



DRUID Working Paper No. 08-22

Technology Commercialization Strategy in a Dynamic Context:
Complementary Assets, Hybrid Contracts, and Experiential
Learning

By

Simon Wakeman

Danish Research Unit for Industrial Dynamics

www.druid.dk



Technology Commercialization Strategy in a Dynamic Context: Complementary Assets, Hybrid Contracts, and Experiential Learning

Simon Wakeman

Assistant Professor

European School of Management and Technology

Schlossplatz 1

10178 Berlin, German

E-mail: wakeman@esmt.org

Abstract:

This paper analyzes the strategic choices of a technology firm seeking to profit from innovation when the established product firms are better positioned to commercialize that innovation. While the predominant framework frames this as a choice between contracting and integration, this paper shows that in a context where the technology firm innovates repeatedly and has the opportunity to learn from its experience in the commercialization process, it may be optimal for the technology firm to pursue a hybrid between these two: contracting with a firm that possesses the complementary assets but retaining rights to participate in the commercialization process. The analysis is motivated by the experience of biotech firms, which in recent years have increasingly sought to retain the rights to participate in the marketing and sales stages of alliances with pharmaceutical firms (known as “co-promotion”). The paper develops a game-theoretic model of a technology firm choosing its strategy in this context, and uses the model to derive the conditions under which the firms will agree to a co-promotion (rather than a pure licensing) arrangement. It uses the model to explain the pattern of arrangements observed in biotech alliances, using a dataset of 565 alliances signed between U.S. biotech and pharmaceutical firms from 1992-2006. The results show that a firm is significantly more likely to enter a co-promotion arrangement when its technological expertise is focused on the product field of the alliance and when it is in a stronger financial position.

ISBN 978- 87-7873-276-7

INTRODUCTION

A critical strategic decision facing a technology firm which has generated an innovation is how to access the complementary assets necessary to bring a product to market. According to Teece (1986), if the technology firm is at a disadvantage relative to the established product firms in accessing the complementary assets necessary to exploit the innovation but has strong appropriability over its innovation (so does not risk an alliance partner expropriating the innovation) then its optimal strategy is to contract with an established product firm to commercialize its innovation. The alternative – integrating downstream into the complementary activities – is not only likely to be costly but may also to allow imitators to catch up. Nevertheless, in exchange for access to the established firm's complementary assets, the technology firm must share the returns from its innovation. Moreover, if it does this repeatedly for successive innovations it will remain in the same disadvantaged position relative to the established product firms and is unlikely to earn superior profits over the long term.¹

In this paper I examine the alternative strategic choices available to a technology-based firm to capture returns from its innovations over the long term. In particular, I analyze the conditions under which it makes sense for the technology firm to pursue a hybrid arrangement between these contracting and integration: contracting with a firm that possesses the complementary assets but retaining rights to participate in the commercialization process. The analysis is motivated by the experience of technology-based firms in the biopharmaceutical industry (i.e., biotech firms), which in recent years have sought increasingly to retain rights to participate in the marketing and sales process (known as “co-promotion” rights) in alliances with pharmaceutical firms. Executives of these firms explain this arrangement as part of a strategy by which they can learn about the commercialization process and thereby acquire the capabilities necessary to commercialize future innovations alone.

¹ By superior profits, I mean the supernormal profits – that is, earnings above the costs of factor inputs – that innovators seek in return for engaging in uncertain process of innovation. These are sometimes referred to as Schumpeterian rents.

To understand what drives the technology firm's choice between these alternative commercialization strategies, I develop a game-theoretic model of a technology firm choosing its strategy in a dynamic context where it innovates on a repeated basis and has the opportunity to learn from its experience in the commercialization process. I use the model to derive the conditions under which both the technology firm and an established firm are likely to agree to a co-promotion arrangement (rather than the traditional or "pure" licensing arrangement).

I then use the model to explain the pattern of arrangements observed in a dataset of 565 alliances between U.S. biotech and pharmaceutical firms signed between 1992 and 2006. The results of the empirical analysis show that a biotech firm is significantly more likely to negotiate a co-promotion arrangement (rather than a pure licensing agreement) when its technological expertise is concentrated in areas applicable to the product field(s) of the alliance and when it is in a stronger financial position. These results suggest that the decision whether to enter into a co-promotion arrangement or a pure licensing agreement involves a trade-off between the technology firm's need for immediate cash and the value of acquiring the knowledge that will enable it to commercialize future innovations alone.

The next section explains the relationship between this paper and the prior literature on technology commercialization strategy and alliance structure. I then present the model of the technology-based firm choosing its commercialization strategy and derive the conditions under which two firms are likely to agree to co-promotion. The following section describes the empirical analysis of a set of alliances in the biopharmaceutical industry. I conclude with some managerial implications.

LITERATURE REVIEW AND MOTIVATION

The paper builds on the framework for analyzing technology commercialization strategy proposed by Teece (1986). Teece posed the innovating firm's strategic choice as a decision between contracting with an established firm and integrating downstream to do the commercialization alone. He emphasized the role that the appropriability regime surrounding the innovation and the innovating firm's position relative to the complementary assets play in the firm's strategic choice, and argued that if the innovating firm has tight appropriability over its innovation but the established product firms are better positioned with respect to the

complementary assets then the innovating firm's optimal strategy is to contract with an established firm to commercialize the innovation.

Nevertheless, since the innovating firm in Teece (1986) innovates only once, the framework does not take into account how the firm's choice of commercialization mode might affect its options for commercializing future innovations. Moreover, although Teece acknowledges that the innovating firm may have to share profits with the holders of the complementary assets, he does not explain how a technology-based firm can strengthen its position and thereby overcome this constraint over the long term, especially when it expects to generate future innovations. Finally, although Teece mentions in passing that firms may use "mixed modes" in transitional phases (Teece, 1986, p.298), he does not explicitly consider how hybrid arrangements may enable a firm to capture some benefits of both contracting and self-commercialization.

Most subsequent research building on the Teece (1986) framework has concentrated primarily on how the firm's appropriability regime impacts its commercialization strategy (see, for instance, Gans, Hsu, & Stern, 2002; Gans & Stern, 2003; Arora & Merges, 2004). One exception is Jacobides, Knudsen, & Augier (2006), which examines how a firm may strengthen its position relative to the requisite complementary assets. They argue that a technology firm is unable to affect its position directly through a bilateral relationship with the holders of those assets, but may instead use venues such as standards-setting bodies to influence the industry architecture and thereby strengthen its position relative to the complementary assets. This paper tackles the same issue, but provides (and illustrates) a clear mechanism by which the technology firm can influence its position directly through its bilateral relationship.

This paper also contributes to the extant literature on contracts and alliances, particularly that which has examined the structure of these arrangements. Williamson (1991) coined the term "hybrid" to describe an arrangement which involves more integration of the contracting parties' activities than the classical, arm's-length contract imagined in the law and economics literature, but which stops short of fully integrating the parties under one hierarchy or governance structure. Most of the literature which has examined the structure of these arrangements in any detail has analyzed how they balance mitigating contractual hazards (governance) with providing the right incentives for investment (Pisano, 1989; Williamson, 1991; Oxley, 1997). A parallel literature,

building on the ‘property rights’ framework (Grossman & Hart, 1986; Hart & Moore, 1990), has also examined the extent to which contracts are designed to give the parties the optimal incentives for effort (Elfenbein & Lerner, 2003) and how their ability to do so is limited by the firms’ relative bargaining power or financial position (Lerner & Merges, 1998; Higgins, 2007). Nevertheless, although interview research (discussed below) suggests that achieving governance and providing incentives are relevant considerations in negotiating the contract, the evidence reveals that the technology firm’s primary motivation for retaining rights to participate in the commercialization process is acquiring the knowledge necessary to commercialize future products alone, which is the focus of this paper. Moreover, while previous articles which analyzed alliance structure have tended to abstract from the actual terms which firms explicitly negotiate to broadly construed variables, such as whether the alliance contains an equity investment (Pisano, 1989) or the allocation of an aggregate of control rights (Lerner & Merges, 1998; Higgins, 2007), this paper follows recent work (such as Lerner & Malmendier, 2005) that focuses on the specific terms of these alliances that firms earnestly negotiate.

There is a large literature on learning through alliances (Hamel, 1991; Khanna, Gulati, & Nohria, 1998; Oxley & Sampson, 2004), a subset of which focuses on how the structure of the alliance may affect learning (Kogut, 1988; Mowery, Oxley, & Silverman, 1996).² However, this literature is primarily focused on horizontal, ‘knowledge sharing’ alliances (in the parlance of Grant & Baden-Fuller, 2004) between firms with complementary technological portfolios in which learning from the other firm is the primary objective (e.g., international technology alliances). By contrast, this paper examines how the learning objective may influence the structure of vertical arrangements, where the primary objective is ‘accessing’ knowledge. Moreover it puts the learning in the context of the firm’s choice of business model for profiting from its innovation.

² Kogut (1988) argues that joint ventures may be more effective for achieving knowledge transfer while Mowery et al (1996) show empirically that firms are more likely to achieve technological transfer through bilateral (vs unilateral) contracts.

THEORY AND HYPOTHESIS DEVELOPMENT

In order to analyze the technology firm's commercialization strategy in a context where it generates successive innovations, I develop a dynamic game-theoretic model of the technology firm's choices. The model incorporates the repeated (or "dynamic") nature of the technology firm's commercialization decision, and shows how experiential learning affects that decision. Modeling the commercialization process also makes it possible to account explicitly for the strategic interaction between the technology and product firms in negotiating the terms of the license contract, something that has not been considered in previous, less formal analyses. Finally, the model makes it possible to characterize the conditions under which the parties will both agree to an intermediate strategy such as co-promotion.

The set-up of the model is based on Gans (2007), which in turn builds on a framework developed by Segal & Whinston (2007). However, it has several significant differences. Segal & Whinston sought to understand how the incumbent's behavior towards its competitors affects the (industry's) overall rate of innovation, while Gans examined how the technology firm's choice of commercialization mode affects its ability to innovate in future periods. By contrast, in this paper I seek to understand how the firm's choice of commercialization mode affects the firm's ability to capture value from its innovations over the long term. Moreover, while both Segal & Whinston and Gans assume that any innovation will be commercialized with certainty, in this paper the probability of commercialization is endogenous to the choice of commercialization in the current and previous periods. Furthermore, both of the earlier models imagine a situation where two firms are competing to become the industry incumbent, with the loser exiting the industry and becoming a challenger – or potential entrant – in the next period. By contrast, in the model presented in this paper, if the technology firm succeeds in acquiring its own commercialization capabilities it becomes another incumbent – in the sense that it obtains the same probability of commercializing an innovation as the already established product firms – without displacing the existing firm(s).

Model Setup

There are two types of firms in the model: a technology firm (T) and N identical product firms ($P_1, \dots, P_N$), each of which has specialized complementary assets in the relevant product field.

The subgame in each period proceeds as follows: T generates an innovation in the relevant product field with probability ϕ .³ T then negotiates with each of the N product firms. T may agree with one of the product firms to either a pure licensing arrangement (L) or a co-promotion arrangement (CP). Alternatively, T may decide not license the innovation (NL). Under the pure licensing arrangement, the product firm which wins the contract – I call that firm P_i and the other firms P_{-i} – obtains the rights to commercialize the innovation in exchange for a fixed payment X^L , which is paid whether or not the innovation is commercialized successfully. Under the co-promotion arrangement, T grants P_i the rights to commercialize the innovation in exchange for a fixed payment X^{CP} , but retains the right to participate in the commercialization process alongside P_i . If T does not license the innovation then it attempts to commercialize the innovation alone. At the same time, each product firm attempts to commercialize another innovation (which may be the result of its own internal research or obtained through a contract with a third party). Once the commercialization attempts have been made and the payoffs realized, the subgame repeats.

The probability of any P_i successfully commercializing an innovation (either T 's or its own) is σ_1 . Since P_i commercializes T 's innovation under both the licensing and co-promotion arrangements, the probability of successfully commercializing the innovation under either arrangement is σ_1 . By contrast, before T has successfully commercialized an innovation alone, the probability of successfully commercializing the innovation if it does so alone is $\sigma_0 < \sigma_1$. (Using Teece's terminology, T is in a disadvantaged position with respect to the complementary assets relative to all P_i .) However, once T has successfully commercialized an innovation, either alone or as part of the co-promotion arrangement, it acquires the commercialization capabilities equivalent to those of an established product firm (i.e., its probability of successfully commercializing an innovation rises to σ_1 in subsequent periods).

If T 's innovation is commercialized successfully, it captures the market for itself (i.e., no other firm is able to earn profits from another product) and it earns profits π_1 (in that period only).⁴

3 That is, with probability ϕ the innovation occurs in the particular product field where the product firms have expertise (call it Z) and with probability $1-\phi$ occurs in another product field (call it $-Z$).

4 This characterization mimics the typical situation in the pharmaceutical industry where a firm with a patented product achieves market exclusivity for the life of the patent.

However, if T 's innovation is not commercialized, then *one* of the product firms P_i that has successfully commercialized an innovation captures the market and earns profits π_0 (i.e., each firm P_i that has successfully commercialized an innovation earns profits π_0 with probability $\frac{1}{M}$, where M is the number of firms which have successfully commercialized an innovation). If no firm successfully commercializes an innovation then all firms earn nothing in that period.

Implications from the model

I use the model to derive a number of implications. First I derive several preliminary results, and then two testable propositions. The workings of the model and the proofs are provided in the Appendix.

The first result (presented here as a lemma) confirms the basic prediction of Teece (1986) that – in the static technology commercialization game with no opportunity for experiential learning – when the established product firm is better positioned with respect to the complementary assets, the technology firm will choose to license the rights to commercialize its innovation to the established firm rather than to commercialize the innovation alone. However, it also shows that when this is extended to a context where the technology firm innovates repeatedly basis and has the opportunity to learn from its experience in the commercialization process, it may be optimal for the technology firm not to license the innovation.

Lemma 1: (a) In a technology commercialization game with no experiential learning, the unique equilibrium outcome is where T licenses the innovation to an established product firm P_i .

(b) In a technology commercialization game with experiential learning, not licensing will be an equilibrium outcome if the number of firms (N) and the probability of T commercializing a future innovation in the particular product field (ϕ) are sufficiently large.

The second result (also presented here by way of a lemma) is that a necessary condition for co-promotion to occur is that there must be more than one established product firm in position to commercialize T 's innovations.

Lemma 2: (a) Co-promotion will be an equilibrium outcome of the technology commercialization game with experiential learning only if $N \geq 2$.

(b) The likelihood that T and P_i will choose to co-promote, rather than license the innovation, is increasing in the number of established product firms with which T could potentially contract to commercialize the innovation.

The third result from the model is consistent with Aghion & Tirole's (1994) prediction that an innovating firm that is financially constrained will be unable to retain control rights, even if it were efficient to do so. It also is also consistent with Lerner & Merges' (1998) finding that the technology firm is more likely to control rights more generally if it is in a stronger financial position.

Lemma 3: The likelihood that T and P_i will choose to co-promote rather than license the innovation is increasing in T 's financial position.

On the basis of these preliminary results, I can derive two testable predictions for when we are more likely to observe co-promotion rather than pure licensing agreements. The first proposition relates to the nature of T 's underlying capabilities, as represented by the probability that it will innovate in the same product field in future (ϕ).

Proposition 1: The likelihood that T and P_i will attempt to co-promote the innovation (rather T merely license the innovation to P_i) is increasing in the probability that T will innovate in the particular product field in future (ϕ) if the number of firms (N) and/or the probability that an established product firm will successfully commercializing the innovation (σ_1) are sufficiently large.

The second proposition relates to P_i 's capabilities, as represented by the probability that P_i will successfully commercialize the innovation (σ_1).

Proposition 2: The likelihood that T and P_i will attempt to co-promote the innovation (rather than purely license the innovation to P_i) is increasing in the probability that an established product firm will successfully commercializing the innovation (σ_1).

Hypotheses

Lemma 1 demonstrates that, even when the established product firms are better positioned with respect to the complementary assets, the technology firm's optimal strategy may not always be in to contract with one of the established firm to commercialize the innovation, particularly if the technology firm expects to generate subsequent innovations in the same product field. By contracting with an established product firm to commercialize successive innovations, the technology firm remains in a weaker position with respect to the complementary assets and hence has to continue sharing the returns in future periods. If instead the technology firm integrates downstream into the complementary assets and thereby learns about the commercialization process, it may be able to capture more value over the long run.

Foregoing the opportunity to learn is not the only way that the technology firm puts itself at a disadvantage by licensing the innovation. As Pisano (1991) argued, if in the process of commercializing the innovation the established-product-firm partner develops specialized knowledge about the commercialization process or the product markets which is useful for commercializing future innovations, it may be in an even stronger bargaining position (relative to both the technology firm and other product firms) in future negotiations to commercialize an innovation. Hence a technology firm which contracts an established firm to commercialize its innovations on a repeated basis may become even more disadvantaged over time.

The model also demonstrates that the technology firm may prefer a hybrid arrangement, in which it licenses the innovation to an established product firm but retains rights to participate in the commercialization process, to either pure licensing or self-commercialization. As discussed above, licensing an innovation to an established firm limits the technology firm's ability to capture profits from its innovation. In order to overcome the constraint on its profitability that comes from being dependent on an established firm, the technology firm must acquire experience in commercialization and develop its own capabilities in commercialization. However, commercializing alone is expensive, and the technology firm's inexperience means that it has a higher risk of failure than when it contracts with an established firm. Entering into this hybrid arrangement reduces the likelihood of failure in commercializing its current innovation. Moreover, at the same time this arrangement allows it to observe the established firm

applying its specialized knowledge, to get advice on developing its own commercialization capabilities, and to practice using these capabilities under the established firm's guidance. Hence, this arrangement is more likely than pure licensing or self-commercialization to put the technology firm in the position to commercialize innovations alone in future.

Nevertheless, there are several constraints which mean that technology firms may not retain rights to participate in the commercialization process in every commercialization alliance, even in the situation where the established product firms are much better positioned with respect to the complementary assets. To start with, an established product firm may be unwilling to allow the technology firm to participate in the commercialization process. Since co-promoting an innovation enables the technology firm to become a product firm, this arrangement potentially creates a competitor which may subsequently affect the product firm's ability to earn profits from its innovation.

Nevertheless, as Lemma 3 shows, if the costs of creating a new competitor are shared among multiple product firms, an individual product firm may be better off agreeing to the co-promotion arrangement. It accepts, it gets access to the innovation and is likely to pay less than if it had negotiated a license. Moreover, if it does not accept, one of its competitors may nevertheless agree to co-promote the innovation and it will not be any better off with respect to future competition in the downstream market. Hence, if the innovation is highly sought after, the technology firm may have the leverage in negotiations to retain rights to participate in the commercialization of an alliance product.

A second constraint on the technology firm's ability to negotiate a co-promotion arrangement is its ability to accept the lower fee, especially when the requisite fee for co-promotion effectively requires the technology firm to pay the product firm for allowing it to co-promote. The alliance contract covers a range of terms, both financial and non-financial, and there is substantial room to trade-off these terms in negotiations. The technology firm may be able to convince the established firm to grant rights to participate in the commercialization process in exchange for giving up a significant portion of the financial payments that it might otherwise have received. Nevertheless, since the technology firm often relies on the financial payments (particularly the upfront fees) to finance its current expenditures, its ability to trade-off financial payments for

control rights depends on its financial position (among other factors). Aghion & Tirole (1994) predicted that a financially constrained firm may have to give up control, even when doing so leads to a less efficient arrangement, and Lerner & Merges (1998) found evidence consistent with this hypothesis. I derive a similar result in Lemma 3.

Nevertheless, even if the technology firm has several firms competing to license its innovation and is in a position to give up financial payments in exchange for retaining rights, it may choose not co-promote the innovation because it does not foresee that acquiring commercialization capabilities in the product field of the alliance will not lead to compensating benefits over the longer term. Capabilities in product commercialization, such as expertise in marketing and sales, are specific to a particular product field. Moreover, building commercialization capabilities requires substantial investments (e.g., hiring and training a sales force) and the firm may also forego productivity on other tasks while this learning occurs. Hence, it is only worthwhile if the firm expects to generate further innovations (and hence products) in the same field in future

These concerns, which are captured in Proposition 1, lead to the first hypothesis that I test in this paper:

Hypothesis 1: A technology firm entering into an alliance to commercialize an innovation is more likely to enter a co-promotion arrangement (vis-à-vis a pure licensing arrangement) when it expects to generate innovations related to the alliance product field in future.

A second factor affecting the technology firm's desire to retain rights to participate in the commercialization process in a particular alliance is the level of expertise it expects to gain from its alliance partner. The level of the partner's expertise determines not only whether the commercialization will be successful (which is the same whether they license or co-promote) but also the savings that the technology firm can potentially make if it does not have to share the profits with a product firm in future. Hence a technology firm is more likely to seek a co-promotion arrangement when the expertise of its product-firm partner is higher. This is reflected in Proposition 2 above, and leads to the second testable hypothesis:

Hypothesis 2: A technology firm entering into an alliance to commercialize an innovation is more likely to enter a co-promotion arrangement (vis-à-vis a pure licensing arrangement) when its partner has greater commercialization experience related to the product field of the alliance.

EMPIRICAL ANALYSIS

Biopharmaceutical industry

Having used the model to derive the conditions under which we are more likely to observe co-promotion arrangements, I apply these predictions to explain the pattern of arrangements in the biotech industry – more accurately called the “biopharmaceutical” industry – which applies biological discoveries to the development of pharmaceutical products.⁵

The biotech industry originates from the founding of Genentech in 1976 to exploit the recombinant DNA techniques discovered by Herbert Boyer at the University of California at San Francisco and Stanley Cohen at Stanford in 1972. Genentech’s first major project was a race with UCSF and Harvard University to clone human insulin, the key protein that diabetics need to normalize their metabolism (Edwards & Hamilton, 1998). The prize, which Genentech won, was an alliance with Lilly to commercialize the discovery (named “Humulin”) as a pharmaceutical product.

The Genentech/Lilly alliance set the framework for interaction between the new “biotech” firms and the established pharmaceutical firms. Under a typical arrangement such as the Genentech/Lilly alliance, the biotech firm licensed all product rights to an established pharmaceutical firm. The biotech firm would remain involved through the pre-clinical stages of development, but then passed all responsibility for the clinical development, marketing, and worldwide sales to the pharmaceutical firm.

It was not uncommon in the early alliances for the biotech firm to retain rights to some territories (especially its home country) or, in a few cases, rights to specific indications. For instance, at the same time as Genentech entered the Lilly alliance, it also signed a deal with Kabi

⁵ The biopharmaceutical or medical “biotech” industry is distinct from the agricultural and industrial “biotech” industries.

Pharmaceutical, a Swedish firm, to commercialize human growth hormone in which it retained the rights to commercialize the product in the United States. At the same time, Amgen (one of the other industry pioneers) retained rights to sell to kidney dialysis patients in its alliance with Ortho Biotech to commercialize EPO.⁶ Nevertheless, in these cases, the firms kept their own commercialization activities separate from those of their pharmaceutical firm.

Over time the structure of these commercialization arrangements has changed significantly. As a first step, biotech firms sought to participate in the clinical development stages of the alliance, both by being involved in management of the clinical trials and by sharing in the costs (and thereby also the profit or loss) from clinical development. This arrangement, known as “co-development”, implied a substantial shift downstream in the biotech firm’s alliance activities. More recently biotech firms have taken a step even further downstream, retaining rights to participate in the marketing and sales of the alliance product, and arrangement called “co-promotion”. **Error! Reference source not found.** shows the trend in biotech firms entering into co-promotion arrangements (relative to pure licensing deals) over time.

Insert **Error! Reference source not found.** here

Under a co-promotion arrangement the biotech firm licenses the marketing rights to the pharmaceutical partner, but retains some rights to participate in the marketing and sales process alongside the partner. The two parties together develop a joint marketing strategy and sales force, sell under the same brand name, and pool – and ultimately split – revenues.⁷ One prominent example is ImClone’s 2001 arrangement with Bristol-Myers Squibb to commercialize its cancer drug Erbitux. Another is the deal between Idec Pharmaceuticals (now part of Biogen Idec) and

6 In cases like the two just mentioned, the biotech firm would attempt to commercialize the product alone in the retained territories or indications. However, in other cases it would license these retained rights to another pharmaceutical firm at a later stage in the process. A popular practice was to license the product rights for Japan to a Japanese pharmaceutical firm at an early stage in the commercialization process, then license the remaining rights to a multi-national pharmaceutical firm at a later stage. The rationale was that the funds gained from the first, partial grant of rights enabled the firm to develop the technology through to a later stage at which it could expect to capture a larger share of the rents.

7 Co-promotion can be contrasted against several other arrangements for commercializing biotech innovations. The most obvious contrast is the pure product license in which the biotech firm licenses all marketing & distribution rights to the pharmaceutical firm. However, one alternative which involves a greater degree of participation by the biotech firm is split territories (or, in a few cases, indications) under which the firms develop, market, and sell the same drug in separate (exclusive) territories. A third, if rare, alternative is co-marketing in which the firms develop, market, and sell the drug in same territory but with different marketing strategies, sales forces, and brand names.

Genentech in 1996 for the commercialization of Rituxan, a drug for non-Hodgkin's lymphoma, which has since become the largest selling monoclonal antibody drug and a significant contributor to the profits of both companies.

Evidence from interviews

In order to understand the motivation for entering co-promotion arrangements, I conducted a series of interviews with biotech firm executives who attended Recombinant Capital's Allicense conference in San Francisco on May 2-3, 2006.⁸ From the list of executives I selected executives from less-mature biotech firms whose firms either had retained co-promotion rights in recent agreements with established pharmaceutical firms (or more-mature biotech firms)⁹ or had recently entered licensing agreements without retaining co-promotion rights but were likely to have been in a position to retain such rights.¹⁰ I contact those executives by email and invited them to speak with me, either generally about why start-up biotech firms retain co-promotion rights in alliances or specifically about the reasons their company chose to retain (or not to retain) co-promotion rights in its recent agreements. I conducted phone interviews with ten executives during late May/early June 2006.

The primary reason the executives cited for retaining co-promotion rights was the belief that the biotech firm will capture a larger share of the value from its technology if it markets the alliance product than if it merely licenses the marketing rights to a pharmaceutical firm. Many echoed the refrain that "Wall Street values 'decision rights' over 'revenue rights'".¹¹ They argued that companies which had only done licensing deals had not been very successful. Some claimed that the revenue the firm earned from the profit split (typically between 33% and 50%) that usually

8 Allicense is the primary industry conference focusing on alliances between biotech and pharmaceutical firms, and is attended by the senior business development executives from all the major pharmaceutical and mature biotech firms, as well as CEOs and other senior executives from many start-up biotech firms.

9 In this analysis, I distinguish between mature biotech firms, such as Amgen and Genentech that already have pharmaceutical products on the market and are regularly licensing technologies or products in from other biotech firms, and less mature or "start-up" biotech firms, which do not have products on the market and are not in a position to commercialize their existing technologies and/or product candidates alone.

10 I estimated the likelihood that the firm would have retained co-promotion rights through an informal inspection of their prior licensing experience, financial strength, and various other observable factors in Recombinant Capital's Alliances database.

11 This statement was made by Stephen R. Davis, Executive Vice President and Chief Operating Officer, Neurogen, in his presentation at the Allicense conference in San Francisco on May 25, 2005.

accompanies a co-promotion agreement was usually greater than it earns from the combination of upfront payments and royalties (typically in the range of 10% of net sales) that a firm can get from an equivalent pure-licensing deal. However, others argued that, even though a pure-licensing agreement could be structured to produce as much income as a co-promotion agreement, a co-promotion arrangement gave the biotech firm greater insight into the business of commercializing pharmaceutical products and therefore was more valuable.

The primary benefit the executives cited for why Wall Street rewarded co-promotion arrangements was that the biotech firm acquires valuable knowledge by participating in the commercialization process alongside the pharmaceutical firm. One executive explained that by retaining co-promotion rights the biotech firm is able to “piggy back” on the expertise of its alliance partner to build its own capabilities. Another stated that the way to “score big” was to “leverage the alliance partner’s expertise internally” to learn the skills necessary to develop the next drug.

A secondary benefit of retaining co-promotion rights is that the firm also retains some control over the development and marketing process. Since neither firm knows at the outset the size of the potential market for the alliance product, a major concern for the biotech firm is that – if the product does not turn out to be sufficiently large – its alliance partner will not put in the resources necessary to commercialize it. Hence, it is important to have a voice at the table to make sure the drug gets developed on the biotech firm’s timeframe. One executive claimed that retaining some rights to participate in the marketing enables the firm to be “the nag that makes sure the drug gets developed”. Others explained that, while the deal could include “due diligence” or “best efforts” requirements, a lot of pharmaceutical firms would not agree to them because it was hard to define “best (or reasonable) efforts” and, if they did agree to such a clause, they were usually very vague and legally meaningless.

Some executives claimed that their firm would always retain co-promotion rights if they could. However, other executives identified cases in which they would not seek co-promotion rights. If the firm needed cash, so was forced to enter an alliance at an early stage in the product’s development, then retaining co-promotion rights was not usually worth the cost (in terms of money foregone). One executive quipped that the “first child” of the biotech firm typically had to

be sold (i.e., licensed exclusively) to a pharmaceutical firm in order to fund that and future products. Also, if the disease field on which the alliance product is focused was outside the firm's "strategic interests", or was in a very competitive field, then the biotech is likely to give up rights to the product.

The executives also explained why they believed pharmaceutical firms were willing to give up marketing rights, even though marketing is their specialty. They argued that pharmaceutical firms often did not have the leverage (especially in negotiations over very promising technologies) to negotiate all the rights to market the product, and hence they were forced to agree to co-promotion in order to secure the biotech firm's agreement. Nevertheless, the pharmaceutical firm may seek to buy those rights back – or even purchase the technology firm outright – if and when the product gets to market.¹² Moreover, one executive claimed that some companies would never agree to share marketing rights, especially when the biotech firm did not have the necessary experience.

Empirical analysis

Data

In order to test the predictions in the model, I compiled a dataset of 565 technology commercialization alliance contracts signed between U.S. biotech firms and pharmaceutical firms between 1992 & 2006. The primary data source is the Recombinant Capital database, which contains detailed information on the alliances, products in clinical trials, and financing of biotech firms. I used the Compustat database to obtain additional information on the biotech firm's financial position, namely the financial information filed with the SEC for publicly listed firms (where available).¹³ I also used data from the NBER patent file (Hall, Jaffe, & Trajtenberg,

12 Amgen's alliance with Abgenix is an example of this phenomenon. In July 2000 Abgenix entered a deal with Immunex to co-promote Abgenix's product panitumumab, a drug for late-stage colorectal cancer therapies that was then in Phase I trials. However, after Amgen acquired Immunex and the product passed through Phase III trials, Amgen purchased Abgenix outright. One rationale for doing so is that Amgen thereby avoided having to share the marketing with a smaller firm.

13 When the biotech firm was listed on a public exchange at the time it signed the alliance, I obtained this information in electronic form from the Compustat dataset. When the firm was not publicly listed at the time it signed the alliance but had subsequently disclosed this information in an Initial Public Offering (IPO) filing (typically if the IPO takes place within 2-5 years of entering the alliance), I extracted this information from the

2001) to obtain information on the biotech firm's patent portfolio. I supplemented these formal datasets with various pieces of data collected from web searches.

For the purposes of this analysis, I selected deals between a U.S. start-up biotech firm and an established pharmaceutical firm that were signed between 1992 and 2006.¹⁴ I excluded mergers and acquisitions, deals where that did not involve the transfer of an intellectual asset, and deals where the biotech firm in-licensed technology from the pharmaceutical firm. Also, in order to focus the analysis on similar types of alliance, I limited the analysis to alliances where the licensed territory included the U.S. (i.e., the biotech's home country). After these restrictions were imposed, there were 565 alliances available for analysis.

Insert **Error! Reference source not found.** here

Error! Reference source not found. presents summary statistics for these alliances. It shows that the dataset includes deals involving products at all stages of commercialization (from discovery stage to approved products), as well as both biotech firms and alliance partners at varying stages of maturity (as reflected by both the firm age and number of prior deals). **Error! Reference source not found.** also reveals that the dataset has missing observations for several of the different variables. The information on firm valuation is only available when it is disclosed to the SEC, either because the firm was publicly listed at the time or because the firm later went public and included this information in its IPO filing. Meanwhile the availability of data on the financial terms depends on the extent to which they were disclosed in the contract filed with the SEC or the press release which occurred at the time of the alliance. The missing values for the stage of product commercialization is due to missing information in Recap's coding.

Insert **Error! Reference source not found.** here

historical balance sheet information in the firm's IPO prospectus (stored in the Recombinant Capital database). The period for which I was able to observe this information depends on the information that the firm chose to disclose in its IPO prospectus.

14 Since the primary purpose is to examine how biotech firms acquired the ability to market and distribute products, I reclassified biotech firms which were already marketing products in the disease field of the alliance as pharmaceutical firms.

Error! Reference source not found. shows the correlations between the various variables used in the analysis. Panel A presents correlations between the presence of co-promotion rights and variables which are determined before or after the alliance is signed. Panel B presents correlations between the presence of co-promotion rights and other terms of the alliance.

Empirical specification

The empirical analysis has two parts. The first analysis examines the relationship between the conditions at the time the two parties signed the alliance and whether or not the biotech firm retained co-promotion rights. The second analysis examines the relationship between whether the biotech firm retained co-promotion rights and its subsequent commercialization activity.

First analysis: Whether the biotech firm enters a co-promotion arrangement

In the first analysis, I estimate a probit model of whether the biotech firm retained rights to co-promote the alliance product. To measure this variable I rely on Recap's coding of whether the technology firm retained co-promotion rights. Recap defines a "Co-Promotion" agreement as "a commercialization venture in which two or more parties promote and sell a single product, with each party obtaining sales revenues and/or net profits from either party's sales of the product".¹⁵

The primary explanatory variables used in this analysis are motivated by Hypotheses 1 & 2: the biotech firm's R&D capabilities in the alliance disease field (as per Hypothesis 1); and the pharmaceutical firm's commercialization experience in the alliance disease field (as per Hypothesis 2).

According to the resource-based theory of the firm (Penrose, 1959; Wernerfelt, 1984), a firm's ability to generate outputs is constrained by its existing set of resources and capabilities. Hence we would expect a technology firm would be most likely to generate future products in those product fields in which it has related research & development capabilities. Ideally I would measure the firm's R&D capabilities in particular product fields using a direct measure such as

¹⁵ Recap codes this information whenever it is contained in the public announcement or observed in the filed contracts. However, they advise that this information is almost always revealed in the public announcement because the firms believe that it will be rewarded by the financial markets.

its stock of patents. However, since patents protect an underlying technology rather than a specific product, it is difficult if not impossible to relate a firm's patent stock to particular product fields. Hence instead I measure the biotech firm's R&D capabilities in the disease field of the alliance using two alternative measures based on its experience in prior R&D alliances: (1) a count of biotech firm's prior alliances in same disease field; and (2) the proportion of biotech firm's prior alliances in same disease field. Since the biotech firms' primary activity in most alliances is R&D, the disease field to which these alliances relate ought to be a good predictor of the nature of the biotech firms' underlying technological capabilities, and particularly the product fields to which they are most closely associated.

I use similar variables to capture the partner's commercialization experience in the disease field of the alliance. Ideally I would use direct measures of the pharmaceutical firm marketing activity in particular product fields. However since this information is unavailable, I instead use measures based on the pharmaceutical firm's activity in prior alliances: (1) a count of partner's concurrent alliances in same disease field; and (2) the proportion of partner's concurrent alliances in same disease field. However, because the partners are established product firms whose marketing focus may have changed over time, in measuring the their commercialization expertise I consider only "concurrent" alliances, which I define to mean all alliances the pharmaceutical firm engaged in during the two years prior to and one year following the alliance.¹⁶

Second analysis: Biotech firm's subsequent commercialization activity

In the second analysis I estimate a series of models where the dependent variables are different measures of the biotech firm's subsequent commercialization activity. As a first step I estimate a probit model of the relationship between retaining co-promotion rights and whether the biotech firm is directly marketing pharmaceutical products within 5 years of entering the alliance. The dependent variable for this analysis is an indicator of whether the biotech firm is selling products (under its own name) in same disease field within the next 5 years.

¹⁶ The reason for including alliances signed within a year after the alliance is that an alliance usually takes 6-18 months to negotiate and during the negotiations the technology firm usually has some information on what other alternatives its potential partner is considering.

However, since it takes 10-15 years from discovery to launch, and there is a large failure rate of products during the commercialization process, whether the firm is marketing products is a crude measure of the firm's intentions with respect to commercialization. Moreover in some cases the products which the biotech firm is selling may be the result of the subject alliance, making the dependent variable endogenous to the type of alliance arrangement. Hence, as an alternative, I estimate a series of OLS models of the extent to which the biotech firm engages in commercialization-related activity in its subsequent deals in the 5 years after the original alliance was signed.¹⁷ I use two alternative measures which attempt to capture the extent to which the biotech firm was engaged in the commercialization process (as opposed to the R&D process) in its subsequent deals: (1) an indicator of whether the biotech firm retained co-promotion rights in a subsequent alliance in the same disease field as the original alliance; and (2) the proportion of the biotech firm's subsequent alliances in the same disease field as the alliance in which the biotech firm was the licensee.

The primary explanatory variable in all these regressions is an indicator of whether the biotech firm retains co-promotion rights (i.e., the dependent variable in the first analysis).

Controls

I include control variables to capture the biotech and partner firms' financial strength, their experience (namely the biotech firm's age in years since founding), the total number of the prior alliances signed by both the biotech and partner firm, indicator variables for whether the biotech/partner had previously entered into a co-promotion alliance. I also include an index of the conditions of the equity markets for biotech firms at the time the alliance was signed.¹⁸

In order to capture the biotech firm's financial strength, I use the firm's most recent valuation at the time of the alliance.¹⁹ For the privately held biotech firms, the valuation is the post-money

¹⁷ The sample of alliances for this analysis is necessarily limited to alliances that were signed from 1992-2001.

¹⁸ Josh Lerner generously provided the index developed in Lerner (1994) and used in Lerner & Merges (1998). However, since the Lerner index is only calculated until 1997, I use the Amex index for 1998-2005. Both indexes are normalized to 100 at 12/31/1997. The correlation between these two indexes for the years they run in parallel is indistinguishable from 1.0000.

¹⁹ Since I expect that the impact of financial position will increase in proportion to the total assets and shareholder's equity, I use the log values of these balance sheet amounts, normalized to December 2006 dollars.

value at the time of the last round of private financing; for the publicly listed firms it is the market capitalization plus long term debt at the end of the prior quarter.²⁰ I also include the partner firm's valuation (where available).

Since the partner's willingness to grant marketing rights may also depend on the underlying capabilities of the alliance partner, particularly whether the partner's core capabilities are focused on technology development (i.e., a mature biotech) or commercialization (i.e., a pharmaceutical firm), I include an indicator for whether the alliance partner is a biotech firm.

As the product progresses through the commercialization process, the development risk – the chance of the product failing – reduces and hence the biotech firm's bargaining power is likely to increase. To capture this I include dummy variables for the stage of product commercialization at the time the alliance was signed. Moreover, since both market conditions and the popularity of certain therapeutic areas change over time, I include year dummies, as well as dummies for the year in which the firm was formed. Since the primary explanatory variables are based on the count and proportion of alliances in the specific disease field of the alliance, and hence are relative to the other firms that have alliances in that same disease field, I include dummies for the disease fields.

Other alliance terms

Whether a biotech firm retains co-promotion rights is only one part of a multi-faceted negotiation across a range of alliance terms. Even if the biotech firm is in a position to retain co-promotion rights, whether it does so depends on how it chooses to trade retaining co-promotion rights off against the other alliance terms. Hence in the second analysis I include a range of other variables to reflect the other alliance terms.

20 The information on firm valuation is only available when it is disclosed in filings with the SEC, either because the firm was publicly listed at the time or because the firm later went public and included this information in its IPO filing. Hence the valuation is missing for a number of firms in the dataset. To adjust for the missing values in the analysis, I replace the missing value with the mean of all the values for which this data is available. However, there is a concern that those firms missing data may be significantly weaker than the rest of the firms in the sample. To allow the mean of the missing values to differ from the available values, I include a dummy variable that indicates whether the value is missing. Mean substitution keeps all observations in the analysis without biasing the coefficients or standard errors on other variables. However it reduces the variance around the mean of the adjusted variable so may overstate the statistical significance (Hair et al., 1998).

Besides the co-promotion rights, the most important terms in the alliance contract are the financial payments from the alliance partner to the biotech firm. Alliance contracts include a range of financial payments, which Recap groups into five types: upfront payments, equity investments, research payments, milestone payments, and royalties. The upfront payments are arguably the most important because they translate into cash upfront for the biotech firm. The equity investments can also be important because they are paid upfront and substitute for financing that the firm would have to raise through the external markets. Moreover, they often come without much sacrifice in control of the firm.²¹ By contrast, the R&D payments are paid strictly on the basis of Full-Time-Equivalent (FTE) researcher cost, and both milestone and royalty payments are contingent on an event (such as the product getting to market) that is heavily discounted. I include the logged values of the upfront, equity, and milestone payments (each as separate variables) in the empirical analysis, but ignore the R&D payments because they translate directly to work done and are not considered “enriching” for the biotech firm.²²

I also include indicator variables for other important non-financial terms of the agreement, namely: (1) whether the product license is worldwide (as opposed to just specific territories, including the U.S.); (2) whether the biotech firm retains rights to participate (to some degree) in the clinical development within a licensed territory without its expenses being fully reimbursed; (3) whether the parties agree to perform research and/or development activities in a single program (i.e., an R&D collaboration); (4) whether the biotech firm is engaged to perform R&D services in the discovery and/or lead stages of the alliance; (5) whether the biotech firm is engaged to perform R&D services in the pre-clinical or later stages of commercialization; (6) whether the alliance partner agrees to take minority equity stake (<50%) in the biotech firm; and (7) whether the biotech firm is engaged to make (or has made) the alliance product for use or sale by the alliance partner.

21 Unlike an equity investment by a venture capitalist, which is often resented for the large dilution of the founders' interest, an equity investment by an alliance partner is often considered almost as good as an upfront payment because typically the actual share of the company taken is relatively small and it binds the partner into the success of the company. From the partner's perspective it is an easier way to justify the cash payment to its own shareholders.

22 Ideally I would also include the royalty payments in the analysis. However, the royalty rate recorded in the Recap database groups the true royalty rates (i.e., payments based on percentage of new sales) with transfer prices (in return for the manufactured product) and profit splits. Since each of these rates means very different things, including the raw royalty rate is likely to lead to misleading results and may bias the analysis.

Results

First analysis: Whether the biotech firm retains co-promotion rights

Table 1: Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M)1,2,3	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M)1,2,3	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<u>Stage of product commercialization at time of alliance:</u>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1
Approved for sale	565	0.03	0.18	0	1
Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8
<u>Relationship between alliance and firms' prior experience</u>					
Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28
Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1
<u>Alliance terms</u>					
<u>Financial terms</u>					
Upfront payments (\$M)1,3	400	9,942	21,754	0	226,405
Equity payments (\$M)1,3	304	13,072	67,909	0	1,141,079
Milestone payments (\$M)1,3	352	74,626	140,202	0	905,618
Royalty rate (max.)4	211	15.7	17.1	0	80.0
<u>Non-financial terms</u>					
License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1
Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1

Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1
¹ in December 2006 US dollars					
² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)					
³ Only available to extent disclosed in SEC filings					
⁴ Recombinant Capital records highest rate listed on alliance					

Table 2: Correlation matrix

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field2	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field2	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log)1	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance2	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance2	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log)1	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000)1,2	0.30	1.00										
(26) Equity payments (\$000)1,2	0.17	0.74	1.00									
(27) Milestone payments (\$000)1,2	0.41	0.57	0.50	1.00								
(28) Royalty rate2	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R2	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R2	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M)1,3	0.048 (0.025)*
(15) Equity payments (\$M)1,3	0.082 (0.036)**
(16) Milestone payments (\$M)1,3	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R2	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log)1,2	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M)1,3	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M)1,3	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R2 0.34 0.37 0.48
Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

presents the results of a probit regression of whether the biotech firm retained co-promotion rights on the various explanatory variables and controls. Panel A shows the results of the regressions with the characteristics of biotech firm, including the two explanatory variables which attempt to capture the biotech firm's R&D activity in and focus on the disease field of the alliance. The various columns show the results of regressions with and without dummies and fixed effects. Panel B shows the results of the regressions with various characteristics of partner, including the two explanatory variables which capture the partner's total activity in and focus on the disease field of the alliance. Panel C shows the results of the regressions with the variables representing the alliance terms. Panel D shows the results of the full regression (i.e., with the combined set of variables from Panels A-C) but reports only the variables which had significant coefficients.

Insert Table 1: Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M) ^{1,2,3}	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M) ^{1,2,3}	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<i>Stage of product commercialization at time of alliance:</i>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1
Approved for sale	565	0.03	0.18	0	1
Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8
<u>Relationship between alliance and firms' prior experience</u>					
Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28

Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1

Alliance terms

Financial terms

Upfront payments (\$M) ^{1,3}	400	9,942	21,754	0	226,405
Equity payments (\$M) ^{1,3}	304	13,072	67,909	0	1,141,079
Milestone payments (\$M) ^{1,3}	352	74,626	140,202	0	905,618
Royalty rate (max.) ⁴	211	15.7	17.1	0	80.0

Non-financial terms

License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1
Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1
Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1

¹ in December 2006 US dollars

² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)

³ Only available to extent disclosed in SEC filings

⁴ Recombinant Capital records highest rate listed on alliance

Table 2: Correlation matrix

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field2	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field2	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log)1	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance2	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance2	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log)1	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000)1,2	0.30	1.00										
(26) Equity payments (\$000)1,2	0.17	0.74	1.00									
(27) Milestone payments (\$000)1,2	0.41	0.57	0.50	1.00								
(28) Royalty rate2	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R2	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R2	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M)1,3	0.048 (0.025)*
(15) Equity payments (\$M)1,3	0.082 (0.036)**
(16) Milestone payments (\$M)1,3	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R2	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log)1,2	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M)1,3	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M)1,3	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R2 0.34 0.37 0.48
Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

here

The results show a strong relationship between the proportion of the biotech firm's prior alliances in the disease field of the alliance (line 2) and whether the biotech firm retained co-promotion rights. Having a prior co-promotion alliance (line 7) is also positively correlated with retaining co-promotion rights. The likelihood of retaining co-promotion rights increases with its valuation (line 7). The variables representing the characteristics of the partner or capabilities in and focus on the disease field of the alliance are generally not significant. A firm which retains co-promotion rights is also likely to negotiate stronger upfront and equity payments, to retain rights to participate in the clinical development process, and to do R&D related to the clinical trials.

Second analysis: The biotech firm's subsequent commercialization activity

Table 4: Biotech's Subsequent Commercialization Activity (Probit)

<i>Dependent variable: Biotech firm markets product in alliance disease field within 5 years (d)</i>				
	(1)	(2)	(3)	(4)
	Full sample		Sample without truncation	
	(1992-2006)		(1992-2001)	
(1) Biotech retains rights to co-promote the alliance product	0.439 (0.194)**	0.202 (0.233)	0.640 (0.240)***	0.560 (0.300)*
(2) Count of biotech's prior alliances in same disease field as the alliance		0.050 (0.027)*		0.138 (0.048)***
(3) Proportion of biotech's prior alliances in same disease field as the alliance		0.222 (0.458)		-0.792 (0.593)
(4) Years since founding (log)		0.101 (0.355)		0.176 (0.401)
(5) Count of biotech's prior alliances in all disease fields (log)		-0.064 (0.243)		-0.073 (0.230)
(6) Biotech has prior co-promotion alliance (d)		-0.202 (0.298)		-0.482 (0.401)
(7) Biotech is publicly listed (d)		-0.103 (0.330)		0.118 (0.356)
(8) Biotech's valuation (log)		0.098 (0.080)		-0.066 (0.090)
Stage of commercialization dummies	N	Y	N	Y
Constant	-1.751 (0.107)***	-2.470 (0.745)***	-1.696 (0.120)***	-2.246 (0.721)***
Observations	566	565	389	388
Adjusted R2	0.02	0.24	0.04	0.25

Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

presents the results of a probit regression of whether the biotech firm is marketing a product within 5 years in the disease field of the alliance. Columns (1) and (2) show the results using the full sample. However, since this variable will be truncated for those alliances signed within the past 5 years, Columns (3) and (4) show the same analysis repeated on the subset of alliances signed between 1992 and 2001. The results show a strong relationship between retaining co-promotion rights and the likelihood of the firm marketing a future product. Moreover this relationship persists after controlling for other factors related to the firm's experience, both generally and in the disease field, that are likely to be correlated with the firm being in the position to integrate downstream.

Insert Table 4: Biotech's Subsequent Commercialization Activity (Probit)

Dependent variable: Biotech firm markets product in alliance disease field within 5 years (d)

	(1) Full sample (1992-2006)	(2) Full sample (1992-2006)	(3) Sample without truncation (1992-2001)	(4) Sample without truncation (1992-2001)
(1) Biotech retains rights to co-promote the alliance product	0.439 (0.194)**	0.202 (0.233)	0.640 (0.240)***	0.560 (0.300)*
(2) Count of biotech's prior alliances in same disease field as the alliance		0.050 (0.027)*		0.138 (0.048)***
(3) Proportion of biotech's prior alliances in same disease field as the alliance		0.222 (0.458)		-0.792 (0.593)
(4) Years since founding (log)		0.101 (0.355)		0.176 (0.401)
(5) Count of biotech's prior alliances in all disease fields (log)		-0.064 (0.243)		-0.073 (0.230)
(6) Biotech has prior co-promotion alliance (d)		-0.202 (0.298)		-0.482 (0.401)
(7) Biotech is publicly listed (d)		-0.103 (0.330)		0.118 (0.356)
(8) Biotech's valuation (log)		0.098 (0.080)		-0.066 (0.090)
Stage of commercialization dummies	N	Y	N	Y
Constant	-1.751 (0.107)***	-2.470 (0.745)***	-1.696 (0.120)***	-2.246 (0.721)***
Observations	566	565	389	388
Adjusted R2	0.02	0.24	0.04	0.25

Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

here

Table 5 presents the results of OLS regressions of 4 measures of the biotech firm's participation in the commercialization process in subsequent alliances. The results show that, by each of the 4 measures, there is a positive and highly significant relationship between retaining co-promotion rights and the likelihood of the firm participating in the commercialization process in subsequent alliances. A biotech firm is significantly more likely to retain co-promotion rights and to be a licensee (i.e., to in-license technology), both generally and in the same disease field, in subsequent alliances.

Insert Table 5 here

Discussion

Hypothesized effects

The strong relationship between entering into a co-promotion alliance and the proportion of the firm's prior (R&D-related) activity in the alliance disease field(s) in Table 1: Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M) ^{1,2,3}	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M) ^{1,2,3}	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<i>Stage of product commercialization at time of alliance:</i>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1

Approved for sale	565	0.03	0.18	0	1
Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8

Relationship between alliance and firms' prior experience

Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28
Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1

Alliance terms

Financial terms

Upfront payments (\$M) ^{1,3}	400	9,942	21,754	0	226,405
Equity payments (\$M) ^{1,3}	304	13,072	67,909	0	1,141,079
Milestone payments (\$M) ^{1,3}	352	74,626	140,202	0	905,618
Royalty rate (max.) ⁴	211	15.7	17.1	0	80.0

Non-financial terms

License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1
Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1
Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1

¹ in December 2006 US dollars

² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)

³ Only available to extent disclosed in SEC filings

⁴ Recombinant Capital records highest rate listed on alliance

Table 2: Correlation matrix

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field2	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field2	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log)1	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance2	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance2	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log)1	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000)1,2	0.30	1.00										
(26) Equity payments (\$000)1,2	0.17	0.74	1.00									
(27) Milestone payments (\$000)1,2	0.41	0.57	0.50	1.00								
(28) Royalty rate2	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R2	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R2	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M)1,3	0.048 (0.025)*
(15) Equity payments (\$M)1,3	0.082 (0.036)**
(16) Milestone payments (\$M)1,3	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R2	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log)1,2	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M)1,3	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M)1,3	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R2 0.34 0.37 0.48
Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

provides some support for Hypothesis 1. Interestingly, while the proportion of R&D activity in a particular area is significant, the total stock is not. This suggests that the primary determinant of whether a firm retains co-promotion rights is the degree to which the firm is focused on the particular disease area. If the firm's R&D capabilities are focused on that disease area then it is likely to foresee that its future products will be in that disease area. Therefore it will be worthwhile to invest in retaining co-promotion rights and learning about the commercialization process because it is likely to be in the position to commercialize future products in that area. By contrast, if the firm's R&D expertise is focused in other areas then – even if it is generating many potential products and therefore engaging in many alliances in this area – it may be concentrating its efforts on building its commercialization capabilities in those other areas. Alternatively, if the firm's R&D expertise is dispersed across multiple areas then it may be choosing to remain a technology-based firm and therefore have no interest in retaining co-promotion rights.

The results in Table 1: Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M)1,2,3	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M)1,2,3	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<i>Stage of product commercialization at time of alliance:</i>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1
Approved for sale	565	0.03	0.18	0	1

Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8
<u>Relationship between alliance and firms' prior experience</u>					
Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28
Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1
<u>Alliance terms</u>					
<i>Financial terms</i>					
Upfront payments (\$M) ^{1,3}	400	9,942	21,754	0	226,405
Equity payments (\$M) ^{1,3}	304	13,072	67,909	0	1,141,079
Milestone payments (\$M) ^{1,3}	352	74,626	140,202	0	905,618
Royalty rate (max.) ⁴	211	15.7	17.1	0	80.0
<i>Non-financial terms</i>					
License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1
Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1
Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1

¹ in December 2006 US dollars

² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)

³ Only available to extent disclosed in SEC filings

⁴ Recombinant Capital records highest rate listed on alliance

Table 2: Correlation matrix

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field2	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field2	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log)1	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance2	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance2	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log)1	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000)1,2	0.30	1.00										
(26) Equity payments (\$000)1,2	0.17	0.74	1.00									
(27) Milestone payments (\$000)1,2	0.41	0.57	0.50	1.00								
(28) Royalty rate2	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R2	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R2	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M)1,3	0.048 (0.025)*
(15) Equity payments (\$M)1,3	0.082 (0.036)**
(16) Milestone payments (\$M)1,3	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R2	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log)1,2	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M)1,3	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M)1,3	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R2 0.34 0.37 0.48
Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

show no relationship between entering into a co-promotion arrangement and either the partner's total activity in or focus on the disease field of the alliance (as is predicted in Hypothesis 2). This finding is on the face surprising since the model predicts that a biotech firm is more likely to retain co-promotion rights when its partner has stronger capabilities in the product field. However, this result may possibly be explained by the fact that neither the model nor the empirical analysis take into account the implications of the pre-contractual matching between the biotech firm and its partner. Those pharmaceutical firms which have significant capabilities in a particular disease area are likely to be more desirable partners and therefore will be in a stronger bargaining position compared to other pharmaceutical firms. As a consequence such a firm may have less need to grant co-promotion rights in order to induce the biotech firm to enter in the alliance. Therefore the biotech firm may choose to trade-off retaining co-promotion rights for the benefits of attracting a highly skilled pharmaceutical firm as partner.

The significant results on the indicator for a co-promotion arrangement in line 1 of Table 4:

Biotech's Subsequent Commercialization Activity (Probit)

<i>Dependent variable: Biotech firm markets product in alliance disease field within 5 years (d)</i>				
	(1)	(2)	(3)	(4)
	Full sample		Sample without truncation	
	(1992-2006)		(1992-2001)	
(1) Biotech retains rights to co-promote the alliance product	0.439 (0.194)**	0.202 (0.233)	0.640 (0.240)***	0.560 (0.300)*
(2) Count of biotech's prior alliances in same disease field as the alliance		0.050 (0.027)*		0.138 (0.048)***
(3) Proportion of biotech's prior alliances in same disease field as the alliance		0.222 (0.458)		-0.792 (0.593)
(4) Years since founding (log)		0.101 (0.355)		0.176 (0.401)
(5) Count of biotech's prior alliances in all disease fields (log)		-0.064 (0.243)		-0.073 (0.230)
(6) Biotech has prior co-promotion alliance (d)		-0.202 (0.298)		-0.482 (0.401)
(7) Biotech is publicly listed (d)		-0.103 (0.330)		0.118 (0.356)
(8) Biotech's valuation (log)		0.098 (0.080)		-0.066 (0.090)
Stage of commercialization dummies	N	Y	N	Y
Constant	-1.751 (0.107)***	-2.470 (0.745)***	-1.696 (0.120)***	-2.246 (0.721)***
Observations	566	565	389	388
Adjusted R2	0.02	0.24	0.04	0.25

*Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%*

and Table 5 provide support for the argument that the reason that biotech firms enter into a co-promotion arrangement in order to acquire the capabilities to commercialize future products. The empirical evidence shows that biotech firms that retain co-promotion rights are more likely to be marketing products – or at least engaged in the commercialization-related activity of future alliances – in future than firms which do not. However, it does not show whether retaining co-promotion rights is what actually caused them to be marketing products or engaged in the commercialization-related activity of future alliances. It is possible that these firms had already set on a strategy of integrating downstream into commercialization and retaining co-promotion rights was merely a step along this path.

Other effects

The results in line 7 of Table 1: Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M)1,2,3	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M)1,2,3	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<u>Stage of product commercialization at time of alliance:</u>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1
Approved for sale	565	0.03	0.18	0	1
Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8
<u>Relationship between alliance and firms' prior experience</u>					
Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28
Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1

Alliance terms*Financial terms*

Upfront payments (\$M) ^{1,3}	400	9,942	21,754	0	226,405
Equity payments (\$M) ^{1,3}	304	13,072	67,909	0	1,141,079
Milestone payments (\$M) ^{1,3}	352	74,626	140,202	0	905,618
Royalty rate (max.) ⁴	211	15.7	17.1	0	80.0

Non-financial terms

License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1
Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1
Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1

¹ in December 2006 US dollars

² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)

³ Only available to extent disclosed in SEC filings

⁴ Recombinant Capital records highest rate listed on alliance

Table 2: Correlation matrix

Panel A

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field2	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field2	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log)1	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance2	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance2	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log)1	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000)1,2	0.30	1.00										
(26) Equity payments (\$000)1,2	0.17	0.74	1.00									
(27) Milestone payments (\$000)1,2	0.41	0.57	0.50	1.00								
(28) Royalty rate2	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R2	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R2	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M)1,3	0.048 (0.025)*
(15) Equity payments (\$M)1,3	0.082 (0.036)**
(16) Milestone payments (\$M)1,3	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R2	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log)1,2	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M)1,3	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M)1,3	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R2 0.34 0.37 0.48
Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

show that the biotech firm's financial position is strongly correlated with retaining co-promotion rights. This is consistent with the prediction by Aghion & Tirole (1994) and the empirical finding by Lerner & Merges (1998). However, set alongside the evidence on the more strategic reasons for retaining co-promotion rights presented above, it suggests that the decision whether to enter into a co-promotion arrangement or a pure licensing agreement involves a trade-off between the technology firm's need for immediate cash and the value of acquiring the knowledge that will enable it to commercialize future innovations alone.

The negative relationship between retaining co-promotion rights and the biotech firm's age, which is highly significant in line 3 of the full regression presented in Panel D, is consistent with the dynamic story told above. In its earlier years, a biotech firm chooses between entering into co-promotion arrangements (to the extent it can afford to) in order to build commercialization capabilities in its primary product area(s), and licensing out products outside those areas. However, once it has integrated downstream into commercialization process in particular product areas, its choice is between commercializing alone in its primary product area(s) and licensing. Since it is possible to observe only licensing and co-promotion (but not commercializing alone) in the data, we are more likely to observe licensing than co-promotion at later years in the firm's life.

The positive relationship between retaining co-promotion rights and the "upfront" financial terms²³ is on the face surprising since the model predicts that there should be a trade-off between financial and non-financial terms. However, a possible explanation is that there is an omitted variable at the same time reflects the biotech firm's bargaining power and also drives the ability to negotiate both higher financial payments and stronger non-financial terms.

The positive relationship between co-promotion rights and co-development rights (reflected in line 18) likely reflects the complementarities between clinical development and marketing. If a firm becomes involved in the commercialization of a particular alliance product, there are

²³ Equity payments are, in effect, upfront payments since they are usually paid in cash at the time of the alliance, albeit in exchange for equity.

efficiencies to being involved in both the development and marketing of that product. Moreover, a firm which seeks to integrate downstream into marketing is likely to want the capability to perform the clinical development of its future products, and hence for similar reasons may retain co-development rights in an alliance in order to be able to develop its expertise in that activity. Meanwhile, there are also likely to be efficiencies created by being involved in R&D related to clinical development, which may explain the significant relationship in line 21 of Table 1:

Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M) ^{1,2,3}	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M) ^{1,2,3}	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<u>Stage of product commercialization at time of alliance:</u>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1
Approved for sale	565	0.03	0.18	0	1
Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8
<u>Relationship between alliance and firms' prior experience</u>					
Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28
Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1
<u>Alliance terms</u>					
<u>Financial terms</u>					
Upfront payments (\$M) ^{1,3}	400	9,942	21,754	0	226,405
Equity payments (\$M) ^{1,3}	304	13,072	67,909	0	1,141,079
Milestone payments (\$M) ^{1,3}	352	74,626	140,202	0	905,618
Royalty rate (max.) ⁴	211	15.7	17.1	0	80.0
<u>Non-financial terms</u>					
License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1

Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1
Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1

¹ in December 2006 US dollars

² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)

³ Only available to extent disclosed in SEC filings

⁴ Recombinant Capital records highest rate listed on alliance

Table 2: Correlation matrix

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field2	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field2	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log)1	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance2	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance2	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log)1	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000)1,2	0.30	1.00										
(26) Equity payments (\$000)1,2	0.17	0.74	1.00									
(27) Milestone payments (\$000)1,2	0.41	0.57	0.50	1.00								
(28) Royalty rate2	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R2	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R2	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M)1,3	0.048 (0.025)*
(15) Equity payments (\$M)1,3	0.082 (0.036)**
(16) Milestone payments (\$M)1,3	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R2	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log)1,2	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M)1,3	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M)1,3	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R2 0.34 0.37 0.48
Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

CONCLUSION

This paper presents a framework for a technology firm to think about its commercialization strategy in the context where it expects to generate successive innovations in the same product area but the established product firms are much better positioned with respect to the complementary assets required to commercialize that innovation. While Teece (1986) argued that an innovating firm's optimal strategy is to contract with an established firm to commercialize its innovation, if it does this for successive innovations then it is unlikely to make superior profits over the long term. At the same time, because commercializing alone involves substantially higher risks, integrating downstream from the start is unlikely to be more profitable. Nevertheless, this paper shows that, under certain conditions, following a hybrid strategy – in which the technology firm contracts with an established product firm but retains the rights to participate in the commercialization process – may enable the technology firm to capture the greater share of the profits from its innovation over the long term. The technology firm prefers this arrangement because it reduces the risk of failure in the short-term, enabling it to bring its latest innovation to market in a timely and cost-effective manner. At the same time this arrangement enables it to acquire the knowledge necessary to commercialize future innovations alone over the long term. At the same time, the established product firm agrees to this arrangement, even though it potentially creates a competitor, if it can share that cost with other product firms. Whether the firms opt for this hybrid option depends not only on the firm's financial strength, but also on the relationship between its underlying capabilities and the product field in which the innovation will be commercialized.

The paper has some pertinent implications for managers. While it may be necessary for a technology firm to partner with an established firm when it first enters an industry, in negotiating such an alliance managers must also consider how the firm can achieve superior profitability over the long term. If the firm expects to generate future innovations in the same product field, it is important to loosen the control that the established firms over the complementary assets

necessary to commercialize an innovation. One way to do this is to use its leverage in alliance negotiations to acquire the knowledge necessary to build its own commercialization capabilities. Specifically, it can negotiate to the rights to participate in the commercialization process, and thereby learn directly from its alliance partner.

However, acquiring commercialization capabilities will only be a worthwhile strategy if the firm generates successive innovations in the same product field. Building those capabilities requires a substantial investment, which will only give a return over the longer term. At the same time, retaining rights to participate in the commercialization process is likely to involve giving up greater financial payments. While maintaining control over the commercialization process and acquiring its own capabilities may give the firm access to a greater revenue stream in the long term, negotiating greater financial payments increases the firm's cash flow and helps it to meet short-term obligations. If it is financially weak, it may have to give up control until it has strengthened its position. If the innovation is outside the firm's core focus then it is likely to be better off licensing the innovation and remaining out of the product field.

APPENDIX

Workings of the model

Benchmark case: No experiential learning

I first calculate T 's expected profits and determine the optimal strategies in the case where T does not learn from experience – that is, its probability of successfully commercializing an innovation does not rise from σ_0 even if it is successful. The profits under this benchmark case also mirror the profits that T will earn if innovates outside the current product field.

Under this benchmark case, co-promotion is equivalent to licensing because T 's probability of successfully commercializing an innovation does not change even if it participates in a successful commercialization. Hence I consider only two strategies: ‘licensing’ (L), in which the product firm obtains exclusive rights to commercialize the innovation, and ‘not licensing’ (NL).

Expected profits calculated at start of each subgame

To begin with I calculate the expected profits at the start of a given subgame – that is, before T has innovated in the product field. Since the relative merits of licensing versus not licensing do not change across periods, T 's choice of strategy is consistent over time.

Let Π_T^L and Π_T^{NL} denote T 's present discounted profits under licensing and not licensing calculated at the start of each subgame. Let $\delta \in [0,1]$ be the discount factor. The values of Π_T^L and Π_T^{NL} are given by the following expressions:

$$\Pi_T^L = \phi[\sigma_1 X^L + (1 - \sigma_1)X^L] + (1 - \phi)[\sigma_1 X^L + (1 - \sigma_1)X^L] + \delta \Pi_T^L = \frac{X^L}{1 - \delta} \quad (1)$$

$$\Pi_T^{NL} = \phi[\sigma_0 \pi_1 + (1 - \sigma_0) \cdot 0 + \delta \Pi_T^{NL}] + (1 - \phi)[\sigma_0 \pi_1 + (1 - \sigma_0) \cdot 0 + \delta \Pi_T^{NL}] = \frac{\sigma_0 \pi_1}{1 - \delta} \quad (2)$$

Let $\Pi_{P_i}^L$ be P_i 's expected present discounted profits when T licenses and P_i is the licensee and Π_{P-i}^L be the same when P_i is not the licensee (respectively). Let λ be the probability that P_i earns

π_0 , given that P_i has successfully commercialized its own innovation *and* T 's innovation has not been commercialized. The values of these variables are described by the following expressions:

$$\Pi_{P_i}^L = \frac{\phi(\sigma_1\pi_1 - X^{L*}) + (1 - \phi\sigma_1)\sigma_1\lambda\pi_0}{1 - \delta} \quad (3)$$

$$\Pi_{P-i}^L = \frac{(1 - \phi\sigma_1)\sigma_1\lambda\pi_0}{1 - \delta} \quad (4)$$

$$\lambda = \sum_{k=0}^{N-1} \sigma_1^k (1 - \sigma_1)^{N-1-k} \frac{1}{k+1} \quad (5)$$

Let $\Pi_{P_i}^{NL}$ be P_i 's expected present discounted profits when T chooses not license:

$$\Pi_{P_i}^{NL} = \frac{1 - \phi\sigma_0}{1 - \delta} \sigma_1\lambda\pi_0 \quad (6)$$

Expected profits calculated at the decision point

The expressions above describe the expected profits at the start of each subgame. However, since the firms make the strategic decision occurs after T has innovated, it is necessary to calculate their profits at that point.

Let V_T^L and V_T^{NL} be T 's present discounted profits under licensing and not licensing strategies at the point that it chooses whether or not to license the innovation. The values of these variables are given by the following expressions:

$$V_T^L = X^L + \delta\Pi^L \quad (7)$$

$$V_T^{NL} = \sigma_0\pi_1 + \delta\Pi_T^{NL} \quad (8)$$

Substituting the value of Π^L from equation (1) into equation (7) gives

$$V_T^L = \frac{X^L}{1 - \delta} \quad (9)$$

Substituting the values of Π_T^{NL} from equation (2) into equation (8) gives

$$V_T^{NL} = \frac{1}{1 - \delta} \sigma_0\pi_1 \quad (10)$$

Let $V_{P_i}^L$ and $V_{P_i}^{NL}$ be P_i 's expected present discounted profits under licensing and not licensing strategies at the point the firms decide whether or not to license

$$V_{P_i}^L = \sigma_1 \pi_1 + (1 - \sigma_1) \sigma_1 \lambda \pi_0 - X^L + \delta \left(\frac{1}{N} \Pi_{P_i}^L + \frac{N-1}{N} \Pi_{P_{-i}}^L \right) \quad (11)$$

$$V_{P_i}^{NL} = \sigma_0 (0 + \delta \Pi_{P_i}^{NL}) + (1 - \sigma_0) [\sigma_1 \lambda \pi_0 + \delta \Pi_{P_i}^{NL}] = (1 - \sigma_0) \sigma_1 \lambda \pi_0 + \delta \Pi_{P_i}^{NL} \quad (12)$$

Substituting the value of $\Pi_{P_i}^L$ from equation (3) and $\Pi_{P_{-i}}^L$ from equation (4) into equation (11) gives

$$V_{P_i}^L = \frac{1 - \delta(1 - \frac{1}{N}\phi)}{1 - \delta} (\sigma_1 \pi_1 - X^L) + \frac{(1 - \sigma_1) + \delta \sigma_1 (1 - \phi)}{1 - \delta} \sigma_1 \lambda \pi_0 \quad (13)$$

Substituting the value of $\Pi_{P_i}^{NL}$ from equation (6) into equation (12) gives

$$V_{P_i}^{NL} = \frac{(1 - \sigma_0) + \delta \sigma_0 (1 - \phi)}{1 - \delta} \sigma_1 \lambda \pi_0 \quad (14)$$

Outcome of the negotiation game

T chooses X^{L*} to maximize the following expression:

$$\max_{X^L} V_T^L(X^L)$$

subject to

$$V_P^L(X^L) \geq V_P^{NL} \quad (15)$$

$$V_T^L(X^L) \geq V_T^{NL} \quad (16)$$

According to condition (15), P_i will offer to license the innovation if after paying X^L P_i is at least as well off (over its time horizon) as it would be if it did not license. This implies that X^{L*} satisfies

$$X^L \leq \sigma_1 \pi_1 - \frac{1 - \delta(1 - \phi)}{1 - \delta(1 - \frac{1}{N}\phi)} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (17)$$

According to condition (16), T will accept the license if and only if the licensing fee X^{L*} leaves it at least as well off as if it were not to license. That is, T will offer to license if

$$X^L \geq \sigma_0 \pi_1 \quad (18)$$

Assume T has the power to set the licensing fee. Hence, since $\frac{\partial V_T^L(X^L)}{\partial X^L} = \frac{1}{1-\delta} > 0$, it will set X^{L*} at the maximum P_i is willing to pay. Therefore, if T accepts the license, it will demand a fee X^{L*} such that

$$X^{L*} = \sigma_1 \pi_1 - \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (19)$$

Under this scenario licensing will occur in equilibrium if:

$$(\sigma_1 - \sigma_0) [\pi_1 - \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} \sigma_1 \lambda \pi_0] \geq 0 \quad (20)$$

Since $\sigma_1 > \sigma_0$, $\pi_1 > \pi_0$, and $N \geq 1$ by definition, this condition is always satisfied and T will always license the innovation in equilibrium. Assuming T has the power to set the licensing fee,²⁴ T will set X^{L*} at the maximum P_i is willing to pay.²⁵ Therefore, it will demand a fee X^{L*} such that

$$X^{L*} = \sigma_1 \pi_1 - \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (21)$$

Licensing vs Not Licensing with Experiential Learning

Now I allow for the possibility of experiential learning if T successfully commercializes the innovation alone. To begin with I consider the choice between only licensing and not licensing.

²⁴ This assumption is unnecessary if $N > 1$, since in a competitive negotiation process the firms $P_1, \dots, P_N$ will bargain away their profits to induce T to enter the agreement. Moreover, in the case with only one product firm, although allowing P to have some (or all) of the bargaining power will change the payoffs, it will not change the equilibrium outcome(s).

²⁵ Since $\frac{\partial V_T^L(X^L)}{\partial X^L} = \frac{1}{1-\delta} > 0$, T sets at the maximum P_i is willing to pay.

Expected profits calculated at start of each subgame

To calculate the expected profits, and hence determine which strategy the firms will choose, I distinguish between the expected profits for not licensing under two different scenarios: (1) before T has successfully commercialized an innovation alone; and (2) after T has successfully commercialized an innovation alone. I use NL as above to represent ‘not licensing’ before T has successfully commercialized an innovation alone and let NL' denote ‘not licensing’ after T has successfully commercialized an innovation alone. Let $\Pi_T^{NL'}$ denote T ’s present discounted profits under that scenario and let Π_T^{L*} and Π_T^{NL*} denote the present value of T ’s expected profits if it innovates outside the particular product field. The values of Π_T^L , Π_T^{NL} and $\Pi_T^{NL'}$ are given by the following expressions:

$$\Pi_T^L = \frac{\phi X^L + (1-\phi)\Pi_T^{L*}}{1-\phi\delta} \quad (22)$$

$$\Pi_T^{NL} = \frac{\phi\sigma_0\pi_1 + \delta\phi\sigma_0\Pi_T^{NL'} + (1-\phi)\Pi_T^{NL*}}{1-\delta\phi(1-\sigma_0)} \quad (23)$$

$$\Pi_T^{NL'} = \frac{\phi\sigma_1\pi_1 + (1-\phi)\Pi_T^{NL*}}{1-\delta\phi} \quad (24)$$

Since T ’s probability of successfully commercializing an innovation outside this product field will not be affected by its prior commercialization activity in this product field, T ’s expected payoffs outside this particular product are equivalent to the payoffs in the case with no experiential learning. Moreover, as the analysis above shows, it is always optimal for T to license when there is no possibility of experiential learning, and hence T ’s expected payoffs under licensing and not licensing (and correspondingly co-promotion) are described by the following expression:

$$\Pi_T^{L*} = \Pi_T^{NL*} = \Pi_T^{CP*} = \frac{\sigma_1\pi_1}{1-\delta} - \frac{1-\delta(1-\phi)}{(1-\delta)[1-\delta(1-\frac{1}{N}\phi)]}(\sigma_1-\sigma_0)\sigma_1\lambda\pi_0 \quad (25)$$

Substituting Π_T^{L*} from (25) into (22) gives

$$\Pi_T^L = \frac{\phi}{1-\delta\phi} X^L + \frac{1-\phi}{(1-\delta)(1-\delta\phi)} \sigma_1\pi_1 - \frac{1-\delta(1-\phi)}{(1-\delta)(1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)]} (1-\phi)(\sigma_1-\sigma_0)\sigma_1\lambda\pi_0 \quad (26)$$

Substituting Π_T^{NL*} from (25) into (24) gives

$$\Pi_T^{NL'} = \frac{\sigma_1 \pi_1}{1-\delta} - \frac{(1-\phi)[1-\delta(1-\phi)]}{(1-\delta)(1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)]} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (27)$$

Substituting Π_T^{NL*} from (25) and $\Pi_T^{NL'}$ from (27) into (23) gives

$$\Pi_T^{NL} = \frac{(1-\delta)\phi\sigma_0 + \delta\phi\sigma_0\sigma_1 + (1-\phi)\sigma_1}{(1-\delta)[1-\delta\phi(1-\sigma_0)]} \pi_1 - \frac{(1-\phi)[1-\delta(1-\phi)]}{(1-\delta)(1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)]} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (28)$$

Let $\Pi_{P_i}^L$ be P_i 's expected present discounted profits when T licenses *and* P_i is the licensee and Π_{P-i}^L be the same when P_i is not the licensee (respectively). The values of these variables are described by the following expressions:

$$\Pi_{P_i}^L = \frac{\phi(\sigma_1 \pi_1 - X^L) + (1-\phi\sigma_1)\sigma_1 \lambda \pi_0}{1-\delta} \quad (29)$$

$$\Pi_{P-i}^L = \frac{(1-\phi\sigma_1)\sigma_1 \lambda \pi_0}{1-\delta} \quad (30)$$

Let $\Pi_{P_i}^{NL}$ be P_i 's expected present discounted profits when T does not license *before* T acquires commercialization capabilities and $V_{P_i}^{NL'}$ be the same *after* T acquires those capabilities. The values of these variables are described by the following expressions:

$$\Pi_{P_i}^{NL} = \frac{\delta\phi\sigma_0\Pi_P^{NL'} + (1-\phi\sigma_0)\sigma_1 \lambda \pi_0}{1-\delta(1-\phi\sigma_0)} \quad (31)$$

$$\Pi_{P_i}^{NL'} = \frac{1-\phi\sigma_1}{1-\delta} \sigma_1 \lambda \pi_0 \quad (32)$$

Substituting $\Pi_{P_i}^{NL'}$ from equation (32) into equation (31) gives

$$\Pi_{P_i}^{NL} = \frac{(1-\delta)(1-\phi\sigma_0) + \delta\phi\sigma_0(1-\phi\sigma_1)}{(1-\delta)[1-\delta(1-\phi\sigma_0)]} \sigma_1 \lambda \pi_0 \quad (33)$$

Expected profits calculated at the decision point

Let V_T^L and V_T^{NL} be T 's present discounted profits under licensing and not licensing strategies at the point that it chooses whether or not to license the innovation. The values of these variables are given by the following expressions:

$$V_T^L = X^L + \delta \Pi_T^L = X^L + \delta \Pi_T^L \quad (34)$$

$$V_T^{NL} = \sigma_0(\pi_1 + \delta \Pi_T^{NL'}) + (1 - \sigma_0) \cdot (0 + \delta \Pi_T^{NL}) = \sigma_0(\pi_1 + \delta \Pi_T^{NL'}) + \delta(1 - \sigma_0)\Pi_T^{NL} \quad (35)$$

Substituting the value of Π_T^L from equation (26) into equation (34) gives

$$V_T^L = \frac{X^L}{1 - \delta\phi} + \frac{\delta(1 - \phi)}{(1 - \delta)(1 - \delta\phi)} \sigma_1 \pi_1 - \frac{\delta[1 - \delta(1 - \phi)]}{(1 - \delta)(1 - \delta\phi)[1 - \delta(1 - \frac{1}{N}\phi)]} (1 - \phi)(\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (36)$$

Substituting the values of $\Pi_T^{NL'}$ from equation (27) and Π_T^{NL} from equation (28) into equation (35) gives

$$V_T^{NL} = \frac{[1 - \delta(1 - \phi\sigma_1)]\sigma_0 + \delta(1 - \phi)\sigma_1}{(1 - \delta)[1 - \delta\phi(1 - \sigma_0)]} \pi_1 - \frac{\delta(1 - \phi)[1 - \delta(1 - \phi)]}{(1 - \delta)(1 - \delta\phi)[1 - \delta(1 - \frac{1}{N}\phi)]} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (37)$$

Let V_{Pi}^L and V_{Pi}^{NL} be P_i 's expected present discounted profits under licensing and not licensing strategies at the point the firms decide whether or not to license

$$V_{Pi}^L = \sigma_1 \pi_1 + (1 - \sigma_1) \sigma_1 \lambda \pi_0 - X^L + \delta(\frac{1}{N} \Pi_{Pi}^L + \frac{N}{N-1} \Pi_{P-i}^L) \quad (38)$$

$$V_{Pi}^{NL} = \sigma_0(0 + \delta \Pi_{Pi}^{NL'}) + (1 - \sigma_0)[\sigma_1 \lambda \pi_0 + \delta \Pi_{Pi}^{NL}] \quad (39)$$

Substituting the values of Π_{Pi}^L from equation (29) and Π_{P-i}^L from equation (30) into equation (38) gives

$$V_{Pi}^L = \frac{1 - \delta(1 - \frac{1}{N}\phi)}{1 - \delta} (\sigma_1 \pi_1 - X^L) + \frac{(1 - \sigma_1) + \delta \sigma_1(1 - \phi)}{1 - \delta} \sigma_1 \lambda \pi_0 \quad (40)$$

Substituting the values of Π_{Pi}^{NL} from equation (33) and $\Pi_{Pi}^{NL'}$ from equation (32) into equation (39) gives

$$V_{P_i}^{NL} = \frac{(1-\delta)(1-\sigma_0) + \delta\sigma_0(1-\phi\sigma_1)[1-\delta(1-\phi)]}{(1-\delta)[1-\delta(1-\phi\sigma_0)]} \sigma_1 \lambda \pi_0 \quad (41)$$

Outcome of the negotiation game

T chooses X^L to maximize the following expression:

$$\max_{X^L} V_T^L(X^L)$$

subject to

$$V_P^L(X^L) \geq V_P^{NL} \quad (42)$$

$$V_T^L(X^L) \geq V_T^{NL} \quad (43)$$

According to condition (42), P_i will offer to license the innovation if after paying X^L it is at least as well off (over its time horizon) as it would be if it did not license. This implies that X^L satisfies

$$X^L \leq \sigma_1 \pi_1 - \frac{1-\delta}{1-\delta(1-\phi\sigma_0)} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (44)$$

According to condition (43), T will accept the license if and only if the licensing fee X^L leaves it at least as well off as if it were not to license. That is, T will offer to license if

$$X^L \geq \frac{1-\delta\phi(1-\sigma_1)}{1-\delta\phi(1-\sigma_0)} \sigma_0 \pi_1 \quad (45)$$

Licensing will occur in equilibrium if the maximum fee which P is willing to pay – that is, the X^L which satisfies (44) – is higher than the minimum fee that T is willing to accept – that is, the X^L that satisfies (45). That is:

$$\pi_1 - \frac{1-\delta}{1-\delta\phi} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} \sigma_1 \lambda \pi_0 \geq 0 \quad (46)$$

Since T has the power to set the fee, if condition (46) is satisfied, it will demand a fee X^{L*} such that

$$X^{L*} = \sigma_1 \pi_1 - \frac{1-\delta}{1-\delta(1-\phi\sigma_0)} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (47)$$

Licensing vs Co-promotion with Experiential Learning

Now consider the situation where co-promotion is an option. Since I am interested in the decision between licensing and co-promotion, I assume that condition (46) is satisfied – that is, that T will always prefer to license the innovation to P_i rather than commercialize it alone in equilibrium.

Expected profits calculated at start of each subgame

Let Π_T^{CP} denote the present value of T 's expected profits from a co-promotion arrangement before it has commercialized an innovation successfully. Once T has successfully commercialized an innovation as part a co-promotion arrangement, it obtains the commercialization capabilities equivalent to an established product firm and hence will choose to commercialize future innovations all alone. Hence in that case T 's expected profits in that case are given by $V_T^{NL'}$ (as above).

$$\Pi_T^{CP} = \frac{\phi X^{CP} + \delta\phi\sigma_1\Pi_T^{NL'} + (1-\phi)\Pi_T^{CP*}}{1-\delta\phi(1-\sigma_1)} \quad (48)$$

Substituting Π_T^{CP*} from (25) and $\Pi_T^{NL'}$ from equation (27) into equation (48) gives

$$\Pi_T^{CP} = \frac{\phi}{1-\delta\phi(1-\sigma_1)} X^{CP} + \frac{1-\phi(1-\delta\sigma_1)}{(1-\delta)[1-\delta\phi(1-\sigma_1)]} \sigma_1\pi_1 - \frac{(1-\phi)[1-\delta(1-\phi)]}{(1-\delta)[1-\delta(1-\frac{1}{N}\phi)]} (\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \quad (49)$$

Let $\Pi_{P_i}^{CP}$ be present value of P_i 's expected profits when P_i is the co-promotion partner (before T has commercialized an innovation successfully) and Π_{P-i}^{CP} be the same when it is not. As above, P_i 's expected profits after T has commercialized an innovation successfully are given by $\Pi_{P_i}^{NL'}$.

The values of $\Pi_{P_i}^{CP}$ and Π_{P-i}^{CP} are given by the following expressions

$$\Pi_{P_i}^{CP} = \frac{\phi[\sigma_1\pi_1 - X^{CP} + \delta\sigma_1\Pi_{P_i}^{NL'}] + (1-\phi\sigma_1)\sigma_1\lambda\pi_0}{1-\delta(1-\phi\sigma_1)} \quad (50)$$

$$\Pi_{P-i}^{CP} = \frac{\delta\phi\sigma_1\Pi_{P_i}^{NL'} + (1-\phi\sigma_1)\sigma_1\lambda\pi_0}{1-\delta(1-\phi\sigma_1)} \quad (51)$$

Substituting $V_{Pi}^{NL'}$ from equation (32) into equation (50) gives

$$\Pi_{Pi}^{CP} = \frac{\phi}{1 - \delta(1 - \phi\sigma_1)} (\sigma_1\pi_1 - X^{CP}) + \frac{1 - \phi\sigma_1}{1 - \delta} \sigma_1\lambda\pi_0 \quad (52)$$

Substituting $V_{Pi}^{NL'}$ from equation (32) into equation (51) gives

$$\Pi_{Pi}^{CP} = \frac{1 - \phi\sigma_1}{1 - \delta} \sigma_1\lambda\pi_0 \quad (53)$$

Expected profits calculated at the decision point

As for the two-strategy case, it is necessary to calculate the firms' profits from the point at which they make the strategic choice. Let V_T^{CP} and V_{Pi}^{CP} be T 's and P_i 's (respectively) present discounted profits under the co-promotion strategy. The values of these variables are given by the following expressions:

$$V_T^{CP} = \sigma_1(X^{CP} + \delta\Pi_T^{NL'}) + (1 - \sigma_1)(X^{CP} + \delta\Pi_T^{CP}) \quad (54)$$

$$V_{Pi}^{CP} = \sigma_1(\pi_1 + \delta\Pi_{Pi}^{NL'}) + (1 - \sigma_1)[\sigma_1\lambda\pi_0 + \delta(\frac{1}{N}\Pi_{Pi}^{CP} + \frac{N-1}{N}\Pi_{P-i}^{CP})] - X^{CP} \quad (55)$$

Substituting $\Pi_T^{NL'}$ from equation (27) and Π_T^{CP} from equation (49) into equation (54) gives

$$V_T^{CP} = \frac{1}{1 - \delta\phi(1 - \sigma_1)} X^{CP} + \frac{\delta[1 - \phi(1 - \sigma_1)]}{(1 - \delta)[1 - \delta\phi(1 - \sigma_1)]} \sigma_1\pi_1 - \frac{\delta(1 - \phi)[1 - \delta(1 - \phi)]}{(1 - \delta)(1 - \delta\phi)[1 - \delta(1 - \frac{1}{N}\phi)]} (\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \quad (56)$$

Substituting $\Pi_{Pi}^{NL'}$ from equation (32) and Π_{Pi}^{CP} from equation (52) and Π_{Pi}^{CP} from equation (53) into equation (55) gives

$$V_{Pi}^{CP} = [1 + \frac{\frac{1}{N}\delta\phi(1 - \sigma_1)}{1 - \delta(1 - \phi\sigma_1)}](\sigma_1\pi_1 - X^{CP}) + [(1 - \sigma_1) + \frac{\delta(1 - \phi\sigma_1)}{1 - \delta}]\sigma_1\lambda\pi_0 \quad (57)$$

Outcome of the negotiation game

T will choose X^{CP*} to maximize the following expression:

$$\max_{X^{CP}} V_T^{CP}(X^{CP})$$

$$V_{Pi}^{CP}(X^{CP}) \geq V_{Pi}^L(X^L) \quad (58)$$

$$V_{Pi}^{CP}(X^{CP}) \geq V_{Pi}^{NL} \quad (59)$$

$$V_T^{CP}(X^{CP}) \geq V_T^L(X^L) \quad (60)$$

$$V_T^{CP}(X^{CP}) \geq V_T^{NL} \quad (61)$$

Since I assume that T always prefers licensing to not licensing (i.e., condition (46) is satisfied), T sets X^{L*} at the point where P_i is indifferent between licensing and not licensing (i.e., $V_{Pi}^L(X^{L*}) = V_{Pi}^{NL}$). Hence, I can combine and rewrite conditions (58) and (59) as

$$V_P^{CP}(X^{CP*}) \geq V_P^L(X^{L*}) \quad (62)$$

Therefore, P_i will agree to co-promote in exchange for a fee X^{CP*} if

$$X^{CP*} \leq X^{L*} - \frac{\frac{1}{N} \delta \phi \sigma_1 [1 - \delta(1 - \phi)]^2}{[1 - \delta(1 - \frac{1}{N} \phi) + \frac{N-1}{N} \delta \phi \sigma_1][1 - \delta(1 - \phi \sigma_0)][1 - \delta(1 - \frac{1}{N} \phi)]} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (63)$$

This can also be written in terms of X^{L*} :

$$X^{CP*} \leq \sigma_1 \pi_1 - \frac{[1 - \delta(1 - \phi)][1 - \delta(1 - \phi \sigma_1)]}{[1 - \delta(1 - \frac{1}{N} \phi) + \frac{N-1}{N} \delta \phi \sigma_1][1 - \delta(1 - \phi \sigma_0)]} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (64)$$

From condition (64) it follows that the maximum fee that P_i is willing to pay under a co-promotion arrangement (X^{CP*}) is lower than maximum fee it is willing to pay under a pure licensing arrangement (X^{L*}). The intuition behind this is that after T acquires the capabilities to commercialize alone through the co-promotion arrangement, it no longer has to compensate P_i in each period. However, since co-promoting with T increases the probability of T becoming a potential competitor and hence reduces the expected profits P_i will earn on its own innovation, P_i demands that it be compensated upfront for this future loss in profits.²⁶ How much compensation

26 Note that, given T has the power to set the fee at the maximum level P_i is willing to pay, T captures all the profits from its innovation, regardless of whether P_i commercializes it or T commercializes it alone. Hence, P_i is not any worse off under co-promotion due to no longer having the opportunity to commercialize T 's future innovations. Moreover because the probability of T 's innovation being commercialized does not change whether T licenses to P_i , co-promotes with P_i , or commercializes alone once it has acquired the capabilities, P_i 's expected returns from its outside option are not any different under licensing or co-promotion. Hence the full amount of the difference between X^{CP} and X^L is due to the capitalized value of P_i expected future losses from T obtaining commercialization capabilities.

P_i demands depends on how many other firms share the cost of T becoming a competitor (i.e., on N).

Since T (weakly) prefers licensing to non-licensing (i.e., $V_T^L(X^{L*}) \geq V_T^{NL}$), conditions (60) and (61) can be combined and rewritten as

$$V_T^{CP}(X^{CP*}) \geq V_T^L(X^{L*}) \quad (65)$$

According to condition (65), T will agree to co-promote if

$$X^{CP} \geq X^L - \frac{\delta\phi\sigma_1(1-\delta)[1-\delta(1-\phi)]}{[1-\delta(1-\phi\sigma_0)](1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)]}(\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \quad (66)$$

Rewriting this in terms of X^{L*} leads to the following expression:

$$X^{CP} \geq \sigma_1\pi_1 - \frac{1-\delta}{1-\delta\phi} \frac{1-\delta\phi(1-\sigma_1)}{1-\delta(1-\phi\sigma_0)} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \quad (67)$$

From condition (67) it follows that the minimum fee T is willing to accept under a co-promotion arrangement is lower than the minimum fee under pure licensing. The intuition is that because there is a positive probability that under the co-promotion arrangement T will acquire the capability to commercialize alone in future and hence will not have to compensate P_i in future periods for the additional threat to its outside option.²⁷

Co-promotion will occur in equilibrium if the maximum fee that P_i is willing to pay is higher than the minimum fee T is willing to accept

$$\begin{aligned} \sigma_1\pi_1 - \frac{[1-\delta(1-\phi)][1-\delta(1-\phi\sigma_1)]}{[1-\delta(1-\frac{1}{N}\phi) + \frac{N-1}{N}\delta\phi\sigma_1][1-\delta(1-\phi\sigma_0)]}(\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \\ \geq \sigma_1\pi_1 - \frac{1-\delta}{1-\delta\phi} \frac{1-\delta\phi(1-\sigma_1)}{1-\delta(1-\phi\sigma_0)} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \end{aligned}$$

This inequality simplifies to

²⁷ Note since T already captures all the profits from the superiority of its innovation over P 's outside option, it does not expect to earn any additional profits from its own future innovation in future under co-promotion.

$$\frac{(1-\delta)[1-\delta\phi(1-\sigma_1)][1-\delta(1-\frac{1}{N}\phi)+\frac{N-1}{N}\delta\phi\sigma_1]-(1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)][1-\delta(1-\phi\sigma_1)]}{(1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)][1-\delta(1-\frac{1}{N}\phi)+\frac{N-1}{N}\delta\phi\sigma_1]} \geq 0 \quad (68)$$

Moreover, it holds if and only if

$$(1-\delta)[1-\delta\phi(1-\sigma_1)][1-\delta(1-\frac{1}{N}\phi)+\frac{N-1}{N}\delta\phi\sigma_1]-(1-\delta\phi)[1-\delta(1-\frac{1}{N}\phi)][1-\delta(1-\phi\sigma_1)] \geq 0 \quad (69)$$

If condition (69) is satisfied, T will set X^{CP*} such that

$$X^{CP} = \sigma_1\pi_1 - \frac{1-\delta}{1-\delta\phi} \frac{1-\delta\phi(1-\sigma_1)}{1-\delta(1-\phi\sigma_0)} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} (\sigma_1 - \sigma_0)\sigma_1\lambda\pi_0 \quad (70)$$

Proofs

Lemma 1: (a) In a technology commercialization game with no experiential learning, the unique equilibrium outcome is where T licenses the innovation to an established product firm P_i .

(b) In a technology commercialization game with experiential learning, not licensing will be an equilibrium outcome if the number of firms (N) and the probability of T commercializing a future innovation in the particular product field (ϕ) are sufficiently large.

Proof: (a) This proposition follows because, since $\pi_1 > \pi_0$ and $N \geq 1$ by definition, condition (20) is always satisfied if $\sigma_1 > \sigma_0$ – that is, as long P_i is better positioned with respect to the complementary assets.

(b) According to condition (46), licensing will occur in equilibrium if

$$\pi_1 - \frac{1-\delta}{1-\delta\phi} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} \sigma_1\lambda\pi_0 \geq 0 \quad (71)$$

Hence, obversely, firms will not license in equilibrium if

$$\frac{1-\delta}{1-\delta\phi} \frac{1-\delta(1-\phi)}{1-\delta(1-\frac{1}{N}\phi)} \sigma_1\lambda\pi_0 > \pi_1 \quad (72)$$

This can be rewritten as

$$(1-\delta)(1-\delta+\delta\phi)\sigma_1\lambda\pi_0 - (1-\delta\phi)(1-\delta+\frac{1}{N}\delta\phi)\pi_1 \geq 0 \quad (73)$$

Hence, the probability that T and P_i will not license in equilibrium (i.e., $\Pr(NL \succ L)$) is:

$$\Pr(NL \succ L) = \Pr[(1-\delta)(1-\delta+\delta\phi)\sigma_1\lambda\pi_0 - (1-\delta\phi)(1-\delta+\frac{1}{N}\delta\phi)\pi_1 \geq 0] \quad (74)$$

It follows that the effect of a change in N on $\Pr(NL \succ L)$ is given by

$$\frac{\partial \Pr(NL \succ L)}{\partial N} = (1-\delta\phi)\frac{1}{N^2}\delta\phi\pi_1 \quad (75)$$

Meanwhile the effect of a change in ϕ on $\Pr(NL \succ L)$ is given by

$$\frac{\partial \Pr(NL \succ L)}{\partial \phi} = \delta(1-\delta)\lambda\pi_0 + \delta(\frac{N-1}{N} - \delta + \frac{2}{N}\delta\phi)\pi_1 \quad (76)$$

The value of $\frac{\partial \Pr(NL \succ L)}{\partial N}$ is positive universally, while the value of $\frac{\partial \Pr(NL \succ L)}{\partial \phi}$ is positive if N and/or ϕ are sufficiently large. This means that the probability of not licensing is everywhere increasing in N and increasing in ϕ for N and ϕ sufficiently large. Hence will prefer not licensing to licensing for some (sufficiently large) values of N and ϕ . Q.E.D.

Lemma 2: (a) Co-promotion will be an equilibrium outcome of the technology commercialization game with experiential learning only if $N \geq 2$.

(b) The likelihood that T and P_i will choose to co-promote rather than license the innovation is increasing in the number of established product firms with which T could potentially contract to commercialize the innovation.

Proof: (a) T and P_i will (strictly) prefer to co-promote rather than license the innovation if and only if condition (69) is satisfied (as an inequality). This condition can be simplified to

$$\frac{N-1}{N}(1-\delta)(1-\delta\phi+\delta\phi\sigma_1) - \delta(1-\phi)[1-\delta(1-\frac{1}{N}\phi)] > 0 \quad (77)$$

Hence, the probability that T and P_i will prefer to co-promote (i.e., $\Pr(CP \succ L)$) rather than license is:

$$\Pr(CP \succ L) = \Pr\{\frac{N-1}{N}(1-\delta)[1-\delta\phi(1-\sigma_1)] - \delta(1-\phi)[1-\delta(1-\frac{1}{N}\phi)] > 0\} \quad (78)$$

If $N=1$, it is straightforward to show that $\Pr(CP \succ L) = 0$ in all cases and hence T and P_i will never agree to co-promote.

(b) The effect of a change in N on $\Pr(CP \succ L)$ is given by

$$\frac{d \Pr(CP \succ L)}{dN} = (1 - \delta)[1 - \delta\phi(1 - \sigma_1)] \frac{1}{N^2} + \delta^2 \phi(1 - \phi) \frac{1}{N^2} \quad (79)$$

Since $0 < \delta < 1$, $0 < \phi \leq 1$, and $0 \leq \sigma_1 \leq 1$ by definition, this expression is always positive and hence the probability that T and P_i agree to co-promote rather than license is always increasing in N . Q.E.D.

Lemma 3: The likelihood that T and P_i will choose to co-promote rather than license the innovation is increasing in T 's financial position.

Proof: If condition (69) is satisfied then, in accordance with condition (70), T will co-promote in exchange for a payment

$$X^{CP} = \sigma_1 \pi_1 - \frac{1 - \delta}{1 - \delta\phi} \frac{1 - \delta\phi(1 - \sigma_1)}{1 - \delta(1 - \phi\sigma_0)} \frac{1 - \delta(1 - \phi)}{1 - \delta(1 - \frac{1}{N}\phi)} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0 \quad (80)$$

The value of X^{CP*} which satisfies condition (70) is lower than the fee at which it will agree to pure licensing (X^{L*}) by $\frac{\delta\phi\sigma_1(1 - \delta)[1 - \delta(1 - \phi)]}{[1 - \delta(1 - \phi\sigma_0)](1 - \delta\phi)[1 - \delta(1 - \frac{1}{N}\phi)]} (\sigma_1 - \sigma_0) \sigma_1 \lambda \pi_0$ (as per proposition(66)), and it is possible that this value may in fact be negative. It may still be optimal for T to enter such an arrangement, even if X^{CP*} is negative, because T expects to recoup the payment through greater profits in future periods.²⁸ It may fund the payment from other revenues or through raising additional finance. However, this assumes that T is in a sufficient financial position to be able to do so. If instead it is financially constrained, so it does not have other revenues and cannot raise the cash to make the payment, it will be forced to forego co-promotion and opt for pure licensing. Q.E.D.

²⁸ Note that this is not the case under licensing. However, the maximum X^{L*} that P_i is willing to accept according to condition (44) is always positive, so this issue does not arise with straight licensing.

Proposition 1: The likelihood that T and P_i will attempt to co-promote the innovation (rather T merely license the innovation to P_i) is increasing in the probability that T will innovate in the particular product field in future (ϕ) if the number of firms (N) and/or the probability of an established product firm successfully commercializing an innovation (σ_1) are sufficiently large.

Proof: Following the reasoning in the proof of Lemma 2, the effect of a change in ϕ on $\Pr(CP \succ L)$ is given by

$$\frac{d \Pr(CP \succ L)}{d\phi} = \delta \left[\frac{1}{N} - \frac{2}{N} \delta + \frac{2}{N} \delta \phi + \frac{N-1}{N} \sigma_1 (1 - \delta) \right] \quad (81)$$

This condition will be positive if

$$\begin{aligned} \frac{1}{N} - \frac{2}{N} \delta + \frac{2}{N} \delta \phi + \frac{N-1}{N} \sigma_1 (1 - \delta) &\geq 0 \\ 1 - 2\delta + 2\delta\phi + (N-1)\sigma_1(1-\delta) &\geq 0 \\ 2\delta\phi &\geq -[1 - 2\delta + 2\delta\phi + (N-1)\sigma_1(1-\delta)] \\ \phi &\geq \frac{\delta - [1 - \delta + (N-1)\sigma_1(1-\delta)]}{2\delta} \\ \phi &\geq \frac{1}{2} - \frac{(1-\delta)[1 + (N-1)\sigma_1]}{2\delta} \end{aligned} \quad (82)$$

Hence the probability of the firm's choosing co-promotion over pure licensing is increasing in T 's expertise in the product field of the alliance if $\phi \geq \frac{1}{2}$ or, more generally, if $\phi \geq \frac{1}{2} - \frac{(1-\delta)[1 + (N-1)\sigma_1]}{2\delta}$. Hence the likelihood that T and P_i will choose to co-promote the innovation (rather T merely license the innovation to P_i) is increasing in ϕ if N and σ_1 are sufficiently large. Q.E.D.

Proposition 2: The likelihood that T and P_i will choose to co-promote (as opposed to license) the innovation is increasing in the probability that an established product firm will successfully commercializing the innovation (σ_1).

Proof: Following the same reasoning as above, the effect of a change in P_i 's expertise (σ_1) on the probability of the parties choosing co-promotion over pure licensing is described by the following expression

$$\frac{\Pr(CP \text{ vs } L)}{d\sigma_1} = \frac{N-1}{N} \delta(1-\delta)\phi \quad (83)$$

Since $\phi > 0$ and $0 < \delta < 1$, this expression is always positive. Hence the probability of the firm's choosing co-promotion over pure licensing is increasing in the probability that P_i will successfully commercialize the innovation. Q.E.D.

ACKNOWLEDGEMENTS

I wish to thank Joel Baum, Dirk Czarnitzki, Bronwyn Hall, Michael Grajek, Matt Higgins, David Hsu, Thorbjørn Knudsen, Robert Merges, David Mowery, Aija Leiponen, Elena Novelli, Scott Stern, David Teece, and seminar participants at the University of California (Berkeley), University of Southern Denmark, the Duke Strategy Conference, and the Wharton Tech Conference for their advice and comments on earlier drafts. I owe a large debt of gratitude to Recombinant Capital, and especially Mark Edwards, for generously giving me access to their data and with it much advice about the biotech industry. I gratefully acknowledge the support of the Innovation, Management, & Organization, the Institute for Business & Economic Research (both at the Haas School of Business), the Kauffman Foundation (through a grant to the Lester Center for Entrepreneurship & Innovation), the Center for Law & the Biosciences at Stanford Law School, and the European School of Management & Technology for financial support of this research. All errors are my own.

REFERENCES

- Aghion P, Tirole J. 1994. The Management of Innovation. *The Quarterly Journal of Economics* **109**(4): 1185-1209.
- Arora A, Merges RP. 2004. Specialized supply firms, property rights and firm boundaries. *Industrial & Corporate Change* **13**(3): 451-475.
- Edwards M, Hamilton JOC. 1998. Ten deals that changed biotechnology, *Signals Magazine*: November 17, 1998.
- Elfenbein DW, Lerner J. 2003. Ownership and Control Rights in Internet Portal Alliances, 1995-1999. *RAND Journal of Economics* **34**(2): 356-369.
- Gans JS. 2007. Start-Up Commercialization Strategy and Innovative Dynamics. In T Hellman, S Stern (Eds.), *Entrepreneurship: Strategy and Structure*. NBER: Cambridge, MA.
- Gans JS, Hsu DH, Stern S. 2002. When Does Start-Up Innovation Spur the Gale of Creative Destruction? *RAND Journal of Economics* **33**(4): 571.

- Gans JS, Stern S. 2003. The product market and the market for "ideas": commercialization strategies for technology entrepreneurs. *Research Policy* **32**(2): 333.
- Grant RM, Baden-Fuller C. 2004. A Knowledge Accessing Theory of Strategic Alliances. *Journal of Management Studies* **41**(1): 61-84.
- Hair JF, Anderson RE, Tathan RL, Black WC. 1998. *Multivariate data analysis*. Prentice Hall: Upper Saddle River, NJ.
- Hall BH, Jaffe AB, Trajtenberg M. 2001. The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools, *NBER Working Paper No. 8498*.
- Hamel G. 1991. Competition for Competence and Inter-Partner Learning Within International Strategic Alliances. *Strategic Management Journal* **12**: 83-103.
- Higgins MJ. 2007. The allocation of control rights in pharmaceutical alliances. *Journal of Corporate Finance* **13**(1): 58-75.
- Jacobides MG, Knudsen T, Augier M. 2006. Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research Policy* **35**(8): 1200-1221.
- Khanna T, Gulati R, Nohria N. 1998. The dynamics of learning alliances: competition, cooperation, and relative scope. *Strategic Management Journal* **19**(3): 193-210.
- Kogut B. 1988. Joint Ventures: Theoretical and Empirical Perspectives. *Strategic Management Journal* **9**(4): 319-332.
- Lerner J. 1994. Venture capitalists and the decision to go public. *Journal of Financial Economics* **35**(3): 293.
- Lerner J, Malmendier UM. 2005. Contractibility and the Design of Research Agreements, *NBER Working Paper No. 11292*.
- Lerner J, Merges RP. 1998. The Control of Technology Alliances: An Empirical Analysis of the Biotechnology Industry. *Journal of Industrial Economics* **46**(2): 125-156.

- Mowery DC, Oxley JE, Silverman B. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal* **17**(Winter Special Issue): 77–91
- Oxley JE. 1997. Appropriability hazards and governance in strategic alliances: a transaction cost approach. *Journal of Law Economics & Organization* **13**(2): 387-409.
- Oxley JE, Sampson RC. 2004. The scope and governance of international R&D alliances. *Strategic Management Journal* **25**(8-9): 723-749.
- Penrose ET. 1959. *The Theory of the Growth of the Firm*. John Wiley: New York, NY.
- Pisano GP. 1989. Using Equity Participation to Support Exchange: Evidence from the Biotechnology Industry. *Journal of Law, Economics and Organization* **5**(1): 109-126.
- Pisano GP. 1991. The governance of innovation: Vertical integration and collaborative arrangements in the biotechnology industry. *Research Policy* **20**(3): 237-249.
- Segal I, Whinston MD. 2007. Antitrust in Innovative Industries. *American Economic Review* **97**(5): 1703-1730.
- Teece DJ. 1986. Profiting from technological innovation. *Research Policy* **15**(6): 285-305.
- Wernerfelt B. 1984. A Resource-Based View of the Firm. *Strategic Management Journal* **5**(2): 171-180.
- Williamson OE. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. *Administrative Science Quarterly* **36**(June): 269.

TABLES & FIGURES

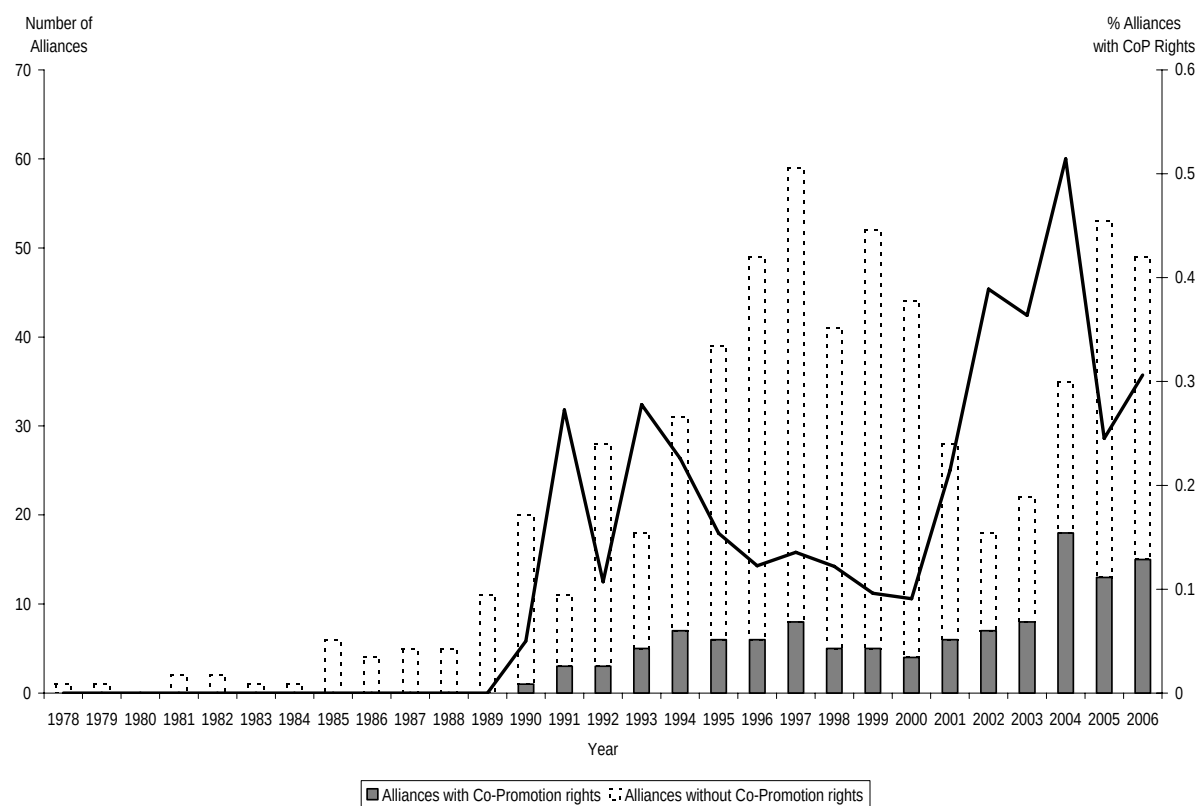


Figure 1: Biotech-to-pharma alliances with and without co-promotion rights

Table 1: Descriptive statistics

	<i>N</i>	<i>mean</i>	<i>s.d.</i>	<i>min</i>	<i>max</i>
<u>Characteristics of biotech firm</u>					
Years since founding (years)	565	10.51	6.41	1	36
Count of prior alliances in all disease fields	565	19.26	20.13	0	142
Has prior co-promotion deal (d)	565	0.28	0.45	0	1
Valuation (\$M) ^{1,2,3}	414	822	2,999	0.18	41,909
Number of assigned patents (for alliances prior to 12/2002)	351	17.23	47.70	0	463.00
<u>Characteristics of partner</u>					
Count of prior alliances in all disease fields	565	52.13	56.85	0	257
Has prior co-promotion deal (d)	565	0.56	0.50	0	1
Biotech firm (d)	565	0.35	0.48	0	1
Valuation (\$M) ^{1,2,3}	321	55,394	58,865	35.49	330,854
<u>Basic characteristics of the alliance</u>					
Year alliance signed	565	1999.3	4.20	1992	2006
Alliance filed with SEC (d)	565	0.91	0.29	0	1
<i>Stage of product commercialization at time of alliance:</i>					
Discovery	565	0.39	0.49	0	1
Lead molecule	565	0.09	0.29	0	1
Preclinical	565	0.13	0.34	0	1
Phase I	565	0.07	0.25	0	1
Phase II	565	0.09	0.28	0	1
Phase III	565	0.06	0.24	0	1
BLA/NDA filed	565	0.01	0.11	0	1
Approved for sale	565	0.03	0.18	0	1
Stage of product commercialization at time of alliance:	460	2.66	2.04	1	8
<u>Relationship between alliance and firms' prior experience</u>					
Count of biotech firm's prior alliances in same disease field	565	2.94	4.61	0	28
Proportion of biotech firm's prior alliances in same disease field	565	0.20	0.28	0	1
Count of partner's concurrent alliances in same disease field	565	1.84	2.60	0	19
Proportion of partner's concurrent alliances in same disease field	565	0.13	0.22	0	1
<u>Alliance terms</u>					
<i>Financial terms</i>					
Upfront payments (\$M) ^{1,3}	400	9,942	21,754	0	226,405
Equity payments (\$M) ^{1,3}	304	13,072	67,909	0	1,141,079
Milestone payments (\$M) ^{1,3}	352	74,626	140,202	0	905,618
Royalty rate (max.) ⁴	211	15.7	17.1	0	80.0
<i>Non-financial terms</i>					
License is worldwide	565	0.85	0.36	0	1
Biotech retains rights to co-promote the alliance product	565	0.21	0.40	0	1
Biotech retains rights to participate in clinical development	565	0.17	0.37	0	1
Parties engage in joint R&D collaboration	565	0.35	0.48	0	1
Biotech to do R&D prior to clinical trials	565	0.34	0.47	0	1
Biotech to do R&D related to clinical trials	565	0.33	0.47	0	1
Partner takes minority equity stake in biotech	565	0.31	0.46	0	1
Biotech manufactures product for use or sale by partner	565	0.18	0.39	0	1

¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings⁴ Recombinant Capital records highest rate listed on alliance

Table 2: Correlation matrix

Panel A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
(1) Biotech has right to co-promote the alliance product (d)	1.00																							
(2) Biotech markets product in alliance disease field within 5 years (d)	0.10	1.00																						
(3) Biotech retains co-promotion right in subs. alliance (d)	0.47	0.09	1.00																					
(4) Biotech retains co-promotion right in subs. alliance in same disease field (d)	0.67	0.16	0.71	1.00																				
(5) Proportion of subs. alliances where biotech is licensee	0.18	0.10	0.23	0.21	1.00																			
(6) Proportion of subs. alliances where biotech is licensee in same disease field	0.12	0.12	0.13	0.15	0.64	1.00																		
(7) Years since founding (log)	-0.03	0.02	0.12	-0.02	0.10	0.07	1.00																	
(8) Count of biotech's prior alliances	-0.02	0.02	0.20	0.11	0.28	0.17	0.47	1.00																
(9) Count of biotech's prior alliances in same disease field	0.18	0.20	0.22	0.31	0.12	0.15	0.22	0.28	1.00															
(10)Proportion of biotech's prior alliances in same disease field	0.19	0.15	0.06	0.22	0.02	0.08	-0.10	-0.18	0.59	1.00														
(11)Count of biotech's concurrent alliances in same disease field ²	0.09	0.14	0.14	0.25	0.12	0.15	0.01	0.12	0.69	0.55	1.00													
(12)Proportion of biotech's concurrent alliances in same disease field ²	0.14	0.15	0.03	0.18	-0.01	0.08	-0.07	-0.15	0.47	0.75	0.63	1.00												
(13)Biotech has prior co-promotion alliance (d)	0.14	0.02	0.52	0.38	0.20	0.05	0.20	0.40	0.24	-0.06	0.07	-0.04	1.00											
(14)Biotech is publicly listed (d)	0.09	0.09	0.16	0.12	-0.05	-0.06	0.35	0.26	0.21	-0.02	0.04	-0.01	0.23	1.00										
(15)Biotech's valuation (log) ¹	0.01	0.10	0.14	0.10	0.34	0.15	0.21	0.40	0.01	-0.09	-0.03	-0.09	0.19	-0.03	1.00									
(16)Count of partner's prior alliances in all disease fields (log)	0.23	-0.03	0.17	0.21	0.03	-0.02	0.11	0.14	0.09	0.05	0.01	0.03	0.11	0.10	-0.01	1.00								
(17)Count of partner's prior alliances in same disease field as alliance (log)	0.21	0.04	0.16	0.21	0.08	-0.03	0.09	0.08	0.22	0.15	0.11	0.09	0.14	0.08	0.07	0.53	1.00							
(18)Proportion of partner's prior alliances in same disease field as the alliance	0.02	0.08	0.02	0.02	-0.05	-0.07	0.12	0.03	0.16	0.09	0.10	0.07	0.05	0.05	0.07	-0.17	0.37	1.00						
(19)Count of partner's concurrent alliances in same disease field as the alliance ²	0.22	0.03	0.18	0.26	0.06	-0.03	0.04	0.00	0.22	0.21	0.16	0.17	0.09	0.04	-0.01	0.36	0.73	0.35	1.00					
(20)Proportion of partner's concurrent alliances in same disease field as the alliance ²	0.00	0.12	0.02	0.03	-0.04	-0.06	0.12	0.06	0.18	0.11	0.15	0.12	0.07	0.04	0.05	-0.18	0.28	0.76	0.38	1.00				
(21)Partner has prior co-promotion alliance (d)	0.19	0.03	0.20	0.19	0.05	-0.01	0.03	-0.03	0.07	0.14	0.03	0.13	0.06	0.13	-0.08	0.57	0.31	-0.16	0.30	-0.19	1.00			
(22)Partner is a biotech firm	-0.16	-0.04	-0.14	-0.15	0.03	0.05	0.09	0.14	-0.03	-0.17	-0.03	-0.17	0.00	-0.09	0.13	-0.35	-0.05	0.18	-0.06	0.24	-0.59	1.00		
(23)Partner's valuation (log) ¹	0.14	-0.06	0.12	0.15	0.13	0.07	0.01	0.12	0.08	0.01	0.00	-0.02	0.07	0.13	0.03	0.58	0.10	-0.29	0.08	-0.29	0.49	-0.53	1.00	
(24)Biotech equity-market index	0.14	-0.07	0.11	0.07	0.12	0.02	0.39	0.36	0.06	-0.12	-0.10	-0.12	0.15	0.15	0.19	0.45	0.33	0.04	0.18	0.07	0.12	0.08	0.27	1.00

Notes:

¹ in December 2006 US dollars

² includes alliances signed in two years prior to or year following the subject alliance

Panel B

	(1)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) Biotech has right to co-promote the alliance product (d)	1.00											
(25) Upfront payments (\$000) ^{1,2}	0.30	1.00										
(26) Equity payments (\$000) ^{1,2}	0.17	0.74	1.00									
(27) Milestone payments (\$000) ^{1,2}	0.41	0.57	0.50	1.00								
(28) Royalty rate ²	0.34	0.20	0.13	0.12	1.00							
(29) License is worldwide	-0.12	-0.18	-0.13	-0.06	-0.32	1.00						
(30) Biotech has right to co-develop the alliance product (d)	0.43	0.37	0.23	0.23	0.58	-0.01	1.00					
(31) Both parties engage in joint R&D	0.05	-0.03	-0.05	0.07	-0.04	0.21	0.03	1.00				
(32) Biotech to do R&D prior to clinical trials	-0.06	-0.16	-0.04	-0.16	-0.11	0.23	-0.04	0.41	1.00			
(33) Biotech to do R&D related to clinical trials	0.02	-0.04	-0.05	0.16	-0.05	-0.06	-0.27	-0.06	-0.11	1.00		
(34) Partner takes minority equity stake in biotech	0.12	0.01	0.17	0.03	0.15	-0.08	0.07	0.04	0.13	0.11	1.00	
(35) Biotech manufactures product for use or sale by partner	0.02	-0.01	-0.02	-0.04	0.31	-0.04	-0.03	-0.05	-0.05	0.00	0.06	1.00

Notes:

¹ in December 2006 US dollars

² only available to extent disclosed in SEC filings

³ Recombinant Capital records highest rate listed on alliance

Table 3: Whether Biotech Retains Co-Promotion Rights (Probit)*Dependent variable: Biotech retains co-promotion rights***Panel A: Characteristics of the biotech firms only**

	(1)	(2)	(3)
(1) Count of biotech's prior alliances in same disease field as the alliance	0.018 (0.017)	-0.004 (0.018)	-0.031 (0.020)
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.825 (0.270)***	0.733 (0.278)***	0.926 (0.339)***
(3) Years since founding (log)	-0.284 (0.137)**	-0.390 (0.147)***	-0.555 (0.461)
(4) Count of biotech's prior alliances in all disease fields (log)	-0.171 (0.100)*	-0.084 (0.103)	0.008 (0.112)
(5) Biotech has prior co-promotion alliance (d)	0.442 (0.159)***	0.342 (0.172)**	0.263 (0.209)
(6) Biotech is publicly listed (d)	0.260 (0.180)	0.306 (0.204)	0.478 (0.257)*
(7) Biotech's valuation (log) ^{1,2}	0.175 (0.046)***	0.185 (0.048)***	0.166 (0.066)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515
Pseudo R ²	0.07	0.16	0.08

Panel B: Characteristics of the partner firm only

	(4)	(5)	(6)
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.074 (0.027)***	0.023 (0.033)	0.038 (0.035)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	0.211 (0.344)	-0.091 (0.386)	-0.298 (0.451)
(10) Count of partner's prior alliances in all disease fields (log)	0.126 (0.081)	0.144 (0.092)	0.058 (0.096)
(11) Partner has prior co-promotion alliance (d)	0.018 (0.190)	-0.071 (0.195)	0.098 (0.208)
(12) Partner's valuation (log) ^{1,2}	0.079 (0.048)	0.103 (0.052)**	0.072 (0.058)
(13) Partner is biotech firm	-0.264 (0.200)	-0.162 (0.229)	-0.329 (0.260)
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	566	534	534
Pseudo R ²	0.16	0.27	0.14

Notes:¹ in December 2006 US dollars² For publicly listed firms, market valuation at end of prior quarter; for private firms, post-money value at end of last financing round (if occurred within past 12 months)³ Only available to extent disclosed in SEC filings

Panel C: Other alliance terms only

	(7)
(14) Upfront payments (\$M) ^{1,3}	0.048 (0.025)*
(15) Equity payments (\$M) ^{1,3}	0.082 (0.036)**
(16) Milestone payments (\$M) ^{1,3}	0.051 (0.037)
(17) License is worldwide	-0.474 (0.216)**
(18) Biotech retains rights to participate in clinical development	1.359 (0.199)***
(19) Parties engage in joint R&D collaboration	0.193 (0.143)
(20) Biotech to do R&D prior to clinical trials	-0.104 (0.147)
(21) Biotech to do R&D related to clinical trials	0.329 (0.160)**
(22) Partner takes minority equity stake in biotech	-0.160 (0.277)
(23) Biotech manufactures product for use or sale by partner	-0.266 (0.199)
Disease-field fixed effects	N
Stage of commercialization, year-of-founding, and year-of-signing dummies	N
Observations	566
Pseudo R ²	0.27

Panel D: Full regression (only selected regressors shown)

	(10)	(11)	(12)
(1) Count of biotech's prior alliances in same disease field as the alliance	-0.010 (0.024)	-0.023 (0.025)	-0.059 (0.028)**
(2) Proportion of biotech's prior alliances in same disease field as the alliance	0.633 (0.321)**	0.669 (0.351)*	1.151 (0.475)**
(3) Years since founding (log)	-0.477 (0.167)***	-0.457 (0.167)***	-1.145 (0.542)**
(5) Biotech has prior co-promotion alliance (d)	0.543 (0.181)***	0.555 (0.199)***	0.487 (0.249)*
(7) Biotech's valuation (log) ^{1,2}	0.114 (0.054)**	0.112 (0.057)**	0.135 (0.072)*
(8) Count of partner's concurrent alliances in same disease field as the alliance	0.034 (0.030)	0.023 (0.036)	0.065 (0.043)
(9) Proportion of partner's concurrent alliances in same disease field as the alliance	-0.270 (0.433)	-0.051 (0.462)	0.123 (0.627)
(14) Upfront payments (\$M) ^{1,3}	0.040 (0.026)	0.046 (0.028)	0.071 (0.034)**
(15) Equity payments (\$M) ^{1,3}	0.079 (0.039)**	0.081 (0.040)**	0.094 (0.056)*
(18) Biotech retains rights to participate in clinical development	1.364 (0.213)***	1.456 (0.246)***	1.816 (0.319)***
(21) Biotech to do R&D related to clinical trials	0.293 (0.157)*	0.293 (0.164)*	0.529 (0.210)**
Disease-field fixed effects	N	Y	Y
Stage of commercialization, year-of-founding, and year-of-signing dummies	N	N	Y
Observations	565	533	515

Pseudo R ²	0.34	0.37	0.48
-----------------------	------	------	------

Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Biotech's Subsequent Commercialization Activity (Probit)*Dependent variable: Biotech firm markets product in alliance disease field within 5 years (d)*

	(1)	(2)	(3)	(4)
	Full sample (1992-2006)		Sample without truncation (1992-2001)	
(1) Biotech retains rights to co-promote the alliance product	0.439 (0.194)**	0.202 (0.233)	0.640 (0.240)***	0.560 (0.300)*
(2) Count of biotech's prior alliances in same disease field as the alliance		0.050 (0.027)*		0.138 (0.048)***
(3) Proportion of biotech's prior alliances in same disease field as the alliance		0.222 (0.458)		-0.792 (0.593)
(4) Years since founding (log)		0.101 (0.355)		0.176 (0.401)
(5) Count of biotech's prior alliances in all disease fields (log)		-0.064 (0.243)		-0.073 (0.230)
(6) Biotech has prior co-promotion alliance (d)		-0.202 (0.298)		-0.482 (0.401)
(7) Biotech is publicly listed (d)		-0.103 (0.330)		0.118 (0.356)
(8) Biotech's valuation (log)		0.098 (0.080)		-0.066 (0.090)
Stage of commercialization dummies	N	Y	N	Y
Constant	-1.751 (0.107)***	-2.470 (0.745)***	-1.696 (0.120)***	-2.246 (0.721)***
Observations	566	565	389	388
Adjusted R ²	0.02	0.24	0.04	0.25

Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Biotech's Commercialization-Related Activity in Subsequent Alliances (OLS)

<i>Dependent variable:</i>	<i>Biotech retains co-promotion rights in subs. alliance (d)</i>		<i>Biotech retains co-promotion rights in subs. alliance in same disease field (d)</i>		<i>Proportion of subs. alliances where biotech is licensee</i>		<i>Proportion of subs. alliances where biotech is licensee in same disease field</i>	
	(1)	(2)	(5)	(6)	(3)	(4)	(7)	(8)
(1) Biotech retains rights to co-promote the alliance product	0.587 (0.046)***	0.483 (0.042)***	0.796 (0.038)***	0.702 (0.040)***	0.053 (0.012)***	0.038 (0.012)***	0.042 (0.015)***	0.036 (0.016)**
(2) Count of biotech's prior alliances in same disease field as the alliance		0.004 (0.005)		0.007 (0.005)		-0.001 (0.001)		0.002 (0.002)
(3) Proportion of biotech's prior alliances in same disease field as the alliance		-0.026 (0.081)		0.152 (0.078)*		0.028 (0.023)		0.044 (0.031)
(4) Years since founding (log)		-0.206 (0.101)**		0.045 (0.096)		-0.065 (0.028)**		-0.033 (0.038)
(5) Count of biotech's prior alliances in all disease fields (log)		0.092 (0.024)***		0.029 (0.023)		0.032 (0.007)***		0.028 (0.009)***
(6) Biotech has prior co-promotion alliance (d)		0.447 (0.043)***		0.261 (0.040)***		0.022 (0.012)*		-0.006 (0.016)
(7) Biotech is publicly listed (d)		0.051 (0.047)		0.041 (0.045)		-0.066 (0.013)***		-0.047 (0.018)***
(8) Valuation (log)		0.001 (0.014)		0.009 (0.013)		0.020 (0.004)***		0.011 (0.005)**
Stage of commercialization, year-of-founding, and year-of-signing dummies	<i>N</i>	<i>Y</i>	<i>N</i>	<i>Y</i>	<i>N</i>	<i>Y</i>	<i>N</i>	<i>Y</i>
Disease-field fixed effects	<i>N</i>	<i>N</i>	<i>N</i>	<i>Y</i>	<i>N</i>	<i>N</i>	<i>N</i>	<i>Y</i>
Constant	0.413 (0.021)***	1.080 (0.386)***	0.204 (0.017)***	-0.502 (0.365)	0.130 (0.006)***	0.181 (0.108)*	0.097 (0.007)***	0.128 (0.144)
Observations	566	565	566	565	566	565	566	565
Adjusted R ²	0.22	0.28	0.46	0.66	0.03	0.30	0.08	0.19

Standard errors (clustered by biotech firm) in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%