

Supplemental Materials for Josh Lerner and Robert P. Merges, "The Control of Technology Alliances: An Empirical Analysis of the Biotechnology Industry," *The Journal of Industrial Economics* 46(2), June 1998, pp. 125-156

1. Detailed Discussion of Case Studies

As part of the effort to understand the structure of technology alliances, one of the authors undertook a series of three case studies. The studies examine three young companies developing advanced human therapeutics that are grappling with the challenges posed by alliances. The biotechnologies pursued by the three firms are quite different: antigen-based allergy drugs (ImmuLogic Pharmaceutical Corporation), advanced drug delivery mechanisms (ALZA Corporation), and monoclonal antibody-based treatments of inflammation (Repligen Corporation). There were considerable differences in the location and sophistication of strategic partners and the stage of development of the technologies.¹

These examinations, captured in ten cases and three teaching notes [Lerner, 1992; Lerner and Tufano, 1993; Kane and Lerner, 1994], are based on public securities filings, internal corporate documents, numerous interviews with senior managers of these firms, and supplemental discussions with investors, outside directors, strategic partners, and other observers. A detailed discussion of these alliances is beyond the scope of this paper: the interested reader is referred to the cases and associated teaching notes. In this section, however, we briefly discuss how control rights were allocated in these alliances, and the parallels to the theoretical literature summarized above.

1. The preparation of these cases was complemented by a series of academic-practitioner roundtable discussions on the role of alliances in the biotechnology industry organized by this author. See the discussion in section 2.

These cases illustrate how the allocation of control rights are determined both by concerns about behavior after the alliance is signed and by relative bargaining power. One alliance that may be considered successful² in many respects was Repligen's May 1992 alliance with Eli Lilly regarding a very early-stage effort to develop a monoclonal antibody-based treatment of inflammation after heart attacks. In the Repligen-Lilly alliance, three control rights were the subject of protracted negotiations. The first was the management of clinical trials: the right to decide which drugs would be pursued and when. A second was the control over the marketing strategy, an arena in which Lilly had extensive experience and Repligen only a slight acquaintance. Finally, both parties wished to control the process development and ultimate manufacturing of the drug.³

2. The net-of-market return for Repligen in the three day window around the announcement of the transaction in May 1992 was +9%, and that of Lilly, +2%. These increases can be compared to the +2.1% reaction to 55 announcements of R&D initiatives by high-technology firms found by Chan, Martin, and Kensinger [1990]. The early-stage project succeeded in getting its lead product candidate into Phase I trials in just thirteen months. After extending the project in June 1995, however, Lilly canceled its involvement three months later, citing shifting internal priorities.

3. Repligen compared favorably on various financial measures to other biotechnology firms at the time that the alliance was signed. For instance, at the end of the 1991 fiscal year, it had \$33 million in cash and equivalents and \$41 million in total assets, both of which were considerably above the mean or median firm in the sample summarized in Table 4. (For the sake of comparison, Repligen's financial statements are expressed in 1995 dollars. The firm's revenues and net income were close to the mean firm in the sample.) Similarly, the firm had outperformed an index of biotechnology securities over its history by over 40%. (Stock price performance is measured from the close of the day of Repligen's initial public offering to avoid including the "underpricing" of the offering—*i.e.*, the discount at which the underwriters sold the shares to the original investors. Repligen's beta did not differ materially from that of other biotechnology firms.) At the same time, investment banking analysts had expressed concern about the financial pressures that might result if Repligen's earlier alliance with Merck was terminated.

The terms of the alliance that emerged from the negotiations appeared to assign the control rights to the parties whose behavior would have the greatest impact on the product development effort. Repligen was allowed a great deal of control over developing the lead product candidate, an area where it had considerable experience, but tangential product development activities were subject to extensive review by Lilly. Lilly was assigned control over all aspects of marketing; while Repligen was assigned all manufacturing control rights, unless it encountered severe difficulties with regulators.

Other alliances illustrate the importance of the relative bargaining power of the two parties. An example was the January 1978 alliance between ALZA and Ciba-Geigy. At the time of the alliance, ALZA faced a major financial crisis. The firm had little more than \$1 million in the bank, was spending \$2 million more per month than it was receiving in revenues, had nearly exhausted its bank credit line, was in violation of several loan covenants, and was precluded from a sale of equity to the public by unfavorable market conditions and the perception that ALZA had been excessively optimistic in its earlier communications with investors and analysts.

The alliance assigned almost total control to the Swiss pharmaceutical giant. Ciba-Geigy was given a super-majority on the joint board that reviewed and approved potential research projects, the right to license and manufacture any of ALZA's current or future products, the ability to block any other alliances that ALZA proposed to enter into, and eight of the eleven seats on ALZA's board of directors. In addition, the Swiss pharmaceutical giant received a new class

of preferred shares. If converted into common stock, the new preferred shares would represent 53% of the equity in ALZA. Until conversion, however, Ciba-Geigy had 80% of the voting rights, an allocation which allowed it to employ ALZA's tax losses.

At the same time, it is reasonable to believe that concerns about the post-alliance behavior of ALZA also motivated Ciba-Geigy to demand strong control rights. ALZA's leaders had displayed little ability to direct the firm's research effort over the course of the 1970s. This may have led Ciba-Geigy to conclude that the benefits of allocating control rights to ALZA's management were limited. Despite the strict control rights contractually assigned to Ciba-Geigy, there were frequent disputes between the two firms as ALZA researchers sought to either circumvent the pharmaceutical firm's middle management or ignored their instructions outright. Frustrated by these problems, Ciba-Geigy agreed to terminate the alliance and sell back its equity to ALZA in November 1981.

A contrasting illustration is presented by ImmuLogic. In March 1991, the firm was considering either entering into an alliance or raising equity in an initial public offering. One concern that led the firm to decide to go public was that a potential strategic partner might exploit its relatively weak financial condition. In other words, ImmuLogic feared that a pharmaceutical company might obtain numerous concessions on key governance and financial issues by protracting the negotiations until ImmuLogic was close to running out of capital. It consequently deferred negotiating an alliance to develop and market its allergy drugs until the firm went public

in May 1991. The firm announced an alliance with Marion Merrell Dow in December 1991, which allowed ImmuLogic to retain numerous control rights, such as an equal role in planning marketing strategy in the U.S.: *In Vivo* magazine hailed the transaction as “push[ing] the limit of the biotech deal ... a partnership in fact as well as name” [quoted in Lerner, 1992, Teaching Note 5-293-118, p. 7]. Just as ALZA’s relinquishment of almost total control to Ciba-Geigy was in large part a consequence of its weak financial position, ImmuLogic’s ability to obtain these control rights reflected its financial strength.

These cases also emphasize two issues that are not highlighted in the theoretical literature (or in the empirical analysis in this paper). One is the interaction between the allocation of control rights and the financial terms of the transactions. For instance, in the negotiations that led to Repligen’s retention of control over manufacturing, the firm agreed to an alteration in its compensation. Repligen accepted a lower royalty than originally envisioned, 5% of the sales price, but agreed to supply the drug to Lilly at a price (about 15% of the sales price) above what it believed its true manufacturing cost would be. Repligen agreed to reduce the price that it charged Lilly if it was able to manufacture the drug for less, but only if its cost was below 8% of the sales price.

A second interesting and unexplored aspect is the apparent signal that the allocation of control rights provided to potential investors and other outsiders. Both ImmuLogic and Repligen highlighted their retention of key control rights in the press releases announcing the transactions

described here. Their ability to obtain these rights attracted favorable comments in the trade press and analyst reports alike. These patterns suggest a richer set of interactions than theoretical treatments of these issues imply.

2. The Roundtable on the Management of the New Biotechnology Firm

This academic-practitioner roundtable has examined over the past academic years a variety of issues associated with the biotechnology industry. Each session has followed a similar formula:

- A package of reading materials is distributed, or suggested references on the World Wide Web provided, to participants in advance of the session. This include academic explorations of the topic to be explored in the session, recent articles in the business press, and background material on the presenter or presenters.
- The session is introduced by the coordinator who briefly summarizes the key issues and disputes in the readings.
- The featured guest (or guests) then makes a thirty-to-fourty minute presentation. This is focused around an example illustrating how his or her organization addressed the issue under discussion.
- A general discussion follows. To insure a lively discussion, in addition to the core group of participants, guests with a special interest in the subject matter are invited to each session.

Participants are drawn from biotechnology, investment, academic (including both the biological and social sciences), government and legal communities. Participation by members of the Harvard community is encouraged: this includes faculty members and administrators as well as students and executive development program participants with industry experience. Many members of the core group have been participants in earlier roundtables.

Over the years, a variety of topics have been considered. The first series focused the strengthening of patent policy associated with the creation of the Court of Appeals for the Federal Circuit in 1982 and its impact on the biotechnology industry. The second focused on health care reform, and its implications for the biotechnology industry. The third series examined the challenges associated with the commercialization of academic science and the various strategies being employed by universities and private investors. The fourth series examined the restructuring of established biotechnology firms in the wake of the product and stock market disappointments of the mid-1990s.

The fourth series, in the 1996-97 academic year, explored the challenging financing environment facing early-stage firms developing biotechnologies and other emerging technologies. This explored not only the challenges facing biotechnology firms, but the root cause for these patterns: e.g., the steady increase in the size of the typical venture capital fund largely driven by the increasing role played by institutional investors, particularly large pension funds. Other sessions explored public policy responses to these patterns, as well as innovative initiatives by independent venture organizations.

The most recent year's roundtable examined the recent growth of the biotechnology industry outside of the United States. These firms are increasingly accessing resources from the financial markets, including both venture capitalists and public market investors. Moreover, encouraging the growth of biotechnology firms has been a major priority of governments around the world, many of which have set up aggressive programs to subsidize these firms and/or their venture investors.

3. Univariate Analyses

One concern with this analysis in the paper is the extent to which the allocation of individual control rights are independent of one another. If these rights are essentially being included on an all-or-nothing basis, it might distort our interpretation of the results. This concern is addressed in Table A-1. In particular, each row of the table summarizes the alliances where a particular control right was present. Each column indicates the percentage of cases where another one of the twenty-five control rights was also present.

There are relatively few cases where two rights appear closely in tandem. For instance, in only 10 out of the 300 pairs do both control rights appear at least two-thirds of the time when the other control right does.⁴ In a supplemental analysis below, we calculate the count of control rights eliminating four classes: the rights to manufacture the final product (#3), to market to product alone (#5), to shelve the project (#12), and to make public equity purchases (#25). After these deletions, no pairs of control rights overlap as described above.

In Table A-2, we examine the correlation between the number of control rights assigned to the financing firm and the characteristics of the firms and the public equity market at the time of

4. To cite one example of such a pair, Right #1 appears 69% of the time that Right #3 does, and Right #3 appears 76% of the time that Right #1 does. Results are similar when we compute correlation coefficients. Correlations are generally positive but modest in magnitude. The average correlation coefficient between the key alliance management rights is 0.026. The others are slightly larger as follows: between the alliance scope rights, 0.030; intellectual property rights, 0.043; governance structures, 0.081. The correlations across the different groups are lower. For instance, the average correlation coefficient between the key alliance management rights and the intellectual property rights is 0.001.

the alliance. Because we are concerned that the results may be shaped by horizontal alliances as discussed above, we also present analyses eliminating two sets of observations, alliances between biotechnology firms and between firms with similar financial resources. We again define these as firms whose assets are within five times of their partners' assets at the end of the year prior to the signing of the alliance.

The correlation analysis reveals a strong negative relationship between the number of control rights allocated to the financing firm and the financial strength of the R&D firm. Biotechnology firms with more revenues in the year before the alliance is signed, as well as those spending more on R&D and having more financial resources, are less likely to negotiate away important control rights.⁵

The interpretation of the results using the measures of the stage of the project is more problematic. We first indicate the stage of the lead product at the time of the alliance through an ordinal rank, with 1 being discovery research and 10 being regulatory approval. (As discussed above, only one project had received regulatory approval at the time the alliance was signed.) When the technology is in its early stages, there are significantly more control rights allocated to

5. It may seem surprising that there is not a strong relationship between net income and the allocation of control rights. This reflects the peculiar economics of the biotechnology industry. While firms attracting more external research funding and receiving revenues from product market sales will report higher net income, early-stage companies with significant financial resources may spend more aggressively on R&D and, consequently, report lower net income (greater losses) than their less well-endowed peers. Thus, net income is a poor indicator of the financial resources of young biotechnology firms.

the financing firm. In two of these analyses, a similar pattern is significant at the 10% confidence level when we examine the number of patents that the R&D firm has. R&D firms with fewer patents give up more control rights. This seems to contradict theoretical suggestions, since we would anticipate that contractual incompleteness would pose the greatest problem in early-stage projects. As discussed above, in those settings project outcomes and R&D firm effort should be difficult to specify in an enforceable contract. These partial correlations, however, may reflect other factors. For example, firms with few patents may also have few financial resources.⁶

4. Supplemental Regression Analyses

In Table A-3, we explore the robustness of the analysis to a variety of alternative hypotheses mentioned above and in the paper.⁷ Panel A of the table addresses the suggestion that

6. We also examine the correlations between the four subsets of control rights and the independent variables. When we examine the key alliance management control rights, designated Rights #1-#5 in Table 5, the patterns seen above continue, but other significant patterns emerge. In particular, when more equity is raised by all biotechnology firms in the public markets during the quarter preceding the signing of the alliance, fewer control rights are assigned to the financing firm. This is consistent with the patterns found using the measures of the R&D firm's financial condition. The other three groups of control rights display correlations similar to those in the analysis reported in Table 7.

7. We also explore the robustness of the results to a variety of changes in unreported regressions. These include the substitution of several alternatives for the independent variables, such as the amount of public equity raised by biotechnology firms in the previous four quarters for the measures of the previous quarter's fundraising or the biotechnology index, and the measures of the R&D firm's sales, R&D, and cash and equivalents instead of assets or shareholders' equity. To examine whether the results may be driven by a few outliers, we express the continuous independent variables in logarithms. We also explore the robustness of the results to the addition and subtraction of particular control rights, for example using only those control rights that appear in between 10% and 90% of the alliances. All of these changes have relatively little influence on the strong positive relationship between the R&D firm's financial condition and the

the insignificance of the variables measuring public market conditions in many of the regressions reflects the extended negotiations that often characterize these alliances. It may be that the essential features of the alliances are agreed to months before the signing date. We employ the same measures of market conditions as before, using the equity index and total equity raised, but examine these values during (or at the end of) the penultimate quarter before the transaction, rather than the quarter immediately prior to the transaction. This has little impact on the results. In unreported regressions, we employ the values from two quarters prior to the transaction, with similar results.

A second concern is that, as discussed above, the effects might reflect some unobserved inter-temporal variation. For a variety of reasons, such as a well publicized lawsuit, the structure of the alliances may have shifted over time. If the financial resources of firms also shifted over time (for example, the typical R&D firm entering into an alliance may have had more financial resources during “hot issue” markets such as 1991-1992), this may lead to a false imputation of causality. To address this concern, we add dummy variables for the year in which each alliance was signed. As reported in Panel B of Table A-3, the variables measuring firm characteristics retain the same magnitude and significance.

Panel C of Table A-3 explores the impact of dropping the control rights that frequently appear alongside others. As discussed above, in ten pairs of control rights out of the 300 pairs,

number of control rights that it retains, or the much more ambiguous relationship between the stage at which the alliance is entered into and the allocation of control rights.

both terms appear at least two-thirds of the time when the other does. These cases can be eliminated by dropping four rights from our analysis. This set of regressions uses as the dependent variable the number of control rights included in the alliances out of a possible 21. The results are little changed.

We then explore the effects of adding other independent variables. Panel D of Table A-3 reports the results when controls are added for alliances *(i)* focusing on agricultural, diagnostic, or industrial applications, which may be less costly to obtain regulatory approval for, and thus pose less of a financial burden on the biotechnological firm, *(ii)* between firms with a previous contractual relationship, *(iii)* where the financing firm made a prior equity investment in the R&D firm, and *(iv)* which may be construed as horizontal. Again, we define horizontal alliances as those alliances between biotechnology firms or between companies whose assets are within five times of the assets of their alliance partner. (In unreported analyses, we repeat this same exercise, defining horizontal alliances as those between firms whose assets are within two or ten times of their partner's assets. We also use definitions based on levels of cash and equivalents and shareholders' equity. These modifications have little impact.) We also add an interaction between the number of related patent awards and the shareholders' equity or the total assets of the R&D firm.

The control variables are uniformly insignificant in the analyses. This result is also true of unreported regressions employing alternative specifications. The interaction term, however, is significantly negative. The R&D firm's additional patents are associated with more control rights

being assigned to the financing firm, but only in cases when the R&D firm has few financial resources. If the R&D firm has more financial resources, a stronger patent position leads to the financing firm receiving fewer control rights. This finding once again does not appear to conform to the Aghion-Tirole model, and raises questions about whether the alliances are really designed to maximize joint value.

Table A-1—The relationship between control rights allocated to the firm financing the R&D activity. The sample consists of 200 technology alliances initiated between biotechnology and pharmaceutical companies or between biotechnology firms in the 1980-1995 period. Each row indicates the percentage of alliances where a particular control right is present that have each of the 24 other control rights.

If This Control Right is Allocated to the Financing Firm How Often is This Control Right Allocated to the Financing Firm?											
	1. Manage trials	2. Process dlpm't.	3. Mnfg. rights	4. Mk't univ.	5. Mk't alone	6. Expand alliance	7. Extend alliance	8. End w/o cause	9. End projects	10. Sub-license	11. License after	12. Shelve
1. Manage clinical trials		6%	76%	73%	81%	15%	25%	34%	12%	25%	46%	91%
2. Undertake process dlpm't	44%		94	56	56	0	25	12	25	31	31	100
3. Manufacture final product	69	12		67	76	15	25	27	13	29	42	93
4. Market universally	62	7	63		83	10	27	31	9	22	43	92
5. Market product alone	57	6	60	69		11	23	31	11	25	47	94
6. Expand alliance	81	0	90	67	81		57	19	5	24	33	95
7. Extend alliance	66	9	70	82	84	27		32	14	30	41	95
8. Terminate without cause	61	3	53	64	78	6	22		16	28	56	89
9. Terminate certain projects	61	17	70	52	74	4	26	43		35	65	96
10. Right to sub-license	57	10	71	57	78	10	25	35	16		41	96
11. License after expiration	59	6	59	63	83	8	20	40	17	23		93
12. Right to "shelve" projects	56	9	63	66	82	11	23	31	12	26	45	
13. Ownership of patents	47	16	58	89	79	11	11	5	5	11	53	95
14. Partial patent ownership	56	10	67	64	79	13	19	30	12	28	45	92
15. Control of patent litigation	73	6	73	76	82	14	20	29	10	20	61	94
16. Know-how transfer	57	8	62	76	84	12	21	24	8	22	47	93
17. Ownership of core tech.	54	8	62	69	92	8	0	8	0	15	54	100
18. Right to delay publications	63	10	70	67	67	17	21	37	14	30	40	87
19. Suppress publications	68	8	68	62	73	14	30	27	8	22	51	86
20. Control of top body	50	17	83	58	67	8	17	50	0	8	33	100
21. Seat on board	52	7	64	64	76	12	19	38	14	29	50	88
22. Equity in R&D firm	63	9	70	63	78	15	25	31	15	25	46	90
23. Participate in financings	59	7	66	66	78	12	22	37	20	20	54	90
24. Register stock	64	5	70	67	79	15	28	33	18	30	56	87
25. Make equity purchases	55	7	61	69	82	10	20	33	9	24	45	93

Table A-1—The relationship between control rights allocated to the firm financing the R&D activity (continued).

If This Control Right is Allocated to the Financing Firm How Often is This Control Right Allocated to the Financing Firm?												
	13. Own patents	14. Partly own	15. Know- how	16. Litig. control	17. Own core	18. Delay pubs.	19. Block pubs.	20. Top body	21. Board seat	22. Equity in firm	23. Finan. right	24. Reg. stock	25. Buy equity
1. Manage clinical trials	8%	70%	32%	45%	6%	39%	22%	5%	19%	56%	21%	34%	74%
2. Undertake process dlpm't	19	94	19	44	6	44	19	12	19	56	19	19	69
3. Manufacture final product	9	77	28	44	6	39	20	8	21	56	21	34	74
4. Market universally	13	69	28	51	7	35	17	5	20	48	20	31	79
5. Market product alone	9	71	25	47	7	29	17	5	20	50	20	30	78
6. Expand alliance	10	90	33	52	5	57	24	5	24	71	24	43	71
7. Extend alliance	5	61	23	43	0	34	25	5	18	57	20	39	70
8. Terminate without cause	2	67	22	34	2	41	16	9	25	50	23	31	80
9. Terminate certain projects	4	74	22	30	0	43	13	0	26	65	35	48	61
10. Right to sub-license	4	78	20	39	4	41	16	2	24	51	16	35	73
11. License after expiration	11	72	33	47	8	31	21	4	23	52	24	38	77
12. Right to "shelve" projects	10	71	25	45	7	33	17	6	20	49	20	28	77
13. Ownership of patents		100	63	68	37	0	26	5	11	21	16	5	100
14. Partial patent ownership	13		24	46	8	40	19	7	21	50	17	29	81
15. Control of patent litigation	24	71		53	12	33	31	8	14	49	16	35	76
16. Know-how transfer	14	73	29		11	31	18	3	20	47	13	26	82
17. Ownership of core tech.	54	92	46	77		8	23	8	8	23	15	15	92
18. Right to delay publications	0	81	23	40	1		16	3	23	66	26	37	69
19. Suppress publications	14	73	41	43	8	30		14	30	62	27	43	70
20. Control of top body	8	83	33	25	8	17	42		42	58	17	25	83
21. Seat on board	5	71	17	43	2	38	26	12		93	52	55	57
22. Equity in R&D firm	4	71	24	41	3	45	23	7	38		40	59	56
23. Participate in financings	7	61	20	29	5	44	24	5	54	100		76	44
24. Register stock	2	69	28	38	3	43	26	5	38	98	51		41
25. Make equity purchases	12	76	24	48	8	31	17	7	16	37	12	16	

Table A-2—Correlation between the control rights allocated to the funding party and (i) the characteristics of the alliance, (ii) the financial market conditions around the time of the alliance and (iii) the characteristics of the firms in the alliance. The sample consists of 200 technology alliances initiated between biotechnology and pharmaceutical companies or between biotechnology firms in the 1980-1995 period. The table presents the correlation coefficients and p-values from the test of the null hypothesis that these coefficients are not significantly different from zero. The analysis uses the number of control rights included in each alliance out of the 25 rights appearing in between 5% and 95% of all the alliances. Correlations are presented as well for two sub-samples which are less likely to have horizontal components: alliances between pharmaceutical and biotechnology firms and where the assets of the financing firm were at least five times greater than that of the R&D firm. The date variable is expressed as a decimal (e.g., July 1, 1995 is coded as 1995.5). The measure of the stage of the alliance is the ordinal rank of the process along a time-line, with 1 being “discovery research” and 10 being “regulatory approval.” The public equity raised and financial position variables are expressed in billions of 1995 dollars. The biotechnology index reflects inflation-adjusted public equity values and is normalized to 1.0 on January 1, 1978.

	All Observations		Pharmaceutical-Biotech Only		Financing Firm >5x Larger	
	Corr. Coeff.	p-Value	Corr. Coeff.	p-Value	Corr. Coeff.	p-Value
<i>Characteristics of Alliance:</i>						
Date of Alliance	-0.04	0.56	-0.05	0.49	-0.05	0.51
Minimum Length of Alliance	-0.01	0.94	-0.01	0.90	0.00	0.97
Stage of Product at Time of Alliance	-0.15	0.04	-0.16	0.04	-0.14	0.05
<i>Condition of Biotech Equity Markets:</i>						
Total Public Equity Raised in Prior Quarter	-0.03	0.67	-0.06	0.42	-0.03	0.67
Total Public Equity Raised in Prior Year	-0.03	0.70	-0.07	0.37	-0.05	0.50
Biotech Index at End of Prior Quarter	-0.05	0.51	-0.08	0.29	-0.06	0.39
<i>Financial Position of Financing Firm:</i>						
Revenues in Prior Year	0.03	0.68	0.03	0.69	0.04	0.57
R&D Expenditures in Prior Year	0.08	0.33	0.10	0.25	0.09	0.24
Net Income in Prior Year	0.05	0.48	0.07	0.39	0.08	0.32
Cash and Equivalents at End of Prior Year	0.20	0.01	0.22	0.01	0.21	0.01
Total Assets at End of Prior Year	0.06	0.46	0.07	0.42	0.07	0.36
Shareholders' Equity at End of Prior Year	0.05	0.49	0.07	0.45	0.07	0.39
<i>Financial Position of R&D Firm:</i>						
Revenues in Prior Year	-0.14	0.05	-0.21	0.01	-0.20	0.01
R&D Expenditures in Prior Year	-0.17	0.03	-0.19	0.02	-0.18	0.02
Net Income in Prior Year	0.07	0.37	0.07	0.35	0.07	0.36
Cash and Equivalents at End of Prior Year	-0.21	0.00	-0.23	0.00	-0.22	0.00
Total Assets at End of Prior Year	-0.21	0.01	-0.24	0.00	-0.23	0.00
Shareholders' Equity at End of Prior Year	-0.20	0.01	-0.22	0.01	-0.21	0.00
Ratio of Funding to R&D Firms' Assets	0.09	0.25	0.10	0.27	0.10	0.21
<i>Patent Holdings of R&D Company:</i>						
Total Patent Awards	-0.10	0.17	-0.14	0.07	-0.12	0.08
Patent Awards Related to Alliance	-0.06	0.42	-0.09	0.27	-0.08	0.29

Table A-3—Supplemental regression analysis of the control rights allocated to the funding party. The sample consists of 200 technology alliances initiated between biotechnology and pharmaceutical companies or between biotechnology firms in the 1980-1995 period. In Panels A, B, and D, the dependent variable is the number of control rights included in each alliance out of the twenty-five rights appearing in between 5% and 95% of the alliances. In Panel C, the dependent variable is the number of control rights included in each alliance out of the twenty-one rights (the rights above minus four which frequently overlap with other rights). In Panel A, the public equity raised and biotech index variables are lagged one quarter. In Panel B, dummy variables are added for the year in which the alliance was signed. In Panel D, additional control variables are employed, including dummy variables denoting whether (i) the project relates to agricultural, diagnostic, or industrial applications, (ii) the pair of firms had previously entered into any contracts, (iii) the financing firm had previously made an equity investment in the R&D firm, and (iv) this is likely to be a horizontal transaction (*i.e.*, whether the firms are both biotechnology companies, or in a similar financial position) and an interaction between the financial and patent measures. In all regressions, the public equity raised and the financial position variables are in billions of 1995 dollars. The biotechnology index reflects inflation-adjusted public equity values and is normalized to 1.0 on January 1, 1978. The dummy variables are coded as 1.0 when the answers to the posed questions are in the affirmative. Absolute t-statistics in brackets.

Panel A: Using Public Market Variables from the Penultimate Quarter Instead of the Previous Quarter		
R&D Firm's Patent Awards Related to Alliance	0.08 [2.32]	0.07 [2.21]
Total Public Equity Raised in Penultimate Quarter	-0.22 [0.53]	
Biotech Index at End of Penultimate Quarter		-0.42 [1.03]
R&D Firm's Shareholders' Equity at End of Prior Year	-11.46 [3.48]	
R&D Firm's Total Assets at End of Prior Year		-7.97 [3.44]
Constant	9.67 [39.34]	10.27 [14.99]
F-statistic	4.31	4.70
p-Value	0.01	0.00
Adjusted R ²	0.05	0.06
Number of Observations	180	176
Panel B: Using Dummy Variables for the Year in which the Alliance was Signed (Not Reported)		
R&D Firm's Patent Awards Related to Alliance	0.08 [2.16]	0.07 [1.99]
Total Public Equity Raised in Prior Quarter	0.03 [0.07]	
Biotech Index at End of Prior Quarter		0.45 [0.61]
R&D Firm's Shareholders' Equity at End of Prior Year	-11.29 [3.36]	
R&D Firm's Total Assets at End of Prior Year		-7.61 [3.24]
F-statistic	1.89	2.01
p-Value	0.02	0.02
Adjusted R ²	0.08	0.08
Number of Observations	180	176
Panel C: Computing the Dependent Variable Not Including Four Overlapping Rights		
R&D Firm's Patent Awards Related to Alliance	0.07 [2.03]	0.07 [2.20]
Total Public Equity Raised in Prior Quarter	-0.02 [0.05]	
Biotech Index at End of Prior Quarter		-0.50 [1.27]
R&D Firm's Shareholders' Equity at End of Prior Year	-9.49 [2.88]	
R&D Firm's Total Assets at End of Prior Year		-7.09 [3.08]
Constant	6.44 [26.15]	7.28 [10.70]
F-statistic	2.83	3.74
p-Value	0.04	0.01
Adjusted R ²	0.03	0.04
Number of Observations	180	176

Table A-3—Supplemental regression analysis of the control rights allocated to the funding partner(continued).

Panel D: Adding Additional Control Variables		
R&D Firm's Patent Awards Related to Alliance	0.20 [3.53]	0.19 [3.34]
Total Public Equity Raised in Prior Quarter	0.03 [0.08]	
Biotech Index at End of Prior Quarter		-0.44 [1.12]
R&D Firm's Shareholders' Equity at End of Prior Year	-9.89 [2.43]	
R&D Firm's Total Assets at End of Prior Year		-6.69 [2.54]
R&D Firm's Patent Awards * R&D Firm's Shareholders' Equity	-0.18 [2.67]	
R&D Firm's Patent Awards * R&D Firm's Total Assets		-0.13 [2.57]
Is Alliance Focused on Diagnostic Applications?	-1.13 [1.41]	-1.19 [1.49]
Is Alliance Focused on Agricultural/Industrial Applications?	-1.55 [1.60]	-1.39 [1.46]
Have Firms in Alliance Undertaken Previous Contract?	0.22 [0.25]	0.20 [0.23]
Has Financing Firm Made Previous Investment in R&D Firm?	2.59 [1.28]	2.08 [1.09]
Is Alliance Between Biotechnology Firms?	-0.14 [0.29]	
Are Two Firms' Assets within Five Times of Each Other?		1.80 [1.30]
Constant	9.58 [34.80]	10.27 [14.92]
F-statistic	2.81	3.12
p-Value	0.00	0.00
Adjusted R ²	0.08	0.10
Number of Observations	180	176