Financial Contracting in Biotech Strategic Alliances

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Abstract

We conduct a detailed, micro-level analysis of 126 strategic alliance contracts, all of which were written to sponsor early-stage, genomics-based biotechnology research at small R&D companies. All contracts prescribe staged investment decisions to capture the option value associated with the sequential resolution of uncertainty, but the contracts deal with agency problems differently. Among pre-IPO companies, many alliances resemble venture capital contracts: they involve convertible preferred equity and sometimes contain anti-dilution provisions, warrants, and board seats. Contracts contain explicit provisions linking equity participation to subsequent IPO activity, and contain clauses designed to insulate both parties from multi-tasking problems. Contrary to the standard assumptions of static contract theory, contracts often specify provisions that are unobservable or difficult to verify. Equity participation is positively correlated with the ambiguity of the contracting environment.

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1 Introduction

Strategic alliances and joint ventures are an increasingly common vehicle through which large organizations engage in research and development. For example, survey evidence from the Pharmaceutical Research and Manufacturers of America suggests that roughly 25% of the $26 billion in US-based, industrially financed, pharmaceutical R&D that occurred in 2000 took place in over 700 collaborative agreements with outside organizations. This fraction has tripled since 1991, and has grown twenty-fold since 1981 (National Science Board, 2000). [1]

While the financial and strategic importance of these contracts is widely acknowledged, little is known about their precise structure. In this paper, we make use of a novel data set to fill this void and conduct a detailed, micro-level analysis of strategic alliance and joint venture contracts. Our data are proprietary contract analyses provided by a major biotechnology industry analysis firm. The analyses are based primarily on SEC materiality disclosures, but are supplemented with information culled from industry trade conferences, scientific meetings, and press releases. Thus, the data are rich in the types of details that allow us not only to compare alliances to other types of financial contracts, such as venture capital contracts, but also to compare alliances with internally conducted R&D projects.

We focus on deals written between large pharmaceutical companies and small, often start-up research companies in the biotechnology sector. All of the 126 agreements we analyze were written to conduct genomics-based research, and are distinct from corporate venture capital agreements (see Hellmann (1997)).

[1] Moreover, these numbers omit international R&D deals and alliances facilitated through programs such as the Advanced Technology Program. Thus, the true size and importance of alliance activity in this sector may be even greater than suggested here.

Instead, in these deals the pharmaceutical firm is a client, sponsoring a research project that the R&D conducts. A common scientific objective in these agreements is to identify genetic 'disease triggers' that respond to specific chemical compounds, which can then be developed (with considerable uncertainty) into new drugs.

A deeper understanding of strategic alliance contracts achieves several objectives. First, on a purely practical level, it provides a better understanding of the organization of industrial research and development. In that regard, this paper complements the theoretical work of Aghion and Tirole (1994). Given the hundreds of billions of dollars spent on industrial R&D committed through federal, academic, and corporate channels, this objective is important in its own right.

Second, given the inherent ambiguity of the contracting environment, strategic alliances and joint ventures are an ideal empirical setting in which to explore the predictions of theoretical models on incomplete contracts and optimal financial contracting. In this regard, this paper is related to a growing body of work that explores the predictions of contract theory in various empirical settings (for an interesting survey article, see Chiappori and Salanié (2000)). The closest papers are Lerner and Merges (1998), which examines how the allocation of broadly defined control rights to the R&D firm varies with the availability of outside funding, Kaplan and Strömberg (2000), which examines term sheets from VC investments in order to examine how these agreements correspond to various theories of financial contracting (see also Sahlman (1990)), and Wong (2001), which presents survey evidence on the role that angel investors play in funding small, nascent firms. As we later show, the patterns in equity participation that we see in these deals are similar to what Kaplan and Strömberg (2000) show for venture capital contracts: for pre-IPO firms, clients often take equity stakes that involve convertible preferred equity that converts to common stock at IPO. These deals sometimes coincide with

board seats, and often involve registration rights and anti-dilution provisions. Preferred equity is much less common among deals involving publicly traded R&D firms.

Because the contracting environment is highly uncertain, it is not surprising that all contracts contain provisions reflecting the option value of abandoning or waiting to continue. Similar to VC contracts, alliance contracts typically state at the outset that investments will be staggered and contingent on certain milestones. In addition to real options, many contracts also contain financial options: contracts for longer research projects often provide the sponsor with warrants, and sometimes provide the biotech firm with puts forcing the sponsor to purchase additional shares in the biotech firm.

However, the alliance contracts in our paper differ from VC contracts in at least one critical respect: VCs provide funding for firms while alliance partners sponsor projects inside firms. This means that the contract must provide solutions to multi-tasking problems (Holmstrom and Milgrom, 1991). This gives rise to a number of important questions. For example, how do firms deal with multiple, simultaneous collaborations? Do clients distinguish between the success of a project and the success of the firm undertaking the project? Our findings suggest that these questions seem to be at the heart of many alliance contracts; one of the paper's main contributions is showing empirically how multi-task principal-agent problems are solved in practice.

Many contracts contain provisions that seem at odds with the predictions of contract theory. The contracts we analyze appear rife with clauses and conditions that are difficult, if not impossible to verify. For example, many contracts require a certain number of man-hours to be performed in various activities. Likewise, many contracts state that the pharmaceutical pursue the development of alliance-developed drugs with the same vigor as their own drug candidates. Discussions with industry insiders suggest that no explicit

mechanisms exist to monitor these considerations. This suggests that implicit contracts based on relational mechanisms (see, for example, Baker, Gibbons, and Murphy (2000)) play an important role.

Based on these observations, it seems intuitively clear that a strategic alliance in biotechnology represents a balance between the added costs of multi-tasking and asymmetric information against the added gains of project abandonment value that would not be present were it organized internally. Thus, our final objective is to shed light on the difference between internally managed research projects and research carried out under the aegis of an alliance contract. Given that many contracts specify labor inputs and capital expenditures, many alliance projects appear designed to look as if they took place inside the pharmaceutical firm. In light of this observation, one possible motive for alliances may be differences in compensation opportunities inside and outside the firm. [2] Another possibility is that contracts are intentionally incomplete, and this incompleteness enhances the abandonment value associated with conducting the research with an outside organization as opposed to conducting it internally.

The remainder of the paper is organized as follows. We begin by outlining the theoretical background. This is contained in Section 2. In Section 3, we describe the data set we have compiled, while in Section 4 we present details from the 126 contracts we analyze. Section 6 presents results from regressions that relate contract characteristics to firm and dyad characteristics. Section 7 concludes by offering future theoretical and empirical research directions suggested by our findings.

[2] See Palia (2002) for evidence that division-level managers in multi-division firms have lower pay-for-performance sensitivity than managers of similarly sized stand-alone firms.

2 Theoretical Motivation

Given that the design of strategic alliances involves elements of organizational design, optimal contracting, real options, repeated games, and many other areas of analysis outside economics, an exhaustive review of the relevant literature is not feasible within the confines of this paper. Instead, this section address some recent theoretical literature that has predictions for particular elements of deal structure that we see. We begin by laying out a common framework for thinking about the transactions we study, then we review results related to equity participation, control and termination.

2.1 A Common Framework for Alliances

A common element in the deals we analyze is the nature of information and the timing of actions between the research organization and the pharmaceutical company. All but two of the deals we analyze concern early stage (i.e. pre-clinical) research. As such, the research company often has specialized knowledge that the pharmaceutical lacks pertaining to the use of a particular technology. In the case of genomics-based research, their specialty lies in identifying gene-based disease triggers that are later screened against a database of compounds. The pharmaceutical plays a dual role as investor and consumer: as an investor it uses licensing and royalties, equity participation, or both, to finance drug development. As a consumer, it takes the R&D firm's output and uses it in the further development of a drug. In terms of the nature of the contracting problem faced by the two parties, a time line common to these projects is as follows:

Time 0: Would-be alliance partners meet, conduct due diligence, and bargain over a potential collaboration. If successful, a contract is written at this time.

Time 1: The R&D firm expends effort identifying drug targets. If a target is

found, it is passed to the client for further development at time 2.

Time 2: A suitably identified target is transferred to the client firm, which then integrates this into the discovery and production of some final drug product.

Time 3: Revenues from the final product occur and are disbursed according to the agreement.

This paper is of course concerned with the specific nature of the details in the contract written at time 0, how these details reflect anticipated behavior at time 1 and 2, and what scope exists for altering or cancelling the contract after time 0. These considerations are in turn a function of the structure of information and the nature of the anticipated incentive conflict between the firms at time 0.

2.2 The Role of Equity

The nature of the activity described above approximates a number of theoretical models of incomplete contracts. In particular, the role of the client in this relationship is a hybrid between the consumer/financier in the Aghion and Tirole (1994) model and that of the VC in models by Casamatta (2000), Repullo and Suarez (1999), Cornelli and Yosha (1997).

Aghion and Tirole (1994) model an incomplete contracting situation between a customer/end user of R&D, and a penniless entrepreneur/researcher who engages in unverifiable effort to generate an R&D output. In their model, both agents supply an input (the customer's input can be thought of as financial investment) that jointly affects the probability of R&D success, and bargain over a transfer price in the event that the efforts result in success. Their results echo the standard prescriptions from Grossman and Hart (1986) and Hart and Moore (1990), namely that when contracts are incomplete, ownership

should be tilted towards the agent whose marginal impact on the value of the project is highest. This is perhaps the most compelling explanation for why these contracts occur between two firms, and not within a firm, where ultimate ownership would not rest with the researcher.[3] In addition, their theory also provides for 'shop rights,' which in our context coincide with the R&D firm's right to own (for the purposes of later development) rights to certain compounds that are not selected by the client.

But a number of features of the Aghion and Tirole (1994) model seem at odds with the data we present here. Most importantly, in their model equity ownership is irrelevant, since it has no effect on the real transfer price of the R&D output: any combination of equity and a license fee can be mimicked by a lower equity stake and a license fee adjusted upward to reflect the difference in the license fee not internalized through ownership. As they explicitly point out, however, a host of questions concerning ownership and management of research processes and mitigating problems with spill-overs may give rise to the need for equity.

Explicit motives for equity participation arise in Repullo and Suarez (1999) and Casamatta (2000), where a double-sided moral hazard problem arising from the financiers dual role as investor and adviser makes the use of equity desirable. Casamatta (2000) shows that in general, when the financier also provides a complementary input (advisory services in her model) equity is necessary to provide the financier with appropriate incentives. Her model develops a prediction that common equity should occur when the financier's investment is low, but convertible preferred equity should occur when the financier's investment is high.

[3] Aghion and Bolton (1992) provides another motive for why these activities occur in alliances as opposed to within the firm–namely, when the private benefits to the R&D are co-monotonic with the social value of the project (the sum of private and monetary benefits to both parties), ownership by the R&D is optimal.

3 Data

The data we use for this study come from a database (`www.rdna.com`) assembled by Recombinant Capital, a biotechnology industry analysis firm that provides access to a wide range of contract-related information based on data culled from public filings, news releases, and presentations at industry conferences. Recombinant Capital not only tracks inter-firm collaborations in human medicine, but also agreements involving universities, and collaborations in related fields such as agricultural technology and veterinary medicine. In order to remove one potential source of contractual variation, we focus exclusively on genomics deals initiated between a drug and a biotech, or between two biotech firms prior to 1998. Broadly speaking, genomics involves using advances in biology and genetics to understand disease processes at the cellular level. Functional genomics specifically entails locating genes that contribute to disease in affected cells.

Genomics companies work at the first stage of the contemporary drug development process: they identify "drug targets"—enzymes or receptors that trigger or block biochemical processes within a cell. The biological role of these targets in disease initiation or progression is then "validated," a process which entails proving that a DNA, RNA, or protein molecule directly participates in a disease process and is therefore a suitable target for development of a new therapeutic compound. Validated targets are then "screened" against (typically hundreds of thousands) molecules, with the aim of pinpointing compounds that trigger or block the processes precipitated by the focal targets. In all of the alliances we examine in detail, the biotech partner identifies and validates targets, which are then developed in collaboration with the client. In some of the partnerships, the biotech partner will also screen compounds against targets, and thus transfer lead development compounds to the client. Although biotech firms continue to expand downstream in the drug develop-

ment chain, the client in the partnership typically conducts the subsequent steps in the drug development process, including animal testing, clinical trials, large-scale manufacturing, and sales and marketing. Roughly speaking, one can think of these alliances as vertical transactions in which there is an upstream / downstream division of effort between the biotech firm and the client in the deal.

The sample was created by searching the `rdna.com` database on the keywords "Combinatorial," "Gene Expression," "Gene Sequencing," "Pharmacogenomics," "Proteomics," "Screening," and "Transcription Factors." In addition, we restricted attention to deals that were already analyzed by Recombinant Capital, meaning that Recombinant Capital employees had synthesized the SEC filings and news announcements into a common document format. Using these screens yielded 218 deals, some of which seem inappropriate for the present analysis, given that they are primarily licensing agreements for already-existing products (for instance, granting access to a proprietary database). For these deals, it is not clear what the intra-firm alternative to the alliance is, and what organizational implications the alliance may have on either counterparty. Since our objective is to understand complex inter-firm relationships, not genomics *per se*, we exclude 66 such deals based on subjective evaluation, leaving a total of 152 deals. Twenty-six further deals were omitted because they were later-stage deals, leaving 126 deals in our final sample.

One shortcoming to our approach is that it is ultimately based on publicly available information, and thus many confidential terms are hidden from us. At the same time, we can conduct tests based on market reactions and subsequent performance that are not normally available in detailed studies of other types of contracts. This allows us to build on previous results that highlight the role of equity as a mechanism for allocating control (Pisano, 1989; Robinson and Stuart, 2000; Boone, 2001). Whereas many papers simply assume that equity stakes confer control rights, citing the incidence of board seats granted

in conjunction with larger equity stakes, our analysis provides details which sharpen this intuition. The propensity of equity deals to involve detailed prohibitions on amassing shares in the open market subsequent to the alliance suggests that equity confers control even when it is not accompanied by board seats, voting rights, or other similar measures.

In part, our sampling strategy reflects the limitations associated with working with data derived from publicly available sources. Due to SEC disclosure provisions, many dollar amounts and percentages are omitted from our documents.[4] On the other hand, since many of the firms in our sample are publicly traded, we have access to information (financials, stock price reactions) that is often lacking in the study of venture activity.

Table 1 shows the sample characteristics over time. While alliances appear every year from 1990 to 1998, roughly 75% of the alliances take place after 1994. The client takes an equity position in the target in 81 deals. Upfront payments appear in 35 of 126 deals. At the same time, the mean size of the deal (a number which includes upfront payments as well as contingent payments that may not occur, but nevertheless approximates the total potential commercial value to the R&D of the project) trends upward too. If we were to extend this sample forward past 1998, we would see genomics-related alliance activity explode–a fact which coincides in part with the push to map the human genome.

Table 2 provides details on the biotech firms involved in these deals. Of the 62 biotech firms represented, 46 were privately held at least once in our sample. Thirty-two firms remain private throughout our sample, and sixteen are public when they enter our sample, leaving fourteen that enter our sample as private firms but appear in our sample again as a publicly held firm. An additional ten

[4] Lerner and Merges (1998) overcome this problem by simply measuring the number of different types of control mechanisms allocated to the biotech firm.

firms IPO during the period, but for these firms we do not record their alliance activity after they become public. The number of deals involving publicly traded trends upward through the sample, reflecting the stock of prior IPOs in biotechnology.

Comparing Tables 1 and 2 illustrates the relative size of the alliance compared to the size of the R&D firm. The total estimated value of all contingent payments that represented in the alliance (Mean Size in Table 1) is roughly half the size of the recorded value of the R&D firm as reported in Table 2. Comparing the mean equity stake in Table 1 to the mean firm size in Table 2, we see that the equity stakes comprise roughly 5% of R&D firm value.

4 A Closer Look at Contract Characteristics

In this section, we examine the features of these contracts by focusing not only on specific examples that illuminate the difficulties inherent in the alliance, but also by presenting tabulations of key contract characteristics.

For clarity, we focus our three specific contracts in detail, and then use these deals as a platform for discussing the board summary statistics presented in the tables. These are the Biogen/Curagen deal signed in 10/1997; the Bristol Myers Squibb/Cadus deal signed in 7/1994; and the Millennium/Bayer deal signed on 9/1998.

4.1 R&D Staging

Every contract in our sample involves the use of staged financing that coincides with research milestones. The BMS/Cadus deal specified a three-year research period with an option to extend, while the other two specified five-year research periods. The BMS/Cadus deal also specified that up to $4 million

per year in research funding would be provided for Cadus, and according to its 1996 annual report, it had received $10.4 million in funding from BMS during the first two years of the agreement.

For 68 deals it is possible to determine the expected length of the collaboration based on the initial contract. This is presented in Table 4. The mean and median are both approximately four years, but the maximum length is ten years, and this occurs in three deals. This length reflects the expected time that both parties anticipate the alliance will last at the inception of the project, as reflected by the contract. Of the remaining 7 deals, only the deal between Ortho Biotech and Cell Therapeutics did not specify an alliance length. The other 6 were either confidential or not available.

Another important part of the terms of R&D is the provision for labor allocation. The Biogen/Curagen and Millennium/Bayer deals both specify a certain number of full-time equivalents (FTEs) to be devoted to the project, while the BMS/Cadus deal does not. Generally, the number of FTEs is confidential in our data, however its very presence is interesting given the potential difficulty in verifying that labor is actually being supplied. That these contracts include what might be regarded as unverifiable actions suggests that theories of implicit contracts along the lines of Baker, Gibbons, and Murphy (1998) may help describe why alliances are successful.

Indeed, Table 1 indicates that of the 126 deals included in our analysis, 57 specify the number of full-time equivalents (FTEs) devoted to the research project. Is this labor input verifiable? Perhaps not, but twelve alliance contracts go further and state that a specific grade or education level be used–for example, this might state that the personnel be appropriately qualified in biochemistry or biology, or that they hold Ph.D.s. In addition, sixteen contracts specify that certain, named personnel be employed strictly on a particular project, that they not be allowed to work on other projects, and that if they should no

longer be employed, that the deal should be renegotiated. This indicates that the contracting parties seem aware of the inalienability of the human capital involved in the research process, as suggested in Hart and Moore (1994).

The source of incentive conflict in many financing theories is private benefits; in models of internal capital markets such as Stein (1997), Stein (2000), and others, managers are motivated by non-appropriable private benefits. One potential source of private benefits in the deals we analyze are publications arising from discoveries. These scientific publications seem like an important of compensation for scientists and are inherently tied to project outcomes. In fact, many scientists at biotech firms are prolific contributors to the scientific literature. Evidence from Stern (1999) indicates that these scientists forgo substantial wage income for the ability to publish in scientific journals. Interestingly, the terms of the R&D section of the contracts provide guidelines for publishing academic articles based on scientific discoveries related to the alliance. While many deals place strict prohibitions on this activity, others permit it given appropriate permissions have been obtained. In the Millennium/Bayer deal, notice must be

> "given 60 days prior to submission to other party. If the other Party informs such Party that its proposed publication could be expected to have a material adverse effect on any Patent Rights or Know-How of such other Party, then such Party shall delay such proposed publication sufficiently long to permit the timely preparation and first filing of patent application(s) on the information involved. Millennium shall not permit a publication that includes information relating to a Bayer Development Candidate without the prior approval of Bayer."

The BMS/Cadus and Biogen/Curagen deals simply specify written prior consent.

4.2 Collaboration Management

Collaboration management is an area in which surprisingly little variation across contracts exists. Equal representation on management committees is the norm, and majority or unanimity is almost always required in order to act on a decision.

The Millennium/Bayer, Curagen/Biogen, and BMS/Cadus deals contain very similar provisions for collaboration management. In all three cases, the deal specifies equal representation from the client and R&D on the project-level committees. In the BMS/Cadus deal, Cadus was responsible for appointing the project coordinator, while the others simply state equal numbers at each level of decision-making. Decisions in the Millennium/Bayer deal are made on the basis of majority opinion, whereas the other two deals require unanimous opinion, and the Millennium/Bayer deal specifies project-level committees as well as a joint steering committee. The distinction, then, is whether a single member of an opposing firm can block a decision, or whether all members of the opposing firm must act in concert to block a decision of the committee.

A far greater degree of oversight appears in these deals relative to what one would expect in venture capital agreements. Moreover, this oversight is not part of an initial control stake maintained by the VC which fades as the project matures; if anything, given the vertical nature of the relationship between the R&D firm and the client, the value of control may in fact increase as the project matures.

4.3 Equity and other Financing

A key element to the deals we analyze is equity cross-ownership. As Allen and Phillips (2000) show, equity ownership in strategic alliances is common

across a wide range of business activities. The deals we describe fit the pattern laid out in Allen and Phillips (2000), in which the larger firm takes an equity position in the smaller firm as part of the funding of the collaboration it sponsors. In this section, we focus not only on the presence of equity, but also with the contractual arrangements that surround the equity stake.

The Millennium/Bayer deal included just over $96M in equity for Millennium Pharmaceuticals. With this came the right for a Bayer representative to attend Millennium board meetings semi-annually. The terms of their agreement specified that Bayer would pay 115% of the maximum of (i) the average Millennium stock price between March 1, 1998 and August 31, 1998, and (ii) the stock price on 21 September, 1998. In fact, the historical average was higher.

The deal was signed on 22 September, 1998. Millennium's stock price dynamics around that date were as follows: on Friday, 18 September, it traded at $14.31/share. The Monday, 21 September, price jumped to $16.50, and the price on the 22nd continued upward to $17.25. This high price continued throughout the year.

One of the interesting features of this transaction was the manner in which contingencies were written into the equity agreement. Since privately negotiated equity placements such as these cannot generally be liquidated through public sale for two years and without prior registration, the assignment of demand and piggyback registration rights is potentially important.[5] The contract provided Bayer with two demand registrations and unlimited piggyback registrations. In addition to these rights, Bayer was prohibited from transferring or selling more than 2.5 million shares in any one year—this prohibition was erased if Millennium entered into a merger agreement. Bayer was entitled to maintain its pro rata share ownership in Millennium, but only if Bayer had

[5] Demand rights allow the holder to force the other firm to register its stock for sale; piggyback rights allow the holder to include its shares in any registration initiated by the other firm.

not sold more than one million shares over the life of the agreement. Not only was Bayer restricted in its ability to sell Millennium stock; Bayer was also prohibited from increasing its share ownership in Millennium for three years after the signing of the contract.

BMS provided Cadus with $20 million in three separate equity transactions. The first two transactions involved $12.5 million (in July, 1994) and $5 million (in September, 1995) of Class B convertible preferred stock, purchased at a share price of $3.50 and $4, respectively. The second equity purchase occurred as a result of Cadus achieving a research milestone. Finally, at the IPO of Cadus in July, 1996, BMS converted its B shares into 1.607 million common shares, and purchased an additional $2.5 million worth of common shares at $7/share.

The Biogen/Curagen deal is unusual in that it combines equity and debt. Biogen purchased $5 million of common equity in Curagen at its IPO price of $11.50/share. The terms of the purchase were such that if Curagen did not IPO within 18 months of the deal date, Biogen had no obligation to purchase further stock–effectively it acted as a large shareholder in the IPO. It also provided a $10 million loan facility. The loan was repayable in cash or Curagen common stock (at current market prices) at the sole discretion of Curagen.

More evidence on the role of equity can be found in Table 3. The striking feature of Table 3 is the distinction between equity positions in pre- and post-IPO firms. Among privately held firms, equity is typically structured as convertible preferred securities. Convertible preferred equity holdings are roughly twice the size of common equity positions taken in pre-IPO firms. Conversion to common equity typically takes place at IPO, and in 15 of the 54 deals, the contract contained provisions requiring the pharmaceutical client to purchase more equity in the public offering. Relatively few deals (7 of 54) involve debt.

A key feature in almost all biotech strategic alliances is the licensing agreement that supports the exchange of revenues between the companies once a drug candidate has been identified. In terms of the time line at the beginning of this section, the licensing agreement takes effect at time 2, once the R&D output has been transferred upstream, and specifies the behavior of the client at time 3. One of the interesting features of strategic alliances in biotechnology, as suggested by Table 1 [in future draft] and as also shown in Robinson and Stuart (2000), is that the licensing agreement is written at the inception of the contract, before the object of the license exists. The alternative to this, which would perhaps be more natural from the point of view of contract theory, would be to postpone the licensing agreement until a discovery materialized. It seems noteworthy that contracts typically do not state that the parties agree to determine licensing terms at a later date.

Each of the three deals described here provides an exclusive license to the client for any compounds that are identified as suitable candidates. (Identifying candidates for the client, after all, is the primary objective of the alliance.) In the Millennium/Bayer deal, Bayer received an exclusive license with respect to selected targets, but only a non-exclusive license with respect to targets that were returned from the selection process. Unfortunately, the royalty rates associated with these licenses are confidential, but we do observe variation in the manner that revenues are divided between the firms: the Millennium/Bayer and BMS/Cadus deals confer worldwide licensing rights to clients for all disease categories, while the Biogen/Curagen licensing revenues are split according to disease category.

Termination rights are a central part of the theories of Bolton and Scharfstein (1990) and Hart and Moore (1998), in which the outside financier's ability to shut down the entrepreneur's project at some intermediate stage (before

unobservable cash flows arrive) provides the entrepreneur with incentives not to enjoy too many private benefits.

There are essentially two aspects of termination provisions. One concerns who is allowed to terminate the deal, and under what circumstances. The second concerns what happens to the existing intellectual property after the termination.

Regarding the first point, the three alliances we scrutinize differ in how they allocate termination rights. The BMS/Cadus deal allocates termination rights to both the client and the R&D equally–each may terminate by material breach only. In the Biogen/Curagen deal, Curagen's right to terminate is limited to uncured material breach, but Biogen has substantially more rights. Biogen too has the right to terminate for uncured material breach or bankruptcy, but also may terminate any time after the second anniversary with six months' written notice. In this event, the contract states that any such early termination shall not affect any license agreement.

The deals also differ in terms of what happens to existing alliance resources after the termination. The Biogen/Curagen deal effectively states that all resources that are not part of an ongoing license shall be returned to the original creator of the resource–all client proprietary material shall be returned to the client or destroyed, likewise with all R&D material. The other two deals make no such provision, except to state that existing licenses outlive any termination. Finally, the three deals coincide in their treatment of transferring technology: each deal prohibits one firm from transferring technology to a third party without written consent of the counterparty, except in the event of a sale or merger.

These findings suggest that termination rights do more than simply provide incentives. Termination rights seem to play an important role in the manner in which intellectual property and other resources are appropriated at the project

level, and kept from being implemented in other projects that one firm have in operation.

Table 4 provides evidence on how alliances end. It shows that the most common outcome is for ownership to revert back to the R&D after a project has been terminated, provided that the contract did not end due to R&D breach. That such a small fraction of alliances involve sharing arrangements supports Aghion and Bolton (1992), who show that typically co-ownership is sub-optimal relative to contingent ownership, since the former exacerbates holdup problems.

5 What Is Missing From These Contracts?

Up to this point, we have focused on what is present in strategic alliance contracts: how financing terms and collaboration management are used together to manage investment projects that are carried out in separate firms. In this section, we ask what might be present in these contracts but instead is missing. In order to do that, we compare alliance contracts with other types of financial contracts that have received recent empirical attention.

5.1 Strategic Alliances and VC Funding

Because these contracts often represent the most important means of financing for small biotechnology firms, venture capital contracts provide a natural point of comparison. Alliance agreements look similar to venture capital agreements in a number of respects: they involve staged capital infusions based on performance milestones that mirror the financing rounds in VC deals; they frequently involve the use of equity, and in particular, convertible preferred stock; and monitoring occurs frequently through board representation. Like Kaplan

and Strömberg (2000), we find that these contracts separately allocate control rights, cash-flow rights, liquidation rights, and board rights.

However, the contracts we analyze here specify VC-like controls far less frequently than do standard VC contracts. Kaplan and Strömberg (2000) report that nearly all VC deals will guarantee at least one board seat; in their sample, a significant fraction actually obtain a board majority. In our sample, less than 20% of the deals with pre-IPO firms involve board seats, and in no circumstance did the deal specify a majority of seats.

Yet these contracts differ from venture capital deals in important ways. The fundamental distinction is that VCs fund the development of *firms*, whereas alliance agreements fund the development of projects *inside* firms. This means that in alliance agreements, significant resources go into delineating the acceptable use of resources in non-project related activities in a way that is not present in VC deals. Prototypical deals between VCs and entrepreneurs typically involve the VC maintaining cash flow rights but ceding control as the entrepreneur's business matures. Not so with alliance contracts. Due to the vertical nature of the relationship between the R&D firm and the pharmaceutical organization, trading off control and residual income over the life of the project is less common. For example, collaboration management is typically handled by a project team comprising members in equal numbers from both the biotech and the pharmaceutical. Decision making is often by unanimous vote, but given the ubiquity of equal representation, even majority voting allow either party to block decisions they view as inappropriate. This differs from what we see in venture capital, where VCs frequently sit on boards (Lerner, 1995) and have voting rights (Sahlman, 1990; Kaplan and Strömberg, 2000), but do not have day-to-day, operational decision-making rights.

6 Regression Results

In this section we present multivariate results relating key contract characteristics to other terms of the contract and the contracting environment. Because all the contract characteristics are determined endogenously, it is difficult to establish a direction of causation; instead, these regression results should be interpreted as conditional correlations, expanding the results presented in table 5.

6.1 Ambiguity and Contract Length

Table 6 presents results from Tobit regressions on the length of the contract– i.e., the number of words required to describe the terms and conditions of the alliance–on a number of contract and dyad characteristics. Since we are not using the physical contracts directly, it is important to describe the dependent variable more carefully.

The dependent variable is constructed by measuring the length (in bytes) of the contract analysis provided by Recombinant Capital. Recall that the contract analyses are presented in a standard format. Every contract in our sample is represented by a computer file with exactly 63 lines, the length of which vary with the complexity of the description of that line item. Therefore, if a contract contains no provisions for the use of equity, then a number of lines of the contract analysis are simply left blank. Similarly, if the nature of the alliance activity is difficult to describe and requires specifying a great many contingencies, then the contract analysis will contain lengthy descriptions in the fields devoted to the description of research. Thus, by measuring the byte-length of the contract, we capture the complexity of the contract in a simple, yet robust manner. Measuring the contract according to its size on a computer instead of counting the words in the contract has the added feature that

lengthy, technical descriptions are ascribed more length than a description with the same word count using simpler words. Also, using contract analyses rather than raw contracts means that we our measures are not confounded by legal terms of art that are lengthy but communicate relatively simple, well-known ideas.

Given the relatively narrow scope of the alliance activity in questions, it may come as a surprise that there is considerable variation in contract length. The mean is 20 kilobytes, and the median is 18 kilobytes, but the fifth and 95th percentiles span from 10 to 35 kb. We take contract length to be a proxy for the difficulty in specifying all the possible contingencies that can arise in the course of conducting the activity in question; likewise, contract length measures the complexity required to describe each possible contingent action.

What explains contract length? We find larger equity stakes coincide with longer contracts. This supports the idea that equity is used as a control device. (Note that we are controlling for whether the deal involves equity, to control for the possibility that deals with equity are longer simply because they must specify the terms of the equity transaction.) Also, we find that when larger upfront payments are made to the R&D, contracts are longer. Interestingly, longer contracts coincide with more frequent meetings of the research oversight committees that monitor the progress of the collaboration.

6.2 Funding Provisions

6.2.1 Upfront Payments

Based on the pairwise correlations presented in table 5, we see that the amount of upfront funding is positively (and significantly) correlated with the size of the project and its stage at inception, positively correlated with the value of the biotech firm, and negatively correlated with the length of the project.

This suggests that the level of upfront funding is an outcome of the relative bargaining power of the two parties involved and the level of ambiguity of the research activity.

Table 7 presents regressions of upfront payment, in millions of US dollars, on various deal characteristics. Regardless of the controls included in the regression, we see that contracts with later stage projects specify larger amounts of upfront funding for the biotechnology firm. While it is certainly the case that the two Phase I stage projects had large upfront payments, excluding them does not change this finding. A simple comparison of mean funding amounts by stage shows that discovery stage projects receive upfront payments at roughly the same frequency as lead-molecule or pre-clinical stage deals (31% for discovery stage versus 35% for the latter types), but the upfront funding is roughly half the size ($1.18 million versus $2.02 million).

Biotech centrality in Table 7 is a weighted measure of the number of past transactions that the firm has engaged in. It is designed to capture two phenomena: how many alliances a firm has formed in the past, and how influential are the prior alliance partners. The basic idea behind the measure is that having formed an alliance with an influential partner is more valuable in terms of reputation building than having formed an alliance with a peripheral partner– one who has done relatively few deals, and with more peripheral firms. In order to capture this intuition, each past transaction is weighted by the centrality of that transaction's counterparty, which is in turn calculated in an analogous manner (see Robinson and Stuart (2000) for mathematical details). Thus, alliances with more central firms are more highly weighted, and alliances formed with peripheral firms are less highly weighted. That biotech centrality is positively correlated with the magnitude of the upfront payment supports the idea that the size of the upfront payment is an outcome of a bargaining process in which biotechs with more bargaining power get more favorable deal terms.

Table 7 also shows that, conditional on firm age and centrality, upfront payments are a great deal smaller in the presence of equity participation. This suggests that equity and upfront payments are substitutes: that one role of equity participation is to mask an upfront cash transfer to the biotech by disguising it as an equity participation. [6]

7 Conclusion

This paper examines the details of 126 strategic alliance agreements. In each of the 126 cases, the collaboration centers on using one firm's expertise in genomics to identify and discover drug candidates that will later become part of the other firm's product pipeline.

Because these deals provide a major source of funding to small, nascent (often pre-IPO) firms, part of our analysis compares these contracts with venture capital deals. Like venture capital deals, the projects often involve staged capital infusions triggered by successful completion of milestones, the use of convertible, preferred equity and debt, and the allocation of monitoring rights through board membership.

But the comparison with venture capital does not fully explain the complexities of the inter-firm collaborative agreements we study. An important component of the contract is delineating the boundaries of the project of interest, and keeping its resources and revenues separate from the rest of the firm responsible for its execution. Thus, we commonly see project-level operational decisions made in teams of equal numbers from both firms. Contracts also clearly specify rights pertaining to the use of intellectual property that arises.

This research highlight the tradeoffs (in terms of agency costs) that agents

[6] This characterization is commonly asserted by corporate development officers responsible for many of these deals.

face when they try to implement organizational structures that are designed to capture abandonment value and other real options value inherent in sequential investment decisions. One important area for future work lay in developing a sharper understanding of this tradeoff. How do organizational mechanisms designed to capture option value in projects balance the benefits abandonment value, sequential investment, and the option to delay against agency costs and other costs introduced in multi-tasking environments?

This suggests that an important direction for theoretical progress on alliances and ventures lies in understanding the mechanisms behind verifying resource allocation between projects at the research firm. Organizing an investment project as a strategic alliance with an outside firm rather than as an internally managed project seems to optimize the tradeoff between gaining abandonment value through the alliance and facing greater multi-tasking and asymmetric information problems by placing organizational boundaries between the project and its funding source. Gaining a better understanding of such inter-firm collaboration is likely to increase our understanding of internal capital markets and decision-making inside firms, as well as shed light on the issues relating to the determinants of the boundaries of the firm.

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Table 1
Contract Characteristics over Time

This table describes the time-series of alliance announcements in our sample, along with other key sample characteristics. Total deals is the number of announcements in year t, while mean size is the mean of total pledged funding as recorded by Recombinant Capital (this includes contingent funding). Expected Length is the number of years that the collaboration is expected to last. Equity deals are the number in which the client purchased equity in the target, while size is the mean size in millions of dollars. '% Share' is the size of the equity stake expressed as a fraction of the total firm value, as measured by Recombinant Capital. The 'Up-Front Fee?' columns record the number each year that involved upfront cash payments. FTEs specified records whether the contract specifies the number of man-hours to be spent on research; 'Pay Grade Named' counts whether these man-hours are to be performed by scientists with specific training or background (e.g., PhD biochemists). 'Persons Named' counts whether a contract is contingent on the performance of a specific, named individual employed at the R&D firm. Screening deals are those in which the contract specifies that the R&D screens targets against a database of compounds.

	Total	Mean	Expected	Equity Deals:			Upfront	Employment:			Screening
Year	Deals	Size	Length	Count	Size	% Share	Fee?	FTEs	Pay-Grade	Persons	Deal
1990	1	29.50	5.00	1	5.00	48%	0	0	0	1	0
1991	8	16.88	3.25	4	3.00	8.5%	3	1	0	0	4
1992	11	14.17	4.23	7	3.18	9.4%	4	4	3	2	7
1993	9	29.21	3.19	6	3.34	5.5%	4	4	1	1	6
1994	14	48.85	3.64	11	7.26	7.9%	1	7	1	1	7
1995	27	45.45	3.63	18	4.87	6.4%	7	13	3	5	12
1996	15	41.61	3.58	10	3.70	6.0%	6	9	1	1	7
1997	29	54.49	3.98	19	6.33	7.5%	8	12	2	5	14
1998	12	60.53	4.11	5	1.58	1.5%	2	7	1	0	7
Overall	126	37.85	3.85	81	4.25	7.1%	35	57	12	16	64

Table 2
Characteristics of Sample R&D Firms over Time

This table describes the characteristics of R&D firms in our sample. Total Firms is the number of distinct firms in our sample in a given year. Firm Value is the value of the R&D firm, as recorded by Recombinant Capital. This figure is based on the last recorded valuation for private firms, and is otherwise the market value of equity. 'Then Publicly Traded' records the number of R&D firms that were publicly traded at the time of the announcement, while 'Later Publicly Traded' records the number of non-publicly traded firms that later went public after the time of the alliance. 'Percent venture' records the (mean) fraction of R&D firm's shares outstanding owned by VC interests. Prior deals measures all corporate transactions recorded by the Recombinant Capital funding database–this includes private equity investments, venture funding, and other sources of funding, but excludes IPOs and option or warrant exercises. Prior alliances measures previous alliance activity in three ways. 'Last 5 Years' measures total alliance activity (with both other biotechnology firms as well as pharmaceuticals), 'Overall' measures all recorded alliance activity for the firm, while 'Equity' activity measures all prior equity alliance activity.

	Total	Firm	Firm	Public	Private	Percent	Prior	Prior Alliances:		
	Firms	Value	Age	At Deal	then Pub?	VC	Deals	Last 5 Yrs.	Overall	Equity
1990	1	10.4	2.58	0	1	14%	6.00	1.0	0.0	0.0
1991	7	78.7	1.61	2	4	57%	4.14	3.0	2.6	1.1
1992	10	130.6	3.19	2	2	43%	5.30	3.8	4.9	2.5
1993	8	78.2	3.27	2	5	59%	7.11	3.9	4.4	1.1
1994	12	84.6	3.94	5	7	49%	7.09	4.8	7.4	2.8
1995	19	95.4	4.63	7	12	54%	7.91	4.7	6.7	2.4
1996	12	101.8	4.91	6	7	50%	7.50	5.8	7.7	1.7
1997	23	171.9	4.67	15	8	41%	8.70	7.3	11.0	3.2
1998	10	290.2	5.54	7	5	32%	10.50	0.0	0.0	0.0
	102	115.8	3.82	46	51	44%	7.14	3.8	5.0	1.6

Table 3
The Use of Equity in Alliance Agreements

This table summarizes equity participation in biotech strategic alliances for our sample of 127 firms. Panel A contains data for all 127 firms; Panel B only summarizes information for firms that were not publicly traded at the time of the alliance, while Panel C summarizes information for the complement. Total deals is the number of deals containing equity, common equity, or preferred equity. Convertible denotes the subset of preferred equity transactions that could be identified as convertible equity. Mean and median amount are in millions and refer to the size of the equity stake. Mean Fraction expresses the equity stake as a fraction of the total R&D firm value, which is based on the firm's valuation in its last venture round. Board seats is the number of equity deals in which a board seat is granted to the client firm as part of the deal (in all but one case, a single seat is given). IPO tie-in refers to whether the initial equity stake is part of a planned IPO of the R&D firm. This includes situations in which the alliance coincides with the R&D's IPO, and when the alliance calls for the client to increase its equity stake at the time of the IPO. Loan tie-in refers to deals in which the equity stake is tied to the repayment of a loan provided to the R&D by the client.

	Total Deals	Mean Amount	Median Amount	Mean Fraction	Board Seats	IPO Tie-Ins	Loan Tie-Ins
	Panel A: All Firms, N=126						
Total	82	7.39	5.4	11	11	15	11
Common	40	8	5	6.5	5	6	8
Preferred	42	6.85	6	14.95	6	9	3
Convertible	32	7.22	6.25	14.6	4		
	Panel B: Pre-IPO Firms, N=72						
Total	54	5.93	5	12.05	9	15	7
Common	14	4.35	4	7.8	3	6	5
Preferred	40	6.45	6	13.7	6	9	2
Convertible	30	6.7	6.2	13.06	4		
	Panel C: Post-IPO Firms, N=55						
Total	28	10.43	8.25	9	2		4
Common	26	10.43	8.25	6.4	2		3
Preferred	2	14.5	14.5	32.3	0		1
Convertible	2	14.5	14.5	32.3	0		

Table 4
How Alliances End: Termination Provisions and Ownership Reversion

This table describes termination provisions and ownership reversion upon termination for a sample of 126 strategic alliance contracts. Ownership reverts to R&D includes all situations in which ownership reverts to the R&D, including cases in which ownership reverts with exceptions. (54 of 75 contracts stipulate that ownership reverts to R&D with no further language.)

Termination Provision	Both/ Either	Only R&D	Only Client	Examples
Uncured Breach Only	0	4	0	
Uncured Breach	100	0	0	Either party may terminate by breach, by bankruptcy, by mutual agreement, or if the other party is acquired by any third party
If Change in Control	11	0	38	
At Will	4	0	16	
At Will after Certain Date	8	0	51	. . . may be terminated by [Client] any time after the 3rd anniversary of signing; . . .
If Insufficient Progress	9	1	20	may be terminated by [R&D] if [Client] has not selected a [Target] for further evaluation prior to the expiration of the Research Period
If Change in Key Employees	0	0	8	In addition, [Client] shall be entitled to terminate the Program upon 90 days' notice after the date that any of [person], [person] or [person] is no longer obligated or able to continue to provide the same level of services as contemplated at the signing of this Agreement.
Reversion Provision	**Both/ Orig.**	**R&D**	**Client**	
Reverts to Non-Breaching	12	0	0	
Reverts to Non-Terminating	6	0	0	
Failures Revert to	0	2	0	
Ownership Reverts to	14	75	6	
Except for: Breach		18	0	
Change in Control		3	0	
Bankruptcy		12	0	

Table 5
Correlations in Contract Characteristics

This table presents pairwise correlations between contracting variables. Correlations denoted with stars are significant at the 10% level. (Diagonal elements are omitted.) Project stage is a variable that equals 1 if the project is discovery stage (107 deals), 2 if it is lead molecule stage (11), 3 if pre-clinical (7), or 4 if phase I FDA trials (2 deals). Project Term is the expected length of the alliance as stated in the contract at signing. Project size is the total amount of financial outlays (both actual and contingent) that the client pledges to the R&D. Equity 0/1 is an equity dummy, while Equity stake measures the size of the equity purchase in millions. Equity fraction measures the equity value as a fraction of the value of the R&D firm as of the last time it received funding. Employment variables record whether the contract stipulates a certain number of full-time equivalents (FTEs), stipulates their level of training (PhDs), or names specific individuals as project members (Names). R&D Puts refers to whether the equity contract allows the R&D to put additional shares to the client; Warrants refers to whether the client has the right to increase its equity stake. These are only defined for equity deals.

	Project			Equity			R&D	VC	Firm	R&D	War-	Roy-	Up-	Employment	
	Stage	Term	Size	0/1	Stake	Frac.	Age	Frac.	Value	Puts	rants	alty?	front?	FTEs	PhDs
Proj. Term	-0.16*														
Size	0.08	0.55*													
Equity: 0/1	-0.13	0.25*	0.23*												
Stake	-0.04	0.50*	0.48*	0.56*											
Frac.	-0.14	0.40*	0.22*	0.53*	0.48*										
R&D Age	0.17*	0.02	0.08	-0.21*	0.03	-0.14									
VC Frac.	-0.06	-0.12	-0.20*	-0.07	-0.17	-0.01	-0.54*								
Firm Value	0.15	0.29*	0.41*	-0.01	0.34*	-0.24*	0.18*	-0.36*							
R&D Puts	-0.12	0.40*	0.36*	.	0.31*	0.23*	0.06	-0.05	0.06						
Warrants	-0.11	0.29*	0.17	.	0.26*	-0.05	-0.05	-0.10	0.50*	0.17					
Royalty?	0.47*	0.09	0.21	-0.13	0.32	0.17	0.49*	-0.25	0.41*	0.42	0.21				
Upfront?	0.03	-0.17*	-0.16	0.14	0.02	-0.07	-0.02	-0.01	-0.11	0.09	-0.03	-0.14			
FTE?	-0.07	-0.04	-0.01	0.07	0.01	-0.03	0.08	0.05	-0.14	-0.02	0.06	0.02	-0.03		
PhDs	0.09	0.01	0.02	0.07	0.01	0.07	-0.08	0.10	-0.16	-0.12	0.03	-0.24	-0.02	0.09	
Names	0.00	0.14	0.15	0.13	0.19*	0.23*	-0.11	-0.03	-0.11	-0.05	0.11	-0.01	-0.06	0.18*	0.69*

Table 6
Determinants of Contract Length

The dependent variable measures the length of the contract analysis in bytes. Meeting frequency records the number of times per year that the oversight committees set up to oversee the research projects meet. Board seat allocated is a dummy variable for whether an equity stake includes a board seat. Equity is a dummy for equity participation, while equity stake measures the dollar value of the equity stake, in millions. Firm value is the value of the R&D firm as recorded by the Recombinant Capital funding database. Publicly traded is a dummy for whether the R&D is publicly traded. Upfront dummy and amount record whether an upfront payment took place, and if so, how large. Robust t-statistics are reported in parentheses.

	Length of Contract			
	(1)	(2)	(3)	(4)
Frequency	0.075	0.928	1.490	1.335
	(0.25)	(2.52)*	(2.15)*	(2.09)*
Board Dummy	-1.650	-0.568	2.199	2.182
	(0.60)	(0.20)	(0.80)	(0.82)
Equity	-1.690	-1.227	-3.501	-3.088
	(0.79)	(0.55)	(1.45)	(1.35)
Equity Stake	0.659	0.568	0.453	0.380
	(3.03)**	(3.22)**	(3.06)**	(2.84)**
Firm Value		0.019	0.026	0.025
		(1.77)	(2.00)	(2.20)*
Publicly Traded		-0.341	-1.329	0.020
		(0.15)	(0.52)	(0.01)
Upfront Dummy			0.616	-0.783
			(0.28)	(0.36)
Upfront Amount			0.712	1.369
			(2.28)*	(3.74)**
Project Stage				-4.517
				(2.63)*
Constant	18.526	13.034	11.204	16.839
	(10.78)**	(5.99)**	(3.95)**	(4.82)**
Observations	99	72	55	55
R-squared	0.19	0.37	0.49	0.54

Robust t statistics in parentheses

* significant at 5%; ** significant at 1%

Table 7
Determinants of Upfront Payments

The dependent variable is the amount of the upfront payment from the pharmaceutical to the biotech in millions of US dollars. Project stage takes on the values 1, 2, 3, or 4 according to whether the project is discovery stage, lead molecule, pre-clinical, or in phase I FDA trials (see table 5.) Publicly traded is a dummy for whether the biotech firm is post-IPO, and firm age is the age of the biotech. Equity dummy and stake, respectively, measure whether the pharmaceutical took an equity position in the biotech, and the size in millions of US dollars. Biotech's Centrality measures the number of connections the biotech firm has to other firms in the industry. Following Bonacich (1987), , for an $NtimesN$ binary matrix $\mathbf{X}$ in which $x_{ij} = 1$ if an alliance has occurred between firm i and j, we define target centrality as:

$$\textbf{Centrality } = \mathbf{c}(\alpha, \beta) = \alpha(\mathbf{I} - \beta\mathbf{X_t})^{-1}\mathbf{X_t}\mathbf{1}.$$

where α is a scaling factor, $\mathbf{1}$ is a column vector of ones, and β is the weight placed on more distant ties. The variable α is determined by solving the following equation:

$$\alpha = \sqrt{\frac{n}{\sum c^2(1, \beta)}}$$

where n is the number of firms in the network. See Robinson and Stuart (1999) for details.

	Upfront Payment, $ millions			
	(1)	(2)	(3)	(4)
Project Stage	2.192	3.261	3.366	3.336
	(2.84)**	(3.95)**	(4.22)**	(4.09)**
Publicly Traded	0.194	-2.330	-2.983	-2.924
	(0.19)	(1.76)	(2.26)*	(2.20)*
Firm Age	-0.000	-0.000	-0.000	-0.000
	(0.50)	(0.61)	(0.67)	(0.74)
Biotech Centrality		2.549	2.852	2.768
		(2.73)**	(3.12)**	(2.96)**
Equity Dummy			-2.353	-2.409
			(2.50)*	(2.13)*
Equity Stake				0.023
				(0.28)
Constant	-2.656	-4.431	-2.901	-2.794
	(2.37)*	(3.51)**	(2.20)*	(2.07)*
Observations	98	90	90	87

Absolute value of t statistics in parentheses

* significant at 5%; ** significant at 1%