determined by an allocation of ownership and, consequently, control rights that will induce an efficient level of investment by parties to the contract. For a thorough review of this literature, see Hart (1995).

[2] Using a transaction cost economics approach, governance or contract structure is chosen on the basis of ex post quasi rents, which are driven by the combination of incomplete contracts and relationship specific assets. Generally, the more specialized are relationship assets (such that partners face sharply reduced values for those assets outside the relationship), the larger the quasi rents and the higher the likelihood of integration (e.g., Williamson 1975; Masten 1984; Joskow 1988).

the choice of equity joint venture over more contractual modes of organization as a function of transaction characteristics. Generally, these studies have focused on the choice of formal organization to control either ex ante or ex post contracting costs. A useful complement to these studies is to examine the effects of informal governance (or implicit contracts) on the design of formal governance.

Here, we examine technology alliance contracts in detail, to explore if and how formal contract terms vary with the availability of informal governance. Traditionally, formal governance has been viewed as the means to address the moral hazard problem, via explicit contractual mechanisms. Via the contract, partner obligations are explicitly specified and uncertainty is dealt with by inclusion of contingent claims.[3] However, complete contracting to ensure cooperative (or at least efficient) behavior is costly, particularly in uncertain environments (e.g., Crocker and Reynolds, 1993). In practice, incomplete, rather than complete contracts appear to be the norm, reflecting the cost (and in some cases the impossibility) of complete specification.

Formal contracting is, of course, not the only solution to the moral hazard problem inherent in alliances. Informal governance, or discipline mechanisms outside the contract itself, can encourage cooperative behavior between partners. More specifically, repeated interactions can, through implicit mechanism, serve to mitigate moral hazard (Benoit and Krishna, 1996, survey the theoretical foundations). Both theoretical and empirical studies have shown that such repeated interactions can act as a discipline mechanism that supports cooperative behavior among competitors. For example, Green and Porter (1984) demonstrate that a cartel is sustainable when firms repeatedly interact. Similarly, Bernheim and Whinston (1990) show that, under certain market conditions, multimarket contact can sustain cooperation between competing firms. The foundations of these

[3] As Crocker and Masten (1991:71) note, "the presumption is clear that courts will either direct specific performance or apply appropriately measured damages to assure that the intentions of the parties are fulfilled."

arguments are comparable to those made by Robert Axelrod (1984): a 'tit for tat' strategy in a repeated game setting can support long-term cooperation. Analogously, repeated contact among allying firms can provide a discipline mechanism that supports cooperation. Ryall and Sampson (2001) extend these earlier theoretical results to the context of R&D alliances and find that indefinitely repeated interactions induce efficiency between partners.[4] In the context of alliances, repeated interaction may take two forms: (1) interactions outside the focal alliance in the form or prior or concurrent alliances between the same partners; or (2) contracts of indefinite duration (i.e., where no termination date is explicitly specified). Given the cost of drafting complete contracts, we expect that where informal mechanisms exist, contracts are less complete. This primary hypothesis is an empirical question, which we tackle via a case study approach rather than a large-scale empirical analysis at this stage.

We use a case study approach to explore the contract mechanisms that reveal a possible interaction between formal and informal governance. Our goal is to explore a set of technology alliance contracts with a view to identifying the terms used by partners to deal with the moral hazard problems inherent in inter-firm alliances. Technology alliance contracts are as varied as the alliances themselves, ranging from contracts for joint development of a simple technology to development of a next generation microprocessor. Some are very formal documents with highly detailed clauses and lengths over one hundred pages, while others are fairly simple five page documents with the most general of terms. This heterogeneity lends itself to a case study approach.

Our knowledge of alliance contract terms is somewhat limited, primarily because of the difficulty in obtaining such contracts.[5] More detailed information on the contract

[4] Our definition of efficiency here is a fairly narrow one; we are concerned with the joint efficiency for the parties to the contract, not efficiency for any broader group.

[5] Recently, the coded terms provided by Recombinant Capital on biotechnology alliances has allowed a more rigorous examination of alliance contract terms (see, e.g., Lerner and Merges, 1998; Robinson and Stuart 2001). However, since Recombinant Capital codes the terms of the contracts, we cannot view the terms in categories not coded nor the actual language used in the contract. Given the substantial

terms themselves can provide, "sorely needed data about the way in which reasonably clever businessmen and lawyers cope with problems that scholars might consider intractable," (Goldberg and Erickson, 1987:369). Here, we provide such analysis of technology alliance contracts in the telecommunications equipment manufacturing and microelectronics industries. While we conjecture here as to the source of discovered contract variation, this exploration is intended primarily to facilitate later empirical analyses to test whether contract regularities are consistent with theoretical predictions as advanced (e.g.) in Ryall and Sampson (2001).[6] With our case study approach, we can examine variation in contract terms with a view to developing a coding scheme for this larger scale empirical analysis. We aim to identify what makes a contract more or less complete, the form of monitoring clauses, adjustment mechanisms and penalty clauses and other clever solutions that firms have devised to resolve inter-firm coordination problems. By examining the actual contracts, we can see first hand the variety of processes that contracting parties have invented and whether these processes are complementary or substitutable for one another.

Our source of alliance 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 alliance contracts. We examine contracts for technology alliances, filed by firms in the telecommunications equipment and microelectronics industries. Since the SEC requirement is to file material documents and not alliance contracts specifically, filing of these contracts is somewhat discretionary. As a result, firms tend to file contracts

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heterogeneity in technology alliance contracts in industries outside biotechnology, we stand to benefit from a broader exploration. By examining actual contracts, we can observe unique solutions firms have devised to deal with thorny contract issues.

[6] As noted by Jensen et al (1989), this case based exploration may also have the opposite (albeit valuable) effect, raising "new questions and puzzles, rather than providing new answers."

for their most substantial or important alliances.[7] In order to obtain the largest sample possible, our contracts are collected for the years 1991 to 2000, inclusive.

We begin with a broad description of the contracts we examine as part of this study – a sample of over 80 technology development alliance contracts. We then explore the variety of formal mechanisms used by alliance partners to deal with the underlying moral hazard problems. This exploration uncovers the diverse clauses used to specify inputs and outcomes, ownership of subsequently developed intellectual property, monitoring and procedures for contract adaptation and dispute resolution over the course of the alliance. Further, we examine the variance of these terms across different contexts, namely examining whether terms differ depending on (1) contract duration (i.e., indefinite or not); or (2) the existence of interactions outside the focal alliance in the form of concurrent or prior alliances. We then conclude by discussing the implications of our analysis and possible links to theory.

2. TECHNOLOGY ALLIANCES IN THE TELECOM EQUIPMENT & 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 collaborate in their R&D activities. Firms involved in technology alliances range in size from the largest players in each industry such as Motorola and IBM, to much smaller, more specialized firms like Global Village

[7] The natural limitation of this data is obvious – we observe only contracts of public companies and likely only the largest and most important alliances. We will only observe small firms in the sample where they have partnered with public companies and the contract is filed with the SEC. However, we feel that this limitation is outweighed by the ability to access actual contract terms and variation. As with any limited sample study, care must be taken in drawing generalized conclusions.

Communication and Positron Fiber Systems.[8] These collaborations take many forms, including cross-licensing arrangements,[9] joint technology development agreements and formal joint ventures for development and manufacturing. Consistent with prior observations on the change in focus of cooperative R&D efforts, we do not see any examples of truly basic research in our sample contracts. Firms appear to focus on end product or manufacturing process driven R&D.

We confine our consideration to those alliances involving some form of joint development whether this joint development is very limited in scope or involves co-location of research personnel in the case of some joint ventures.[10] These alliances, 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[11] to developing a 'next-generation' ferroelectric chip.[12] These variations in purpose, along with the difference in availability of informal governance, are likely reflected in the structure of the alliance contracts.

Contracting for joint technology development is difficult at best. The complexity and uncertainty surrounding collaborative R&D efforts creates a fertile environment for partner opportunism. Firms often cannot directly observe their partner's R&D efforts.

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

[9] Interestingly, these cross licensing arrangements are often explicitly set up as covenants not to sue for patent infringement.

[10] Thus, we explicitly exclude those alliances 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 degree of contracting difficulty (in most cases) as alliances involving some joint development between firms. We wish to focus on the contract heterogeneity that may result from the existence of informal governance. As such , we try to control for other sources of heterogeneity by limiting our scope of examination and, thus, excluding license contracts.

[11] For example, the 1997 alliance between Fujitsu and Ross Technology is for the development of a microprocessor core based on Ross' 'Colorado 4 Architecture' for use by Fujitsu as an embedded microcontroller.

[12] The 1999 alliance between Ramtron International and Fujitsu was for this purpose.

Further, because of the idiosyncratic nature of R&D,[13] it is frequently not possible to infer effort provided by observing outcomes. Further, since joint technological development often requires pooling or at least exposure to partner firm technologies, firms are naturally concerned about leakage of intellectual property outside the spirit of the alliance. Substantial moral hazard and, consequently, contracting difficulties result. Below, we turn to the responses of firms to these contracting challenges and explore what terms firms use to constrain non-cooperative behavior.

3. STRUCTURE OF THE ALLIANCE CONTRACTS

There are multiple dimensions upon which we can examine alliance contract structure. Since we are interested in the interaction between formal and informal governance, we focus here on variation in those terms that we expect will become less important in ensuring cooperative behavior when strong informal governance is present. We consider here the degree of contractual completeness, the extent of monitoring and adjustment mechanisms, and the availability of penalties for underperformance. Contract completeness refers to the degree to which required inputs, expected outputs and division of intellectual property rights are fully specified. Monitoring mechanisms are a complement to these terms specifying effort and performance requirements, but become more important in situations where complete contracting is not feasible. Via monitoring, the probability that underperformance will be detected increases. Coupled with penalties for non-compliance with agreed terms, monitoring is a possible solution to the moral hazard problem. Finally, formal adjustment mechanisms allow firms to change the terms of the contract over time in order to ensure continued efficiency typically in response to environmental uncertainties. All of these mechanisms are costly to draft and, as such, we

[13] Holmstrom (1989:309) notes that R&D projects are: "...(a) risky - there is a high probability of failure, but also extraordinary returns; (b) unpredictable - many future contingencies are impossible to foresee; (c) long term and multistage - the project has an invention, a development and a completion stage, and can be terminated between those; (d) labor intensive - all stages require substantial human effort; and (e) idiosyncratic - not easily comparable to other projects."

might expect to see less well specified contracts, fewer monitoring and adjustment mechanisms and fewer penalty clauses when firms have alternative means of governing their technology collaborations.

As mentioned above, we then consider two signals that may capture the extent of informal governance: termination dates (indefinite or definite) and interactions outside the current alliance (whether prior or concurrent alliances between the same partners). Termination dates are typically spelled out in alliance contracts and either specify whether the alliance is ongoing unless terminated (e.g., for material breach) or has a fixed end date. We see the entire range in our contracts here – contracts with very short time frames of eighteen months or less, contracts that terminate on completion of specified tasks (expected to last two to three years), and contracts that continue indefinitely. Of those contracts with fixed termination dates, many have provisions for renewal, some automatic, some only on mutual agreement of the partners. Contracts of indefinite duration signal that the number of future interactions between the partners is uncertain. There is a positive probability that the firms will have an ongoing relationship at any point in the future, in contrast to contracts with fixed termination dates or those that terminate on the successful completion of a task.[14] The prospect of retaliation in future periods may curb non-cooperative behavior in current periods. An alternative means to capture informal governance is via the existence of repeated interactions *outside* the focal alliance. The idea here is similar to that with termination dates, in that firms may retaliate outside their current alliance and that the threat of this retaliation curbs current non-cooperative behavior.[15]

[14] In this last case, firms may be better able to assign a probability of future interactions than in the indefinite case, but uncertainty still exists.

[15] Given that we can only observe past and concurrent alliances, there is another possible interpretation of our measure of informal governance – reputation. These past and concurrent alliances may signal a positive reputation (albeit relationship specific). To the extent that the firm has an interest in preserving this reputation, likely based on its expectation of future beneficial transactions with that partner, the firm may refrain from non-cooperative behavior (Kreps, 1990). In this sense, the past relationship may signal future value to be destroyed with non-cooperative behavior. While such reputation does not directly signal the

As is illustrated in the paragraphs below, there is considerable variance between contracts in the level and detail of specification, even when the stated purposes of these alliances are similar. For example, both the ST Microelectronics/Benchmarq and AMD/Fujitsu alliances are for the purpose of developing flash memories (CMOS), but the contracts vary substantially. The ST Microelectronics/Benchmarq alliance contract is fairly detailed, listing, for example, the number of employees contributed by each firm to a joint production team and fixed prices for wafers supplied to the project. Monitoring provisions are similarly detailed, specifying the frequency and precise content of progress reviews. In contrast, the AMD/Fujitsu alliance contract is far less detailed, specifying, for example, that parties shall 'fully cooperate' but not detailing what contributions and timing that full cooperation requires. Unlike the ST Microelectronics/Benchmarq contract, there are no specific requirements for process reviews; the contract is silent on monitoring of joint development.

Could this sharp contrast result from the substitution of informal for formal governance? The ST/Benchmarq agreement has a fixed termination date, while the AMD/Fujitsu contract does not. Further, AMD and Fujitsu have an extensive history of prior alliances together. From these two facts, it might appear that AMD and Fujitsu have more substantial informal governance to support their current alliance, in contrast to ST and Benchmarq. While confirming (or refuting) this conjecture is left for larger scale empirical work, exploration and development of a coding scheme that indicates the extent of formal governance is the goal of our analysis below.

Before exploring the contract variation, it is worthwhile to discuss what we have found as common terms between alliance contracts or 'boilerplate' terms. With an understanding of what is common among these alliances, we can then focus on what is not in common. Most alliance contracts contain similar provisions on ensuring

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extent of future repeated interactions, reputation does represent an informal governance mechanism and is, thus, relevant for our examination here.

confidentiality of partner technologies and no leakage to third parties, the right to terminate the alliance on bankruptcy or change in key management of a partner, limitations of liability, and arbitration provisions. Still common, but less frequent, are clauses specifying cross licensing of all partner patents (whether related to the alliance technology or not) so as to avoid infringement over the course of the alliance. In joint venture alliance contracts, percentage stakes in the venture are usually specified, as are the establishment and composition of a board of directors. Not surprisingly, when firms are engaged in multiple alliances with the same partner, these boilerplate terms are identical between alliance contracts. Examples of the contract language used in these boilerplate terms are set out in Appendix A.

One boilerplate provision worth discussing further is the use of arbitration provisions. Most of the alliance contracts in our sample have provisions that specify 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.[16] Some arbitration provisions also create disincentives for seeking arbitration by, for example, in the case of a cross-border joint development alliance, requiring arbitration to be conducted in the language and country of the partner firm NOT bringing the dispute.[17] These arbitration provisions likely reflect the inefficiency of external resolution of contract disputes, particularly when contracts are necessarily incomplete. Courts (and even arbitrators) have difficulty inferring the

[16] For example, the alliance contract between Fujitsu and Ross Technology (dated 3/31/97) states, "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."

[17] The joint development agreement between Ramtron International and ULVAC (Japan) (dated 4/9/97) requires arbitration to take place in Japan and be conducted in Japanese if Ramtron, a Colorado microelectronics company, initiates the dispute, and in the US in English if ULVAC initiates the dispute.

intentions of contract parties and, as such, legalistic enforcement is often sub-optimal when compared to private resolution.[18]

These boilerplate terms likely reflect the issues common to all technology alliances – concerns over leakage to third parties, fundamental changes in partner status (such as ownership), and the inefficiency of external dispute resolution. The terms that vary arise out of differences in alliance goals, environmental uncertainty, and propensity for strategic behavior. These factors affect whether firms can craft complete contracts and the cost of doing so. The availability of informal governance, we argue, determines the need for such complete contracts.

For our initial analysis, we focus on the contracts of a few firms in the sample.[19] In order to minimize contract variation from firm-specific boilerplate terms, we chose firms with multiple technology alliance contracts in the sample.[20] Here, we analyze the alliance contracts of two firms: Fujitsu Ltd. and Ramtron International Corporation. Both of these firms have extensive alliance experience, particularly in alliances concerning technology development and transfer, over the last decade.[21] Hopefully, this extensive prior alliance experience means that the clauses are approaching 'equilibrium' and we will observe less

[18] Crocker and Masten (1991:71) note, "The legal system does not costlessly and unerringly assess remedies. On the contrary, there are reasons to believe that courts systematically deviate from efficient awards. Claims for damages, for example, are subject to a requirement of 'proof with reasonable certainty.' In cases where lost profits cannot be adequately established, recovery is likely to be limited to the cost of reliance, implying lower than optimal awards on average. An even if court-determined damages were not systematically biased, the cost of adjudicating damage awards would diminish the attractiveness of litigated enforcement." Further, legal remedies for breach of contract under neoclassical law are limited and often frustrated by various excuse doctrines (Macneil, 1974).

[19] This draft is preliminary and incomplete. Our analysis will deepen as we continue to add contracts.

[20] In later drafts, we will conduct further comparisons to see if these terms are consistent across the body of the contracts.

[21] According to the Securities Data Corporation (SDC) Database on Joint Ventures and Alliances, Fujitsu and Ramtron entered into 353 and 18 alliances, respectively, during the years 1991 to 2000. Given that SDC collects information on alliances from public sources such as news reports and industry journals, coverage of larger firms is typically better than that for smaller, more focused firms like Ramtron. Unfortunately, we do not have a contract for each of these alliances. As mentioned above, the number of alliance contracts available is far less than the number of alliances for a firm, since firms are only required to file 'material documents' and not alliance contracts specifically.

randomness, since the firms have had opportunity to adapt alliance contract terms in response to successes and failures over time. Below, we give brief backgrounds on the firms and then discuss the contracts across three dimensions: completeness of specification, extent of monitoring and adjustment mechanisms and whether penalties for underperformance exist.

Ramtron International Corporation

Ramtron is a developer of specialty high performance semiconductor memory devices. Ramtron has two primary product lines: ferroelectric random access memory (FRAM) and high-speed dynamic random access memory (DRAM). These memories are used in many electronic devices, including PCs, communications devices, laser printers and video graphics systems. Ramtron is a US based company, with its headquarters in Colorado Springs.[22] Ramtron filed two technology alliance agreements during the sample period: (1) with ULVAC Japan in 1997; and (2) with Fujitsu Ltd. in 1999.

Ramtron's alliance with ULVAC[23] was for the development of thin film process systems and materials used in its FRAM technology.[24] This 1997 alliance was the first between the two parties. The alliance contract is a detailed one, relative to several others in our sample. Via the 'Statement of Work' ('SOW') incorporated in the contract, work schedules and milestones set out a fairly detailed framework for planned activities and events. The firms detail two development phases for developing manufacturing improvements using four types of ULVAC fabrication equipment. These development

[22] Sources: Media General, Dow Jones and Hoover's Inc.

[23] ULVAC Japan, Ltd., is a Japanese based global supplier of production systems, instrumentation, vacuum pumps and components for semiconductor, flat panel display, disk/magnetic media and industrial vacuum and medical applications. (Source: Dow Jones)

[24] Clause 1: "… Under the development project, the parties shall jointly conduct materials and process solution experiments to the FRAM fabrication process that shall result in achieving optimal FRAM performance at the device level, pursuant to the terms and conditions as more fully described in the Statement of Work…"

phases are well defined; the contract specifies the time frame for completion[25] and the requirements for the completion of some, but not all, phases.[26]

Perhaps more importantly, the contracts describe the contributions required by each firm. For example, Ramtron is responsible for providing a minimum of fifty wafers per month for development, while machine time and technical support for joint development work will be at ULVAC's cost.[27] Specific persons are designated in the contract as project leaders for the joint development work.[28] The contract also clearly sets out intellectual property rights for each of the parties: both firms retain intellectual property rights for their respective technologies developed prior to the alliance, while IP rights on inventions by either party during the alliance are shared equally (even if independently developed).[29] Also specified are how the two firms will share costs[30] and the termination

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[25] From SOW, clause 2.1: '…this phase, lasting nine months from the date of signing this agreement'

[26] From SOW, clause 2.1: '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.'

[27] There are multiple examples of these specific contributions in the SOW. We set out two for illustration here.

> Clause 4.1: 'Necessary number of stack and/or individual layer films will be patterned photolithographically at Ramtron for etch development work at ULVAC.'
>
> Clause 2.2: 'Phase 2: The SPZ-1000 machine will be transferred to Ramtron, Colorado Springs at the beginning of Phase 2. The work undertaken will include composition, microstructural, electrical and other optimizations. Specific Phase 2 objectives will be defined by the parties through mutual consultations. A minumum of 50 wafers per month will be supplied by Ramtron for the development. Machine time for joint development work will be shared with customer evaluations, at ULVAC's cost and Ramtron prototype production. ULVAC will provide in-house support during Phase 2 to the extent agreed by the parties…'

[28] From the contract, Clause 2: 'The parties hereby agree that the Project Leader for Ramtron shall be Mr. Tom Davenport and the Project Leader for ULVAC shall be Mr. Yoshifumi Ota. The responsibilities of the project leaders shall be to coordinate the individual work and/or shared work as set forth in the SOW with respect to the equipment deliverables as described in Attachment "B" and the cost sharing as described in Attachment "C"…'

[29] Clause 11(c): 'Ramtron and ULVAC shall jointly own, in equal and undivided shares, all right, title and interest in and to any improvements, enhancements and/or inventions made by either party during the terms of this Agreement… In the event that any patentable joint improvement is discovered under this Agreement during the preceding period,… the Joint Development Technology Committee shall… determine… whether or not a patent application will be prepared and filed for such invention…'

date of the alliance (four years from the date signed, unless extended by mutual agreement). Overall, the contract is quite detailed, with explicit contributions, benchmarks, and property rights set out.

While the contract is quite detailed, it does not have provisions for monitoring development progress by either party or penalties for underperformance. Some clauses do allow flexibility in, for example, determining the completion of phases,[31] there are no explicit clauses for renegotiation or adjustment of terms over the life of the alliance.

The contract between Ramtron and Fujitsu Ltd., for the development of a new ferroelectric chip, is also well specified. While the development goal is broader in this alliance, with the parties aiming to develop a 'next generation' ferroelectric chip, the length of the contract is shorter[32] and the contract appears to be as well specified as the Ramtron/ULVAC contract. A detailed development plan with target dates, the number of engineers and specific equipment to be provided by each party, and responsibilities for maintaining equipment is included as part of the alliance contract. Both firms specify particular managers to serve on the joint development project. In this alliance, each firm is largely responsible for the work conducted at its own facility,[33] in contrast to the assignment of tasks by function in the Ramtron/ULVAC alliance. However, specific technological contributions from each side are set out in the contract, independent of

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[30] Attachment "C" to the contract splits the costs between firms, specifying, for example, that Ramtron is responsible for costs pertaining to wafers for evaluation and evaluation work of the samples, while ULVAC is responsible for sampling work and modification of work materials.

[31] Clause 2.1, SOW: "…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…"

[32] The alliance lasts only, 'until the end of calendar year 2000,' which is little over eighteen months from the contract signing date. However, given the parties had a substantial pre-existing working relationship with several alliances since beginning to work together in 1996, this short clock for completion of the tasks may not be entirely unrealistic.

[33] For example, from the Ramtron/Fujitsu contract, clause 4(a): 'Ramtron shall provide Program management and oversight for that portion of the Program that takes place at the [Ramtron] facility,...'

location.[34] Intellectual property rights are specified similarly to the Ramtron/ULVAC contract. A common thread of these two contracts is that both have fixed termination dates and are reasonably complete contracts, in terms of specifying inputs, intellectual property rights, and milestones for completion.

Notwithstanding these similarities, important distinctions exist. First, Fujitsu has the right to terminate the contract if Ramtron does not meet the milestones set out in the development plan; Ramtron has no similar right to terminate.[35] This early termination on underperformance may well be considered a penalty clause. Second the contract provides for some limited monitoring, via joint quarterly reviews of progress compared to the development plan.[36] This review is contemporaneous with payments of approximately $1M by Fujitsu to Ramtron. Finally, the firms have explicitly provided for adjustments to the development plan over the course of the alliance.[37]

Fujitsu Limited

Fujitsu Ltd. is a manufacturer of computers and information processing systems with applications in the software, information processing, telecommunications and electronic device sectors.[38] Fujitsu is substantially larger than Ramtron, with over $41 billion in

[34] Clause 5(e): '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,…' Similarly, clause 4(d) provides, 'Ramtron shall provide and make available to the Program Ramtron's FRAM technology,…'

[35] Clause 11(b): '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…'

[36] Clause 3 provides: "… 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…"

[37] Clause 3: "… Fujitsu and Ramtron anticipate that, from time to time, they may by mutual agreement refine and modify the objectives and/or specifics of the Development Plan. Fujitsu and Ramtron agree to negotiate in good faith any additions or changes to the Development Plan… Fujitsu and Ramtron may amend the Development Plan in writing; and, upon the written approval of any such amendment… the amended Development Plan shall become party of this [agreement] and shall replace the then-current Development Plan."

[38] Source: Worldscope.

assets compared to Ramtron's $38 million, and is much more diversified than Ramtron. Fujitsu filed four technology alliance contracts during our sample period. These contracts are with (1) Ramtron International (as discussed above); (2) Ross Technology in 1997, (2 alliance contracts); and (3) Advanced Micro Devices ('AMD') in 1993.

Fujitsu's multiple alliances with Ross Technology[39,40] surround the development of a microprocessor core for Fujitsu based on Ross' proprietary microcontroller technology. The first of two related alliance contracts (dated 3/31/97) is scheduled to terminate on completion of specified goals. Contributions are specified for both parties: Ross is to develop a new microprocessor core in conformance with specifications supplied in the agreement,[41] while Fujitsu bears all silicon and other development costs.[42] Fujitsu also pays Ross for the development work, suggesting that, while Fujitsu is covering costs, Ross is providing the bulk of the technology and development work. Explicit payment terms are set out in the contract; Fujitsu pays a total of $4.5M to Ross upon completion of various benchmarks.[43]

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[39] Two of these alliances are discussed here. However, Fujitsu entered into more than half a dozen alliance contracts with Ross International (previously Cypress Semiconductor) over the sample period. Information on other alliances during the period comes from the Securities Data Corporation ('SDC') Database on Joint Ventures & Alliances.

[40] Ross Technology is a supplier of SPARC microprocessors and SPARC system products to both OEM and end user markets. (Source: Dow Jones)

[41] Clause 2.3(a) states, 'Ross hereby agrees to develop and complete the Manufacturing Test Vector Suite, Test Vehicle and the initial System Development Board in accordance with the Schedule and in Conformance with Specifications.'

[42] Clause 3.4(a): 'Fujitsu shall bear all mask charges and silicon costs… and the cost of PGA packages for all prototype units. Fujitsu shall also pay the cost of the test fixture hardware to be used by Ross to verify the Test Vehicle at rated speed, provided that the purchase of any such hardware has been pre-approved by Fujitsu in writing.'

[43] Clause 3.1: 'Develoment Fee. Fujitsu shall pay a total of … ($4,500,000) to Ross for the performance of the services and delivery of the Deliverables… which shall accrue as follows: (a) $3.5 million on acceptance by Fujitsu of the Existing Core…; (b) $0.2 million on acceptance by Fujitsu of the Verilog Model and Simulation Environment…' This type of benchmarking 'cash for development' clause is similar to those found in biotechnology alliances.

While Fujitsu is to provide 'reasonable assistance' and input regarding the development of the specifications of the new microprocessor, the bulk of the development work rests with Ross.[44] Thus, in contrast to the alliance contracts above, where firms engage in more joint development with each contributing technologies, this alliance resembles a 'fee for services' arrangement more closely than a collaborative development venture. As we might expect with service type contracts, the party paying the fee has explicit rights to review progress and levy penalties for failure to meet deadlines. Ross is to provide written progress reports on Fujitsu's request and Fujitsu has the right to conduct physical reviews at Ross' premises. If Ross fails to deliver on schedule, Fujitsu can reduce the specified benchmark payment by 10% and may terminate the contract in the case of repeated failures.[45] If the contract is so terminated, Ross is required to pay offset fees to Fujitsu of up to $1.5M. Interestingly, Ross retains ownership of developed intellectual property and all new inventions over the course of the alliance remain the sole property of the inventor. Joint technology developments, though not anticipated by the parties, are to be discussed on a case-by-case basis.[46] This allocation of intellectual property rights may reflect the relative importance of each firm's upfront investment. That is, consistent with property rights theory (e.g., Grossman and Hart, 1986; Hart and Moore, 1990), residual rights over developed assets are left with the firm whose contribution is more important for the success of the alliance.

Fujitsu's second alliance contract with Ross (dated 4/1/97) also is for the development of Ross technology for Fujitsu purposes. The technology under the contract

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[44] Clause 5.1: '…Ross has primary responsibility...'

[45] Clause 6.3(b), states that, '…For each Deliverable that is delivered more than thirty (30) days late…Fujitsu will reduce the applicable milestone payment by ten percent (10%)…' Clause 6.3(a) allows termination on repeated failures: 'If Ross fails to deliver a Deliverable without errors or otherwise acceptable to Fujitsu after two attempts, Fujitsu may terminate this Agreement…'

[46] Clause 8.2(c): 'Although the parties do not anticipate joint development of inventions hereunder, in the event of joint development of an Invention, the parties will meet in good faith to discuss, on a case-by-case basis, ownership and license rights…'

is a different technology than that in the contract described above and the terms vary slightly. Like the first contract, the alliance terminates automatically on completion of the specified tasks. However, this second contract differs from the first on several dimensions. First, Fujitsu is more involved technologically in the development, supplying licensed technologies and making its engineers available to Ross.[47] Second, intellectual property rights on jointly developed technologies are jointly owned. Finally, Ross has five times to correct an error in a deliverable before termination for underperformance, in contrast to the two attempts allowed under the first contract. Ross is also permitted to request modification of the milestone schedules, which was not permitted in the first contract. These differences may reflect a more uncertain development project, with the resulting need to allow broader tolerances for performance, and/or the joint involvement of both parties from a technological standpoint.

The final alliance contract considered in this preliminary analysis is between AMD and Fujitsu (dated 3/26/93) for the purposes of developing CMOS (flash memory) technology for the AMD-Fujitsu joint venture (Fujitsu AMD Semiconductor Ltd.). Unlike the prior agreements considered here, the joint development contract is of indefinite duration – no termination date or event is specified. Some obligations of the firms are specified in the contract. For example, firms are required to contribute managers to a Joint Development Committee, which has the right to amend the joint development program by consensual decision making.[48] This joint decision making facilitates adjustment by mutual agreement over the course of the alliance. AMD and Fujitsu both are also required to set up process development teams with co-leaders from

[47] Clause 3.3 states, 'Engineers. At the request or Ross, Fujitsu will consider making available to Ross, to assist in the performance of the Services, Fujitsu and/or HaL engineers familiar with the SPARC architecture and with the development of SPARC-compatible microprocessors.'

[48] Section 2.1 states, 'In order to amend [the development plan], the parties shall establish a committee consisting of engineering managers from each party (the "Joint Development Committee")… The Joint Development Committee shall agree unanimously before making any amendments…'

each firm. The development processes are set out in a reasonable level of detail, specifying development steps for both new processes and new products. While this process and benchmarks are specified, there is little specification of actual inputs required of each firm. No particular managers or personnel are specified, in contrast to the Ramtron/ULVAC contract agreement for example, and while contributions are valued in the agreement, specific contributions are not laid out.[49] Each firm is to bear its own costs in the course of the development and design work.

Unlike the other contracts considered so far, the joint development work in this alliance is actually co-located – the contract stipulates that the development work is to be jointly conducted at the same location.[50] This is a relatively rare provision. Several of the development contracts thus far analyzed permit some engineer exchange, but few actually stipulate co-located development. This, along with a pre-existing joint venture between the firms, suggests that the level of technological interdependence between the Fujitsu and AMD is high. While such co-location allows greater monitoring of partner activities, it also increases the likelihood of unintended technology transfer.

Intellectual property rights over jointly developed technology are shared and neither firm may patent the new technology without the consent of the other. However, both Fujitsu and AMD have the right to use and sell products related to the new technology independently, without permission of the other firm. If the technology is developed independently without the use of the other firm's technology, the developer retains exclusive rights to the technology. This is in contrast to some of the above contracts,

[49] Section 13.13: 'Tangible Property. The parties agree that the tangible portion of the property delivered and to be delivered by AMD to Fujitsu is valued at [blocked] and by Fujitsu to AMD is valued at [blocked]'

[50] Section 2.3: 'The parties shall fully cooperate with each other in performing such development and design work and *will jointly conduct such work at the same location* to the extent possible to enable Fujitsu and AMD *to develop a better understanding of each other's technological culture and methodology*. 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 so that the other party might join in such work and shall inform the other party of all results of such work immediately upon its completion.' Emphasis added.

where firms may retain exclusive rights to new technologies if the new technology relates to the firm's existing core technologies. This may reflect the fact that Fujitsu and AMD have much more technological overlap than partners in above considered agreements.

4. INTERPRETATION & DISCUSSION

The alliance contract detail we provide here illustrates the breadth of solutions that allying firms have devised to coordinate R&D across firm boundaries. In designing their contracts, allying firms have to devise means to constrain non-cooperative behavior. We summarize three dimensions of this formal governance here.

First, firms can draft tight contracts to better define cooperative behavior. This 'contractual completeness' can be considered on multiple grounds, including whether specific development goals and benchmarks are set (as in the Ramtron/ULVAC and Fujitsu/Ross contracts) or whether goals are more general in nature (as in the AMD/Fujitsu contract). Several other dimensions of contract completeness are identified here, including: (1) the extent to which time frames for completion are set; (2) the specificity of intellectual property rights (for example, whether specific technology improvements are reserved for one firm, rather than equally shared); and (3) the extent to which responsibilities for bearing costs of development are specified. The more complete the contract, the easier it is to observe failure to meet objectives and the more efficient is external enforcement. All of the contracts in our initial analysis specify contributions to some degree.

Second, firms can require periodic progress reviews and physical audits to monitor joint development. Monitoring dauses appear to be relatively straightforward to assess – three situations are observed (in the case of a two firm alliance): (1) both firms are monitored and subject to review by, for example, having to provide reviews to each other on particular technology improvements; (2) only one firm is subject to review, as in the case of more one-sided technology development; or (3) neither firm is explicitly subject to formal review by the other. Clearly, both firms being subject to review suggests the

strongest formal governance, as far as monitoring is concerned. Some, but not all, of contracts in our sample have requirements for periodic reviews.

Finally, firms can levy penalties on their partners for underperformance. This underperformance is typically defined as failure to meet benchmarks within a set timeframe. We observe two types of penalties here: (1) financial penalties; and (2) early termination. The availability of these penalties strengthens formal governance and may discourage non-cooperative behavior. Few contracts specify penalties for underperformance.

A summary of the terms available to the firms, as illustrated by the contracts analyzed here, is set out in Appendix B in the form of a suggested coding scheme. We expect that the greater the number of these mechanisms used, the stronger the formal governance.

The question is, can we link the strength of formal governance to the presence of informal governance? In our limited sample here, contracts appear to be more specific when the termination date is definite and when firms lack a pre-existing relationship. This may, however, reflect the fact that contracts are indefinite when contracting for more uncertain tasks. Thus, comparisons between contracts with similar purposes, like the comparison between the ST Microelectronics/Benchmarq and AMD/Fujitsu contracts, become more important. As we add more contracts to the sample, we will be better able to control for clause heterogeneity due to reasons unrelated to the extent of informal governance.

Of course, the real contribution of this paper lies in potential links to theory. While more rigorous empirical analyses are required to test our primary hypothesis, the evidence here seems to suggest that informal governance is indeed a possible substitute for formal. By developing the means to categorize formal governance in these contracts, this empirical analysis becomes possible.

APPENDIX A:
BOILERPLATE CONTRACT TERM ILLUSTRATIONS

Arbitration:

Ross Technology & Fujitsu (3/31/97):

"14.8 Arbitration. Any dispute , controversy or claim arising out of or relating to this agreement or the subject matter hereof, or in the interpretation, enforceability, validity, performance, breach or termination hereof or thereof, including, without limitation, this arbitration clause, shall be solely and finally settled in Los Angeles, California in accordance with the rules of the American Arbitration Association, as modified by the provisions of this Section 14.8…"

Confidentiality:

Lucent Technologies & Broadband Technologies (2/4/98):

"7.01 Each party agrees:

(i) that it will not use the Lucent Information (in the case of BBT) or the BBT Information (in the case of Lucent), except as expressly provided herein;

(ii) that it shall keep the Lucent Information or BBT Information, as the case may be, confidential;

(iii) that it will not, without the other party's express written permission, make or have made, or permit to be made, more copies of any of the Lucent Information or the BBT Information, as the case may be, than are necessary for its use hereunder;…"

Right to Terminate:

Benchmarq Microelectronics & ST Microelectronics (9/22/93):

"24.1 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:

a) Filing of a petition in bankruptcy…by the other party, or the appointment of a receiver for the business of the other party…;

b) Material breach of the provisions of this agreement, which breach has not be cured within thirty (30) days after written notice of said breach."

Lucent Technologies & Broadband Technologies (2/4/98):

"6.01 Lucent may terminate this Agreement by notice in writing to BBT upon the occurrence of (1) a Change of Control of BBT,…"

Limitation of Liability:

Ramtron International & ULVAC (Japan) (4/9/97):

"19 This Article 19 states each party's total liability and responsibility, and each party's sole remedy, for any actual or alleged infringement of any patent, trademark, copyright, or other intellectual property right…. In no event shall either party be liable for any indirect, special, incidental, or consequential damages resulting from such infringement."

Cross Licensing:

Benchmarq Microelectronics & Sanyo Energy (4/17/95):

"5.1(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]…" (An identical provision for licensing by Benchmarq to Sanyo follows.)

Patent Indemnity:

Benchmarq Microelectronics & ST Microelectronics (9/22/93):

"25.1 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…"

Percentage Stakes (Joint Venture Only):

MEMC Electronic Materials & Khazanah Nasional Berhad (12/20/96):

"3.3 Shareholding Percentages.

…the total issued share capital of the JVC shall… be held by the Parties… in the respective percentages stated… below:

MEMC 75%
Khazanah 25%…"

Board of Directors (Joint Venture Only):

MEMC Electronic Materials & Khazanah Nasional Berhad (12/20/96):

"5.1 Nomination
There shall be no fewer than 7 (seven) and no more than 10 (ten) JVC Director… the JVC Board shall be constituted as nearly as may be possible,… in the Shareholding Percentages…

5.1.1 7 (seven) JVC Directors shall be nominated by MEMC; and

5.1.2 2 (two) JVC Directors shall be nominated by Khazanah."

APPENDIX B:
SUGGESTED CODING SCHEME

Contract Completeness:

- Development specifications (such as tolerances) included
- Time frame for completion of each stage specified
- Number of employees to be contributed specified
- Specific persons stipulated for management or other development work
- Specific technologies to be contributed described
- Intellectual property rights defined over specific technologies
- Detail of cost sharing, either in dollar terms or with respect to certain tasks, set out

Monitoring:

- Reviews of development work required
- Timing of reviews specified
- Content of reviews specified
- Physical audits of development work permitted
- Reviews required of both (all) firms

Penalties:

- Financial penalties for underperformance
- Right to terminate for underperformance (as distinct from 'material breach')

Adjustment Mechanisms:

- Explicit mechanisms to adjust development plans
- Completion of development stages assessed jointly

Informal Governance:

- Termination dates - 3 categories:
    - (i) Fixed termination date (based on calendar);
    - (ii) Fixed termination date (based on completion of tasks);
    - (iii) No termination date.
- Existence of concurrent/prior alliances between the same partner firms

APPENDIX C:
CONTRACT TERM FREQUENCY

[Forthcoming.]

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