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Two Essays on Corporate Finance

Qiancheng Zheng
University of South Florida, qzheng@usf.edu

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by

Qiancheng Zheng

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Major Professor: Ninon Sutton, Ph.D.
Jianping Qi, Ph.D.
Christos Pantzalis, Ph.D.
Daniel Bradley, Ph.D.

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ABSTRACT

In the first essay titled "The Value of Strategic Alliances in Acquisitions and IPOs," I investigate how firms' strategic alliance experience affects their valuations as acquisition targets or in IPOs. I propose that strategic alliance experience serves as a valuable signaling device for target and IPO firms, particularly those with more intangible assets and greater opacity. The results show that takeover targets with alliance experience receive higher premiums than those without such experience. More recent alliance experience as well as alliance experience in the same industry also contributes to a larger target gain. Similarly, IPO firms that have alliance experience are shown to obtain higher valuations than those without the experience. Finally, alliance experience increases the likelihood that private firms exit by going public rather than being acquired.

In the second essay titled "For Better or For Worse: The Spillover Effect of Innovation Events on Alliance Partners," I examine the spillover effects of breakthrough innovations on the strategic alliance partners of the innovative firm. I find direct stock market evidence that the shareholders of strategic alliance partners significantly benefit from the spillover effects of these innovations. Multivariate analyses indicate that young and newly listed innovator firms with better growth opportunities generate bigger abnormal returns when announcing innovation events and bring larger spillover effects for their alliance partners with similar characteristics. In addition, I explore the risks associated with alliance partnerships, showing that FDA warning letters cause significant wealth losses for both the innovative firm and their alliance partners.

THE VALUE OF STRATEGIC ALLIANCES IN ACQUISITIONS AND IPOS

1. INTRODUCTION

The information asymmetry surrounding firms presents a valuation challenge to potential outside investors. This valuation challenge is particularly daunting for unlisted (private or subsidiary) firms. Faced with significant valuation difficulty, potential acquirers or IPO investors may discount the amount that they are willing to pay for the firm. For example, Officer (2007) notes that the premiums paid for unlisted targets are significantly lower than those paid for comparable public targets. While unlisted firms are generally more difficult to value, those that have a history of collaboration with other firms may have reduced levels of information asymmetry. In particular, the previous alliances that these firms have had with other firms can send positive signals about their value and reduce the asymmetric information problem for outside investors. According to a recent *Wall Street Journal* article, industry giants, such as General Mills and Procter & Gamble, are using their partnerships with a "crowdfunding" site to get to know more about certain start-ups and "...CircleUp's partnerships with big conglomerates could be 'a good thing for a business that's looking to get acquired, eventually'..."[1]

Indeed, several studies have shown that strategic alliances are common forms of collaboration that create value for the firms involved (e.g., Chan, Kensinger, Keown, and Martin,

[1] See "P&G, General Mills Tap Into Startups," *Wall Street Journal,* February 14, 2013. According to this article, "…Cincinnati-based P&G said it offers the founders of startups listed on CircleUp mentoring as well as help setting up licensing deals or joint ventures. A P&G spokeswoman also confirmed that P&G may occasionally acquire a startup's business or technology."

1997; Bodnaruk, Massa, and Simonov, 2013). In examining alliances between biotech and pharmaceutical companies, Nicholson, Danzon, and McCullough (2005) find that the valuations of biotech firms increase after they have formed their first alliance, suggesting that the alliance sends a positive signal to investors. Furthermore, Ivanov and Lewis (2008) show that IPO firms with alliances obtain higher valuations on the day of the offering and also have more positive long-run return performance. Thus, if alliances increase the perceived value of a firm by alleviating the asymmetric information faced by outside investors, alliances may play an important role in influencing the valuation the firm receives as an acquisition target, and in the case of a private firm, in its exit via either a takeover or an IPO. The exit outcomes of private, or more generally, unlisted firms are of particular interest because of the greater informational asymmetry surrounding these firms and, consequently, the greater benefit of strategic alliances as signals.

Building on the literature, this paper examines the value of strategic alliances in mergers and acquisitions as well as in initial public offerings. I are interested in examining the signaling effects of alliances for not just public targets but also unlisted targets; the latter provide unique valuation challenges for potential acquirers because of their lack of publicly available information. I also compare the value of alliance experience for firms with different levels of asymmetric information (i.e., unlisted, newly public, and more mature public targets) to explore the contingent effect of firm stages on the role of strategic alliances in acquisition premiums. Moreover, I perform subsample analyses on different types of alliances, such as horizontal versus non-horizontal alliances, strategic alliances versus joint ventures, R&D alliances, and marketing alliances, since certain types of alliance partnerships may be more valuable than others.

Using a sample of 29,089 completed acquisitions of public and unlisted targets announced during 1990-2010, our results show that the premiums paid for takeover targets with prior strategic alliance experience are significantly higher than those without such experience, especially for targets

that are unlisted. While strategic alliance experience increases the premium on average by 3.70% for public targets (7.98% for new IPO targets and 1.37% for mature public targets), the increase is 10.38% for unlisted targets. Alliance experience provides a stronger positive signal for unlisted firms and IPO targets because they have less publicly available information and hence are more difficult to value, consistent with signaling theory. Also consistent is our finding that alliance experience that is in the more recent past or that is in a related industry results in a higher premium, as the signal it provides is more timely or relevant.

I next examine whether strategic alliances provide value for entrepreneurial firms that go public. Using a sample of 3,039 IPOs, I find that the valuation premiums for IPOs with alliance partners are 2.13 times higher than those without alliance partners. Furthermore, in examining how alliance experience influences the exit choice of private firms, I find that the firms with alliance relationships are more likely to exit via IPOs rather than being acquired by other firms. Thus, strategic alliances appear to provide value to the sellers by alleviating the information asymmetry challenge faced by outside investors.

The key contribution of our research is to show that firms' alliance experience serves as a signaling device to reduce information asymmetry and increase their valuations. Indeed, alliance experience positively affects the willingness of acquirers or IPO investors to pay higher premiums for allied target or IPO firms. By exploring the more nuanced effects of specific types of alliance ties, the paper also advances our understanding of the various contingencies and boundary conditions of the role of strategic alliances in acquisitions and IPO valuations. This paper is also the first, to our knowledge, to combine comprehensive data on acquisitions, strategic alliances, and IPOs to examine the possible impact of alliance experience on entrepreneurial firms' choices of exit.

The rest of the paper proceeds as follows. Section 2 reviews the related literature and develops our hypotheses on the signaling role of strategic alliances. Section 3 describes the data

sample for mergers and acquisitions, strategic alliances, and IPOs, as well as the dependent, independent, and control variables. Section 4 reports the univariate results and multivariate regression results that demonstrate the effects of alliance experience on target premiums. Section 5 presents evidence on the beneficial role of strategic alliance experience on IPO valuations. Section 6 examines the impact of alliance experience on the private firms' choices of exit via IPOs or acquisitions. Section 7 concludes.

2. RELATED LITERATURE AND HYPOTHESES DEVELOPMENT

Researchers in finance have only recently begun to investigate the value implications of strategic alliances. Chan et al. (1997) examine the share price response to formation of strategic alliances and find positive stock price reactions and better subsequent operating performance for firms entering alliances. Allen and Phillips (2000) study corporate equity ownership and find that the largest increases in targets' stock prices, investment, and profitability occur when block equity purchases are combined with strategic alliances or other product market relationships. Robinson (2008) develops and tests a model to address why firms sometimes prefer alliances over internally organized projects and shows that strategic alliances help to overcome managers' incentive problems. Palia, Ravid, and Reisel (2008) analyze the motivation of internal project financing versus funding via outside alliances, and find that project risk is an important consideration. In a similar vein, Bodnaruk et al. (2013) argue that alliances help to improve firm operating flexibility and reduce agency costs related to free cash flows and capital allocation within the firm. Fang, Francis, Hasan, and Wang (2012) find that firms with alliance experience enjoy a lower cost of bank debt and are less likely to use collateral and covenants in their loan contracts.

Exploring the role of strategic alliances on IPO performance, Ivanov and Lewis (2008) examine 2,165 IPOs with positive EBITDA, including 280 IPOs with strategic alliance experience. Their findings show that IPO firms with alliance experience receive higher valuations on the offering day and exhibit better long-run returns, but these firms also have a higher degree of underpricing. Lindsey (2008) finds that strategic alliances improve the probability of exit by venture backed firms, via either IPOs or acquisitions. Furthermore, strategic alliances are shown by Ozmel, Robinson, and Stuart (2013) to serve as an alternative source of funding to venture capital for early stage high-tech firms. Relatedly, Reuer, Tong and Wu (2012) study the signaling role played by prominent venture capitalists, underwriters, and alliances in takeovers of IPO targets, and find that such associations increase the acquisition premium for the newly public firms.

While the previous research provides useful evidence on the value of alliances, the literature has not addressed the role of alliances for unlisted targets which would likely benefit more from the signaling effect, given their general lack of publicly available information. Also unexamined is the contingent effect of various types of alliance partners as signals in acquisitions or IPOs, as well as the differential signaling value of alliance experience between the relatively more recent and distant past and between related and unrelated industries. Finally, it remains an open question whether strategic alliance experience influences private firms' exit choice of IPO versus takeover.

It is well recognized that participants in the takeover and capital markets possess different information sets. Thus, acquirers or IPO investors may face the "lemons" problem (Akerlof, 1970) when offering to buy or invest in another firm. A number of solutions have been suggested to alleviate this problem. In the so-called market solution, acquirers select targets that are publicly traded, which have much more publicly available information for correct valuation. Empirical evidence, however, widely documents that the acquisition of public firms often generates negative abnormal returns for the acquirers around the acquisition announcements (see Fuller, Netter, and

Stegemoller, 2002, among others). An alternative proposed in the literature is the ownership solution, in which the acquirer buys a certain equity stake of the target as "toehold" before bidding for the firm (Betton, Eckbo, and Thorburn, 2009). Although toehold positions increase the odds of winning a bid for the toehold investors, studies have shown that the equity investments cause the toehold acquirer to bid more aggressively and end up overpaying in the acquisitions ("owner's curse"). A third way to mitigate the information asymmetry challenge is a contractual relationship between the acquirer and the target. For example, a contingent payment or earnout contract allows the acquirer to contingent certain payments on the target's subsequent performance. Under the earnout contract, incumbent management of the target firm remains in place in the acquired firm, overseeing its operations and fulfilling the incomplete contracts (Kohers and Ang, 2000). Another important contractual relationship is a strategic alliance or a joint venture between the acquirer and the target before the acquisition. Empirical evidence on the acquisitions of prior alliance partners in the pharmaceutical industry indicates that alliances reduce the information asymmetry and the likelihood of overpayment by the acquirers (Higgins and Rodriguez, 2006). By focusing on the attempts of acquirers to mitigate the asymmetric information problem, however, the existing evidence sheds little light on the potential benefit of strategic alliances for acquisition targets.

The information asymmetry problem is costly for high quality target firms as they would suffer from being "pooled" with low quality firms. Thus, as pointed out first by Spence (1973), the good may take certain actions to differentiate themselves from the bad. For high quality targets, particularly those having more opaque, less tangible, or harder-to-assess assets, strategic alliances may serve as a credible signal to convey their higher quality to potential acquirers (Reuer and Shen, 2004). Strategic alliances typically involve some formal contractual agreements between the partners, which can be important reference points for acquirers. These contracts are legally binding, often involving a large amount of funding from more established partners to smaller partners, or the

licensing of some key innovative products from one partner to another. By providing an inter-organizational endorsement, strategic alliances helps the involved targets differentiate themselves through various relational assets (Stuart, Hoang, and Hybels, 1999). Given the potential certification or endorsement benefits provided by strategic alliances for the targets in reducing the asymmetric information and adverse selection discount, I hypothesize:

Hypothesis 1 (H1): Strategic alliance experience of target firms serves as a valuable signal, resulting in higher premiums paid by acquiring firms.

Strategic alliances are especially helpful for unlisted targets having little or no publicly available information, and for unlisted targets with intangible assets, the ability to signal their quality through external endorsements by alliance partners is even more valuable. The literature in alliance formation and partner selection has highlighted that one of the most fundamental drivers for firms to forge alliances with other firms is to reduce firm-specific uncertainty associated with R&D and boundary spanning activities that are mostly internal to the firm (Beckman, Haunschild, and Phillips, 2004; Gulati, Lavie, and Singh, 2009). Since acquisitions involve decision-making with incomplete knowledge and information, acquirers are most concerned about the firm-specific uncertainty and strive to mitigate this problem by looking for external signals such as strategic alliances. While uncertainty exists with or without information asymmetry, the term "firm-specific uncertainty" used here refers to all that results in the so-called "hard-to-value" phenomenon, including that arising from asymmetric information. I capture the relative degree of firm-specific uncertainty by several attributes of firms, such as privately held or publicly traded firms, newly or more mature public firms among public targets, and firms with more or less intangible resources (e.g., R&D development capabilities and high-tech intensive assets). To the extent that targets' alliance partnerships help to mitigate firm-specific uncertainty associated with such attributes, I expect:

Hypothesis 2 (H2): The signaling effect of targets' alliance experience is stronger when firm-specific uncertainty is greater in the acquisition process.

The signaling value of alliance experience is likely to exhibit a temporal dynamic in that the signal conveyed by a more recent alliance experience would be more relevant and valuable to acquirers than one from a more distant past. Consistent with this view, Gulati (1995) suggests that the likelihood of two firms entering a new alliance diminishes as the elapsed time increases since their last alliance. Research on organizational change also argues that, as organizations, firms tend to have short memories (e.g., Amburgey, Kelly, and Barnett, 1993; Gulati, 1999). Similarly, strategic alliance experience has been shown to be helpful for R&D development, but the value of this experience depreciates over time (Sampson, 2005). The average age of the strategic alliances is also negatively associated with new product development (Rothaermel, 2001). Thus, I conjecture:

Hypothesis 3 (H3): The signaling effect of targets' alliance experience decreases as the time duration between their alliance experience and the acquisition announcement increases.

In the context of initial public offerings, scholars have examined the endorsement effect of strategic alliances in public offerings of new ventures in the biotechnology industry. For example, Stuart et al. (1999) find that biotechnology startup firms with ties to more established and prominent pharmaceutical companies go public faster and earn greater valuation at IPOs than firms without such ties. In a paper on the contingent effects of inter-organizational partnership on IPO success, Gulati and Higgins (2003) highlight the moderating role of different equity market conditions on the signaling value of various ties for young biotechnology firms. Pollock and Gulati (2007) further find that pre-IPO alliances have a visibility enhancing effect on alliance formations for the firms after IPOs.

Clearly, private firms with strategic alliance partners are likely to have more resources available and more visibility than those with no alliances.[2] Their relationships with established partners can serve the role of certification as well as that of monitoring to reduce potential agency problems at the project level (Bodnaruk et al., 2013). A strategic alliance contract can also signal that the private firm has certain (perhaps intangible) assets that are valued by the established partners. Consistent with these predictions, Ivanov and Lewis (2008) find that alliance experience provides higher IPO valuations to "successful" firms, those with positive EBITDA. I add to their work by examining a broader sample of not just profitable but also unprofitable IPO firms which may be at an earlier stage of growth. It is reasonable to expect that the signaling and certification role of strategic alliances would be at least as pronounced for unprofitable (and likely younger) IPOs.

Hypothesis 4 (H4): IPO firms with alliance experience are more likely to receive higher valuations than those without such experience.

Although takeover is very profitable and is the more likely form of exit by an entrepreneurial firm, going public is generally viewed as an even more profitable and more successful mode of exit for the firm. Gompers and Lerner (2004) suggest that a new venture that goes public usually yields the highest return for its investors. In line with this view, Brau, Francis, and Kohers (2003) document that insiders of private firms who choose exit by IPO earn a 22% higher premium than those who sell out to acquirers (13.3 vs. 10.9, p-value < 0.1). Concerning the choice of exit via an IPO or an acquisition, Poulsen and Stegemoller (2008) find that firms with more growth opportunities, more capital constraints, and less information asymmetry (larger and VC-backed firms) are more likely to go public. In a theoretical analysis, Bayar and Chemmanur (2011) argue that the

[2] In the context of biotechnology strategic alliances, Robinson and Stuart (2007) provide a good example for the certification role of large alliance partners in the IPO book building process: "…in the alliance between Bristol-Myers Squibb (BMS) and Cadus, BMS purchased a total of $20 million of Cadus equity in three separate transactions… Finally, at Cadus's IPO in July 1996, BMS converted its B shares into 1.607 million common shares and purchased an additional $2.5 million worth of common shares in the IPO."

IPO investors' prior assessment of the private firm's value, the private benefits of control to the firm's insiders, and the degree of product market competition are important factors driving the firm to choose an IPO exit.

I extend this research by examining the impact of strategic alliance experience on the choice of private firms going public versus being acquired. Our thesis is that private firms with strategic alliances are more likely to go public because the signaling benefit provided by the alliances is more valuable to prospective IPO investors than to potential acquirers. A priori, public market investors are likely less informed than a potential acquirer about a private firm because of free riders and duplication costs in their information production. To the extent that an alliance sends a credible, public signal about the value of the private firm, it helps to mitigate such free-rider and duplication cost problems for public market investors. Thus, by reducing the information cost more for potential IPO investors than for acquirers, an alliance increases the relative attractiveness of the IPO choice.

Hypothesis 5 (H5): The probability of going public versus being acquired is greater for private firms with alliance partners than for those without partners.

3. DATA AND METHODOLOGY

3.1. Alliances sample

I use the Strategic Alliances and Joint Venture section of the Securities Data Company (SDC) database to obtain our original alliance sample. From that sample, I select all strategic alliances and joint ventures where both partners are U.S. firms. I match the alliance partners with the takeover and IPO samples described below, and obtain all targets and IPO firms that have alliance experience as well as those that do not have this experience. I only keep alliances that are within five years of

the acquisition announcements or IPOs, based on the previous research that suggests an estimated duration of about five years for strategic alliances (Chan et al., 1997).

3.2. Takeover sample

The takeover sample is obtained from the M&A section of the SDC Platinum database, with announcement dates between January 1, 1990 and December 31, 2010. Bidders and targets are both U.S. firms. The acquirers are publicly listed, but the targets can be public or unlisted (private or subsidiary) firms. The acquisitions must be completed, and the acquirers must own more than 50% after the transaction. To be included in the sample, the transaction value reported in SDC must be over $1 million.[3] The resulting sample consists of 4,767 public targets and 24,612 unlisted targets. Among the 4,767 public targets, 1,277 firms have alliance experience and the remaining 3,490 firms do not. Among the 24,612 unlisted targets, 986 targets have alliance experience while 23,626 targets do not. Following Song and Walking (2000), I define a horizontal takeover as one between a target and a bidder that share the same three-digit primary SIC code. Otherwise, the takeover is classified as being non-horizontal. By this criterion, 12,082 acquisitions are horizontal while 14,766 are non-horizontal.

3.3. IPO sample

I collect our initial IPO sample from the SDC New Issues database. After eliminating closed-end funds, spin-offs, unit issues, real estate investment trusts, limited partnerships, financial firms (SIC 6000–6999), as well as offers that are priced at less than $5 per share, I obtain a total of 3,093 IPOs. In this sample, 706 IPO firms have various numbers of strategic alliance partners while 2,387 do not have any.

[3] In robustness tests, I also use a $10 million transaction value cut-off and the main results do not change.

3.4. Variables

3.4.1. Dependent variables

The main dependent variable for the acquisition sample is the target premium, defined here as the transaction value to sales ratio (*Premium*), following Brau, Sutton and Hatch (2010) and Koeplin, Sarin, and Shapiro (2000).[4] The transaction value is the amount paid for the target firm, and sales is defined as the target's revenue in the year prior to the takeover announcement. Following Pollock, Chen, Jackson, and Hambrick (2010), I measure *IPO valuation* as the logarithm of the IPO firm's market capitalization at the end of its first day of trading — the total number of shares outstanding multiplied by the first trading day's closing share price. I calculate the mean and the median valuation for our IPO sample. For the logistic regression analysis on the choice of IPO versus acquisition, our dependent variable is an indicator variable which equals one if the private firm successfully goes public, and zero if otherwise. For the hazard rate analysis of time to IPO and time to acquisition, the dependent variable is the hazard rate of an unlisted firm going public or being acquired in a given year after it is founded, where the firm's founding date is from SDC VentureXpert database.

3.4.2. Independent variables

To capture previous alliance experience, I use *allied target/IPO* as an indicator variable which takes the value of one if at least one alliance was formed between the target or IPO firm and another company within five years preceding the acquisition announcement or the IPO issue date, and zero if otherwise. *Total alliances* is a categorical variable that measures the total number of

[4] Financial statement data is largely unavailable for private firms. Sales is the best available variable to use for the premium measure for two reasons: first, sales is the most widely available data item for our sample, and second, sales is generally less subject to manipulation than other income statement measures such as earnings. As a robustness check for the sample of public targets, I also use an alternative measure of premium: the percentage difference between purchase price and target valuation four weeks prior to the date of acquisition announcement in SDC database. The results are similar to those using our original measure of premium.

alliances a target firm has in the last five years, with 0 indicating no alliance in the time period, 1 indicating one alliance partner, 2 indicting two to five alliance partners, and 3 indicating more than five partners. I create this variable to test whether more alliance experience impacts target premiums. I also use logarithms of the alliance count in IPO valuation regression as well as the analysis on the choice of IPO vs. acquisition.

Previous research suggests that the signaling value of alliance partnership is contingent upon specific types of ties, or the actual content of information that flows across different network ties (e.g., Podolny and Baron, 1997; Uzzi, 1996; Gulati and Higgins, 2003). To investigate more in-depth the impact of various alliance relationships, I include as independent variables a number of variables related to the nature of alliances. Specifically, *horizontal alliance* is an indicator variable that equals one if the target or IPO firm shares the same three-digit SIC code as its alliance partner. This variable is used to test the hypothesis that alliances formed in the same industry send a stronger signal about the target or IPO firm's quality. I also test the effects of other alliance characteristics, such as public versus private alliance partners, cross technology transfer agreements, research and development agreements, and manufacturing agreements. For targets with multiple alliance partners during the five years prior to acquisitions, the variable *R&D alliance* measures the percentage of the target or IPO firm's research and development that is attributable to the agreement with the partners. M*arketing agreement* measures the percentage of joint sales and services, OEM, as well as valued-added resale agreements. Likewise, the percentage of supply collaboration between target or IPO firms and their alliance partners is captured by *supply agreement*, the frequency of funding relationships between the two is measured by *funding agreement*, and the frequency of technology or product market exploration collaboration agreements between them is measured by *exploration agreement*. In the takeover sample, I also control for cases in which the acquirer is a strategic alliance partner of its target.

High tech target/IPO is an indicator variable which takes the value of one if the target or IPO is from a high-tech industry, and zero if otherwise. This independent variable is used as a proxy for the level of firm-specific uncertainty in the acquisition or IPO process. The inherent risk associated with technological innovation makes the intangible assets of high-tech firms particularly difficult to value (see Kohers and Kohers, 2001; Benou, Gleason, and Madura, 2007). *Alliance duration (in days)* is a continuous variable which measures the number of days between the target or IPO firm's announcement of the alliance partnership and the acquisition announcement or the IPO issue date. For targets or IPOs with multiple alliance partners, this variable takes the average alliance duration of all these alliances. This variable is created to test the "duration" hypothesis, which proposes that the signaling value of an alliance relationship for an acquisition target or an IPO firm decreases as the duration of this relationship prior to the acquisition or IPO increases.

3.4.3. Control variables

Previous studies have shown more acquisition activities taking place when stock market valuations are high (Andrade, Mitchell, and Stafford, 2001). Similarly, IPOs experienced a hot market during the period of 1999 and 2000 (see Bradley, Jordan, and Ritter, 2008). *Bubble period* is an indicator variable which takes the value of one if the merger or IPO was announced during the stock market bubble period of 1999-2000, and is zero if otherwise. *Private target* is an indicator variable which equals one if an unlisted target is a private firm, and is zero if it is a subsidiary. Following previous merger studies, I use a *horizontal merger* indicator variable that is equal to one if the target and the acquirer have the same three-digit SIC code, and is zero if otherwise. *Target size* is the natural logarithm of the target's total assets. To control for the influence of investment banks, I employ *IB-advisor* as an indicator variable which equals one if the target hires an investment bank advisor, and is zero if none is hired. Similarly, I control for the impact of *VC-backing* by including the dummy variable for the target or IPO firm that is supported by venture capital. In addition, *stock* is a dummy

variable indicating that stock is the method of payment, and *mix* indicates the payment method by a mixture of cash and stock. It is also important to control for targets' growth opportunities since firms with better growth opportunities are possibly more attractive as alliance partners. Thus, in a subsample analysis involving public targets, I control for targets' *Tobin's Q* within one year prior to being acquired. Tobin's Q is calculated using the method proposed by Chung and Pruitt (1994). In addition, I add *analyst coverage* of the targets during the year prior to acquisitions as another control for targets' perceived quality, where the data on the number of analysts is from the Institutional Brokers Estimate System (I/B/E/S).

For the IPO valuation regressions, I control for *hot IPO market* since prior research (e.g., Stuart et al., 1999; Gulati and Higgins, 2003) has suggested that market conditions have an important impact on investors' valuations of the firms that go public. The hot IPO market variable is constructed by calculating the monthly average change between the offer price and the closing bid price on the first day of aftermarket trading during 1990-2010, following Ritter (1984). I also control for *IPO proceeds*, which is the total amount the IPO firm collects from the offering. Additionally, I control for *underpricing*, *share overhang*, and *partial adjustment* in the IPO valuation regressions because previous research has shown that first day return, share retention and partial adjustment are potentially associated with IPO market valuations (e.g., Ljungqvist and Wilhelm, 2003; Bradley and Jordan, 2002). I create a dummy variable for top tier underwriters when the IPOs were taken public by an investment bank with a Carter-Manaster ranking of 8 or above on a 1-9 point scale, based on Carter and Manaster (1990) and the literature on the role of prestigious underwriters in IPOs. Given that our sample includes multiple industries, it is of interest to see whether certain high-tech industries fare better than others during the IPO process. For this purpose, I include high-tech dummy variables, such as *biotech*, *computer equipment*, *electronics*, *communications*, and *other high-tech*, based on SDC special high-tech classification code, following Kohers and Kohers (2001).

On the likelihood of exit via IPO or acquisition, I add other control variables such as *leverage, market return, industry return, industry market to book ratio (M/B), industry long-term debt to equity ratio, industry net profit margin*, *industry return on assets,* and *R&D intensity* by three-digit SIC code.[5] For the detailed descriptions of all these variables, see the Appendix 1.A: Variable Definitions.

3.5. Empirical methods

In the multivariate analysis, I use OLS regressions to investigate the factors that contribute to the variation in target premiums. The baseline model (1) in Table 1.3 is specified as follows:

TARGET PREMIUM = β_0 + β_1(ALLIED TARGET) + β_2(PRIVATE TARGET) + β_3(IB-ADVISOR) + β_4 (ALLIANCE DURATION) + β_5 (STOCK) + β_6 (MIX) + β_7 (HORIZONTAL MERGER) + β_8(TARGET SIZE) + β_9 (VC-BACKING) + ε_i .

Similarly, I use OLS regressions to investigate the factors that contribute to the variation in IPO valuations. The baseline model (1) in Table 1.5 is specified as follows:

IPO VALUATION = β_0 + β_1(ALLIED IPO) + β_2(SHARE OVERHANG) + β_3(OFFER PRICE) + β_4 (ALLIANCE DURATION) + β_5(UNDERPRICING) + β_6(TOP TIER UNDERWRITER) + β_7(PARTIAL ADJUSTMENT) + β_8 (HOT IPO MARKET) + β_9 (LOG(PROCEEDS)) + β_{10} (VC-BACKING) + β_{11} (HIGH TECH DUMMIES) + ε_i .

In investigating the choice of IPO versus acquisition, I use a logistic regression model to examine the determinants of the likelihood to go public or be acquired. The baseline model (1) in Table 1.6 is specified as follows, where P_i is the probability of going public:

LOG ($P_i/1-P_i$) = β_0 + β_1(ALLIED FIRM) + β_2 (LEVERAGE) + β_3(MARKET RETURN) + β_4 (LOG(AGE)) + β_5 (INDUSTRY ROA) + β_6 (INDUSTRY M/B)+ β_7(INDUSTRY RETURN) + β_8 (LOG(ASSETS)) + β_9 (VC-BACKING) + β_{10} (ALLIANCE DURATION) + β_{11} (OTHER CONTROLS) + ε_i .

As a robustness check for the analysis on the choice of IPO versus acquisition, I also fit a Cox proportional hazard model to examine the time to IPO versus time to acquisition.[6] The model can be specified as: $h(t, \boldsymbol{X}) = h_0(t)\exp(\boldsymbol{\beta X})$. The Cox model states that the hazard rate of a

[5] To control for the possible effect of outliers, all the industry level variables are winsorized at the 1% and 99%.
[6] I also use a piecewise exponential hazard model to analyze the effect of alliances on the choice of IPO vs. acquisition. The results are similar to those that use the logistic and Cox proportional hazard models, and are available upon request.

particular event at time t is the product of two quantities. The first of these, $h_0(t)$, is called the baseline hazard function. The second quantity is the exponential expression to the linear sum of $\boldsymbol{\beta X}$, which is over the j explanatory variables similar to those in the logistic model. The baseline hazard function is an unspecified function, which makes the Cox model a semiparametric model and also can incorporate time-varying covariates (Cox and Oakes, 1984; Kleinbaum and Klein, 2005).

4. EMPIRICAL RESULTS ON TARGET PREMIUMS

4.1. Univariate results on target premiums

In Panels A of Table 1.1, I report the descriptive statistics for the target sample and related deal characteristics. The deal characteristics show that targets with alliance experience more frequently hire investment bank advisors, have bigger deal value, and are acquired more in the form of horizontal mergers than targets without alliance experience. An examination of the sample firm characteristics shows that targets with alliance partners are more likely to be public firms, have greater total assets, have larger net sales, have higher Tobin's Q, are covered by more analysts, are more likely to be in the high-tech industry, and have a higher probability of VC support.

Panel B of Table 1.1 shows the alliance frequency distribution of 2,241 targets that have alliance partners in our sample. Similar to the definition of horizontal mergers, I define a horizontal alliance as one between two partners that share the same three-digit primary SIC code. The mean value for the frequency of horizontal alliance of all targets is 0.58, indicating that 58% of alliance partners are in the same industries as the target firms. Each target firm in this sample has, on average, 2.5 alliance partners during the five years prior to the acquisition announcement. In addition, I present various characteristics of alliances, such as the mean value for frequency of public alliance partners involved (0.82), only private alliance partners involved (0.17), cross technology transfer

agreements (0.19), research and development agreements (0.24), and the average alliance duration before the acquisition (763 days). About 8.0% of the targets are acquired by their alliance partners. About 88.8% of the alliances are strategic alliances, while 11.2% of the inter-firm collaborations take the form of joint ventures.

Table 1.2 compares the premiums for targets with and without alliance experience by the types of targets, the methods of payment, and the characteristics of alliance. In Panel A of Table 1.2, for public targets, the overall mean (median) premium is 7.68 (2.21) if the targets have alliance experience but only 3.99 (1.87) if they do not. The T test for the mean difference and the Kruskal-Wallis test for the median difference indicate that the differences between the targets with and without alliance experience are statistically significant at the 1% level. I further divide the public targets into IPO targets, those acquired within five years of going public, and mature public targets, those acquired after five years as a public firm. For IPO targets, the mean (median) premium is 13.44 (3.78) for allied targets, and 5.45 (2.40) for non-allied targets. The differences between the IPO targets with and without alliance experience are also statistically significant at the 1% level. For mature public targets, the premium difference between targets with and without alliance experience is much smaller, at 1.37, significant at the 10% level. Thus, younger, less mature IPO targets appear to benefit relatively more from alliance experience than more mature public targets, consistent with signaling theory.

Also consistent with signaling theory are our findings that unlisted targets benefit more from alliance experience. For unlisted firms, the mean (median) premium is 16.72 (2.49) for allied targets, and 6.34 (1.10) for non-allied targets. These differences in the mean and median premiums are significant at the 1% level.[7] A further examination reveals that the results for unlisted targets are driven by private targets, which receive an average (median) premium of 21.11 (2.93) if they have

[7] To control for the possible effect of outliers, the transaction value to sales ratio is winsorized at the 1% and 99%.

alliance experience, but only 7.04 (1.18) if they do not have any. Alliance experience does not have the same positive influence for subsidiary targets. The mean premiums for allied and unallied subsidiary targets are similar, while the median premium for non-allied subsidiaries (1.53) is significantly higher than that for allied subsidiary targets (0.94). The signaling effect of alliance partnerships may be unimportant for a subsidiary target due to its link to the parent firm. The parent may also sell the subsidiary at a discount, for example, if it needs a large infusion of cash (Officer, 2007).[8] Another result in Panel A is that allied targets in horizontal mergers have higher premiums than non-allied counterpart, with both significant mean and median differences (p value= 0.01). Overall, the results provide preliminary support for our hypothesis that alliance experience enables targets, especially private targets, to receive higher premiums in acquisitions.

Target premiums by the methods of payment follow a largely analogous pattern. For every method of payment, the mean (median) premium is significantly higher for unlisted targets with alliance experience than without the experience. The mean (median) difference in the premium for allied targets versus non-allied targets is 2.60 (0.88) in cash offers, 6.63 (0.73) in stock offers, and 0.70 (0.85) in mixed offers. In general, cash offer premiums are less than stock offer premiums for both targets with and without alliance experience, consistent with Brau et al.'s (2003) argument that the seller's risk decreases with a higher level of cash vis-à-vis stock payment.

In Panel B of Table 1.2, I compare target premiums by the characteristics of the targets' alliance partners. I compare alliances formed within one year of the acquisition announcement with those formed between one and two years (i.e., less than two years but more than one year), as well as those between two and five years, from the merger announcement. I find a large and significant difference (mean = 9.82, median = 0.46) in target premiums between the targets with the alliance

[8] Since targets' sales are the most widely available data for analysis of premiums (Brau et al., 2010), I use the transaction value to sales ratio (*premium*) as dependent variable in most of our analysis. As a robustness check, I also use offer price to book value of equity as dependent variable. The basic results remain unchanged and are available upon request.

duration measure of less than one year and those with the duration of one to two years. The premium difference is even larger (mean = 14.40, median = 0.88) between the duration of less than one year and that of two to five years. There is also a significant premium difference (mean = 4.56, median = 0.42) between the targets with the duration of one to two years and those with the duration of two to five years. These comparisons provide preliminary support for our duration hypothesis *(H3)* that alliances formed in the more distance past (i.e.., with a longer duration) are less valuable as signals for target quality. I also examine the *public alliance partner* effect*,* where the public status of targets' alliance partners is defined as being public both as of the alliance announcement date (based on SDC alliance data) and as of the acquisition announcement date (based on Compustat and CRSP data). Targets with public partners do tend to have higher premiums, especially for private targets, with a mean difference of 8.50 (p value = 0.01) compared to other targets with non-public alliance partners. This result is consistent with Reuer et al.'s (2012) finding of a stronger signaling effect of more prominent alliances, those involving public alliance partners.

Panel C of Table 1.2 investigates the effects of partner acquisitions and brokering. In a partner acquisition, the target is acquired by one of its previous alliance partners, while in a brokerage acquisition, the acquirer and the target share a common alliance partner. A prior partnership between the acquirer and the target could reduce information asymmetry and hence the adverse selection problem (e.g., Higgins and Rodriguez, 2006). A common alliance partner for the acquirer and the target could potentially also reduce information asymmetry via a brokering effect (e.g., Lindsey, 2008). Among all allied targets, 113 targets are acquired by their alliance partners and have premium data available. Based on mean differences, partner acquisitions have a 2.85 higher premium than other allied targets, although not statistically significant. Based on median differences, partner acquisitions have a 0.23 higher premium (p value = 0.10). This suggests that targets acquired by their partners receive higher premiums, although not substantially so. The brokering effect is

more ambiguous, however, with brokerage acquisitions having a lower mean premium than other allied targets but a similar median premium. In any event, the effects of partner and brokerage acquisitions are not strong enough to subdue the signaling benefits of other alliance types.

In a related test, I find that targets with horizontal alliance partners have higher premiums. In particular, targets that have horizontal alliances and are acquired in a horizontal acquisition (*alliance-acquisition align*) receive a substantially higher premium, with a statistically significant mean difference of 8.08 ($p = 0.01$) and a median difference of 1.05 ($p = 0.01$). The higher premium suggests that the intra-industry alliance experience of targets sends an important positive signal and is highly valued by acquirers in the same industry. Subsequent multivariate results confirm this interesting finding.

4.2. OLS Regressions of the takeover premium

In this section, I test our hypotheses in a multivariate framework using OLS regressions. The results are presented in Table 1.3. The sample excludes partner and brokerage acquisitions to ensure that the signaling effects of alliance partners are not confounded by such ties. I also include industry and year fixed effects to control for possible impacts of industry and time periods. The primary variable of interest in model 1 is the *allied target* dummy. The coefficient for this variable is positive and significant at the 1% level in model 1, thereby confirming our main hypothesis (*H1*) that alliance experience serves as a valuable signal. To further examine whether alliance experience is more valuable when information asymmetry is greater, model 1 includes an indicator variable *private target* as a proxy for asymmetric information, and model 2 includes an interaction term between *private target* and *allied target*. Both the indicator variables and the interaction term are positive and significant at the 1% level, providing support for our hypothesis (*H2*) that the targets' alliance experience has a stronger signaling effect when the target exhibits more firm-specific uncertainty or opacity. All

models in this table also test the duration hypothesis (*H3*). The alliance duration variable is negative in all models and significant at the 1% level in most, supporting our hypothesis that more time-distanced alliances are less valuable as a signal. This result is also consistent with Gualti's (1995) finding on the temporal dynamics of prior alliance ties, and Sampson's (2005) argument that the experience effect depreciates over time.

In model 3 of Table 1.3, I use an alternative variable for targets with alliance experience. The coefficient for *total alliances* is 4.85 (p = 0.001), which is smaller than the coefficient of 15.74 (p = 0.001) for the *allied target* variable in model 1. Thus, additional alliance partnerships do not matter much for a higher acquisition premium. So long as a target firm has the endorsement of one alliance partner, the discount effect on the target is substantially diminished. This result is consistent with the conclusion in the previous literature that the first alliance is the most important (Nicholson et al., 2005) and that the marginal value of additional VCs is declining (Pollock et al., 2010).

In models 4 through 11 of Table 1.3, I include variables related to certain characteristics of the alliances, to proxy for the informational content of network ties (Gulati and Higgins, 2003). In model 4, the main variable is *horizontal alliance*. The result shows that alliance experience in the same industry is valuable for enhancing the target premiums. Model 5 adds the interaction term between horizontal alliances and horizontal mergers, *alliance-acquisition align*, which has a positive and significant coefficient of 5.24 (p = 0.01), in addition to the still highly significant and positive coefficient for *allied target*. Thus, alliance experience in the same industry appears to be especially valuable for enhancing the target premiums in intra-industry acquisitions. This finding provides further support for our main signaling hypothesis (*H1*) since alliance partnerships in the same industry are likely to send a more relevant signal to within-industry acquirers.

Model 6 tests the interaction term between *non-horizontal ally* and *diversifying* acquisition, indicating that the target's alliance partner(s) do not share the same 3-digit SIC code with the target

and the target is later acquired in a diversifying acquisition. The coefficient for this interaction term, *non-horizontal ally*diversify,* is positive (5.93) and significant (p = 0.01), suggesting that acquirers making diversifying acquisitions are willing to pay higher premiums for targets with alliance experience in a different industry. It is possible that these targets are more versatile, having broader experience that is of interest to the acquirers in their diversifying acquisitions. While this finding is consistent with Reuer et al.'s (2012) evidence that alliance experience is of a greater signaling value to targets in inter-industry acquisitions, I further identify the kind of alliance experience that is more valuable for targets in diversifying acquisitions.

Model 7 of Table 1.3 tests the impact of *strategic alliance* and shows a positive and significant coefficient of 7.33 (p < 0.001), indicating the positive effect of strategic alliance relative to joint venture. Model 8 tests the effect of alliance partners that are public firms and shows that such alliances increase target premiums, with a coefficient of 2. 67 (p value = 0.05).[9] Models 9 through 11 test the effect of three other types of alliances: R&D alliance, licensing agreement, and manufacturing agreement. The results for these alliance types are generally insignificant, with the exception of the licensing agreement alliance. The coefficient for licensing agreement is 3.89 and significant at the 0.01 level. Recent research on the value of different types of alliance partnerships has shown that downstream alliances (or exploitation alliances such as manufacturing and marketing agreements) are more valuable for smaller firms (e.g., Alvarez and Barney, 2001; Katila, Rosenberger, and Eisenhardt, 2008; Yang, Zheng, and Zhao, 2013), whereas upstream alliances (or exploration alliances such as R&D alliances) are more valuable for larger firms (Yamakawa, Yang, and Lin, 2011). Since the sample for Table 1.3 includes all firms, large or small, the effects of different types of

[9] I define an alliance partner as public if it is publicly listed both as of the alliance announcement date (based on SDC alliance data) and as of the acquisition announcement date (based on Compustat and CRSP data). As an alternative, I also defined public alliance partner based on SDC alliance data only to avoid any survivorship bias from using the Compustat and CRSP database. While the alternative definition provides a higher number of alliance partners defined as public, the results using these two alternative definitions of public alliance partners are similar.

alliances are not obvious. The subsample analyses in Table 1.4 show a clearer picture of their differential effects. In sum, the results in the models of Table 1.3 support the three hypotheses (*H1, H2,* and *H3*), indicating significant benefits of alliance experience in acquisitions.

4.3. Subsample analysis and robustness checks

In this section, I present the results from additional multivariate regression tests for the purpose of robustness checks. First, I separate our sample by public versus unlisted targets and test the impact of the main alliance variables on the premiums of these two types of targets. I further divide public targets into IPO targets and more mature targets. Unlike public targets, I cannot control for certain firm-specific characteristics of unlisted targets (e.g., Tobin's Q). Thus, following previous research such as Rau and Vermaelen (1998), Barber, Lyon, and Tsai (1999), and Kohers and Kohers (2001), I use a matched sample method for unlisted targets to control for the potential endogeneity issue. I match each allied unlisted target with, on average, five non-allied targets based on size (75% to 125% of the size of the allied unlisted target), industry (based on four-digit SIC code), VC-backing status, and time frame (in the vicinity of five years around the acquisition announcement of the allied unlisted target).

Panels A through D in Table 1.4 report the results of the subsample analyses. Consistent with signaling theory, strategic alliances are more important for unlisted than public targets, and for IPO than mature public targets. Indeed, the coefficient for *allied target* is notably larger for the unlisted target subsample (33.87 in model 1 of Panel B) than for the public target subsample (4.98 in model 1 of Panel A), and also larger for the IPO target subsample (13.14 in model 1 of Panel C) than for the mature public target subsample (-1.89 in model 1 of Panel D). The coefficients for *VC-backing* and *IB-advisor* show largely a similar pattern. These results suggest that targets with less publicly available information, unlisted rather than public targets and IPO rather than more mature

targets, are in the greater need of endorsement from outside parties, and therefore, do benefit more from alliance partnerships. Notably, for IPO targets, all the main alliance variables, such as allied targets, total alliances, horizontal alliances, strategic alliances, and public alliance partners, are positive and significant, while for mature public targets, only specific types of alliances, such as R&D alliances and licensing agreements, are positive and significant. For mature public firms, the coefficient for R&D alliance is positive and highly significant (4.52, $p = 0.01$), suggesting that for larger and more mature firms, upstream alliances such as R&D alliances are more valuable for potential acquirers. This type of alliance may send a stronger signal of growth possibly because large firms are less subject to the concerns of knowledge appropriation and alliance uncertainty. The result is consistent with the recent research suggesting that firm age has an important impact on firms' alliance-formation choices and subsequent firm performance (Yamakawa et al., 2011).

4.4. Additional analyses

For additional robustness checks, I conduct a number of other empirical tests.[10] First, to provide further evidence on the value of strategic alliances for high asymmetric information targets, I divide our sample by high-tech versus non-high-tech targets and run the regression models from Table 1.4. For both the high tech and non-high tech subsamples, the coefficients for the target's allied dummy (allied target) are positive and significant. However, the coefficients for the alliance dummy and other alliance-related variables are larger for the high-tech than for the non-high-tech subsample. This difference suggests that alliance experience is more important for targets with greater firm-specific uncertainty, providing further support for our hypothesis *(H2)*.

Next, I examine an alternative explanation for the higher premium for targets with alliance experience. When purchasing targets with alliance partners, the acquirer may gain knowledge about

[10] For the sake of brevity, the results of these additional tests are not shown but are available upon request.

the R&D activities and technological pursuits of the partner firm. Thus, the partner may try to discourage the target from agreeing to the takeover. The acquirer may then have to pay a higher premium to entice the target to accept the deal. To empirically examine this possibility, I analyze the market reaction for the (non-acquiring) alliance partners of all the targets in our sample. If the acquirer was expected to gain a competitive advantage over the non-acquired partner, the partners' market reaction around the merger announcement would be negative. However, the results show that, around the acquisition announcement dates, targets' alliance partners have positive returns on average, though statistically insignificant in general. Furthermore, I run regression analyses using the abnormal returns for alliance partners as the dependent variable, along with other control variables such as an equity ownership dummy, a horizontal alliance indicator, the premium paid, method of payment, etc. The results show that the equity ownership dummy is positive but not significant in all models. This indicates that even for targets' alliance partners with equity investment in the targets, there is no evidence of strategic information transfer from the acquisitions.

5. VALUATION PREMIUMS FOR IPOS WITH AND WITHOUT STRATEGIC ALLIANCES

This section examines the role of strategic alliances in the IPO process. Our hypothesis (*H4*) predicts that IPO firms with alliance experience receive higher valuations than those without such experience. Our IPO valuation variable is the logarithm of the IPO's market capitalization at the end of its first day of trading — the total number of its shares outstanding multiplied by the closing share price at the first trading day (Pollock et al., 2010).

I examine the role of alliance partners on IPO valuations by OLS regressions of IPO valuations on main alliance variables and other control variables. Column 1 of Table 1.5 presents

the results for baseline regression model of IPO valuations. The main alliance indicator variable, *allied IPO*, has a positive and significant coefficient of 0.10 (with a p-value of 0.01). This indicates that IPOs with prior alliance experience gain significantly higher valuation in the public markets than IPOs without such experience, after controlling for other relevant factors. Alliance experience appears to send a positive signal to IPO investors, in addition to other indicators such as proceeds, offer price, and share overhang that are also significantly associated with IPO valuations. Notably, alliance experience has a greater coefficient than VC-backing and top tier underwriter (both with p value = 0.01). In column 2, I use an alternative alliance variable, the logarithm of one plus the total number of alliance partners, to capture the incremental effect of multiple alliance partners. Compared to the alliance experience indicator variable (*allied IPO*), the coefficient for *log (total alliances)* is 0.08 (p value =0.001), indicating that multiple alliance partners have little incremental effect on IPO valuation. In columns 3 through 10, I test the impact of various types of alliance partners on IPO valuations. Alliances in the same industry, strategic alliances, public alliances, as well as R&D alliances, all have positive impact on IPO valuation (columns 3, 4, 5, 8, and 10). The overall results in Table 1.5 support our hypothesis (*H4*) that alliance partnerships provide IPO firms with higher valuations in the public markets.

6. THE EFFECT OF ALLIANCES ON THE CHOICE OF IPO VERSUS ACQUISITION

In this section, I examine the role of alliance partners on the likelihood of exit by private firms via IPOs or acquisitions. Table 1.6 reports the results of the logistic regressions for the choice of IPO versus acquisition. The baseline model in column 1 tests the impact of the main independent variable, *allied firm*, on the choice of IPO versus acquisition. The positive and highly significant coefficient 2.43 (p-value = 0.001) indicates that private firms with alliance experience are more likely

to go public, instead of being acquired. Going public is generally viewed as a more successful and profitable form of exit by a private firm. By sending a positive signal to public market investors, alliance experience increases the probability that the private firm goes public. Furthermore, consistent with our duration hypothesis, the alliance duration variable has a negative and significant coefficient of -0.62, indicating that the impact of alliance experience on the decision to go public decreases as the duration increases. The results for the control variables are consistent with the previous literature (e.g., Brau et al., 2003; Poulson and Stegemoller, 2008). For example, private firms with VC backing are more likely to go public than to be acquired. Larger firms, higher *log(assets*), are more likely to go public, especially when the industry return is high. A higher industry market to book ratio (*industry M/B*), higher industry net profit margin (*industry NPM*), or higher R&D intensity (*industry RDS*) also positively predicts the propensity of going public by private firms. In column 2, the logarithm of the alliance count variable *(log(Total alliances))* has a smaller coefficient (0.68, p value = 0.001) than the alliance experience indicator variable *(allied target),* indicating that the number of alliance partners do not have an incremental effect on the probability of going public.

Columns 2 through 6 in Table 1.6 test the specific impact of various types of alliance partners on the choice of IPO versus acquisition. The results show that except for manufacturing agreements and supply agreements, all other types of alliance partnerships, including horizontal alliance, public alliance partner, strategic alliance, R&D alliance, licensing agreement, and marketing agreement, have positive and significant impacts on the probability of going public. There is some evidence that certain types of alliances have more positive effects than others. For example, strategic alliances have a much higher positive effect (1.84, p value = 0.001) than joint ventures on the likelihood of going public. Private firms with public alliance partners are also more likely to go public. Taken together, the results in this section support our hypothesis (*H5*) that private firms have a higher probability of going public if they have prior alliances than if they do not have any.

To ensure the robustness of this set of result on the choice of IPO vs. acquisitions, I also employ the method of event history analysis. I fit a Cox proportional hazard model, where the dependent variable is the hazard of a private firm going public in a given year after it is founded. I treat acquisition events as competing risks to avoid the loss of timing information. The firm's founding date is from SDC VentureXpert database. Following the sampling procedure of Ozmel et al. (2013), I include only venture-backed firms in the tests to minimize the scope for heterogeneity in firm quality. The independent variables and control variables in these hazard models are similar to those in the logistical regression models in Table 1.6.

Table 1.7 reports the Cox proportional hazard regression analyses regarding the effect of alliance partnerships on the time to IPO (*hr_iva*). In model 1, I include only the alliance experience indicator variable, *allied firm*. The coefficient shows that alliances have a large positive effect (2.10, p value = 0.001) on the hazard rate of going public.[11] After controlling for other variables as in model 1 of Table VI, the effect is even greater. Thus, alliance experience appears to increase the speed of going public for firms in our sample, consistent with the results from the logistic regression models. All other covariates also have similar patterns to those in the logistic regression models.

7. CONCLUSION

Using a comprehensive sample that captures the strategic alliance experience of target and IPO firms during the period of 1990-2010, this paper shows that alliance experience enables target and IPO firms to obtain higher valuation premiums. Our evidence supports the hypothesis that strategic alliance experience serves as a credible signal for target and IPO firms. Indeed, target and

[11] The coefficients for hazard models have been transformed into hazard ratios, which give the percentage change in the hazard of going public with one-unit change in the corresponding covariates. The equation is as follows: hazard ratio = exp(β), where β is the original raw coefficients for the corresponding covariates. The similar transformation is employed in Ozmel et al. (2013), among others.

IPO firms with more intangible assets and greater firm-specific uncertainty appear to benefit more from the signaling effect. Alliance experience that is more recent or that is in the same industry also has a higher signaling value.

This paper contributes to the literature by highlighting the importance of strategic alliances, particularly for firms that otherwise would face significant valuation challenges because of greater firm-specific uncertainty or information asymmetry. I shed new light on the determinants of target and IPO valuations, adding to the work of Officer (2007), Bargeron et al. (2008), Bauguess et al. (2009), and Gulati and Higgins (2003). While Officer (2007) points out that information asymmetry may explain part of the acquisition discount for unlisted targets, I emphasize the role of strategic alliances as signal in mitigating this asymmetric information discount. Furthermore, our findings show that the signaling value of alliance relationships is contingent on the stages of the firm. For instance, the signaling value of alliance experience is greater for unlisted than public targets, and among public targets, it is greater for newly public than more mature targets. The other findings of this paper suggest that the signaling value of alliances depends also on the types of partnership ties. For example, certain alliance contracts, such as R&D partnerships, can signal asset quality even for established firms.

Concerning the role of alliances in private firms' choice of going public versus being acquired, this paper provides evidence that alliances increase the relative likelihood that these firms choose to go public. Since IPO is commonly viewed as a more successful form of exit by private firms, our results suggest that strategic alliances provide the additional benefit for private firms. In this context, this paper contributes to the emerging literature on exit choice (e.g., Brau et al., 2003) by demonstrating the importance of external ties in the decision to go public or be acquired.

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Table 1.1: Descriptive Statistics for Target Sample, 1990-2010

This table describes our sample which consists of 29,089 acquisitions of public and unlisted targets announced during 1990-2010 in the Securities Data Company's (SDC) Merger and Acquisition database. All the variables for firm characteristics, methods of payment, and deal value are obtained from SDC. Panel A and Panel B are descriptive statistics for acquisition deal characteristics and firm characteristics. Panel C describes the types of agreements between 2,241 targets and their partners. All variables are defined in Appendix 1.A: Variable definitions. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A. Deal Characteristics and Firm Characteristics

	Non-allied target			Allied target			Differences in	
Variable	N	Mean	Median	N	Mean	Median	Mean	Median
Deal characteristics								
Value of transaction (mil.)	26848	139.57	22.17	2241	1635.82	138.23	1496.25***	116.06***
Equity value (mil.)	10600	216.38	30.47	1693	2388.75	212.21	2172.37***	181.73***
Cash value (mil.)	20391	95.85	18	1282	549.15	90	453.3***	72.00***
Stock value (mil.)	9793	143.44	16.25	1281	2077.24	141.80	1933.80***	125.55***
Earnout value (mil.)	1509	20.13	4.852	93	57.54	10	37.41***	5.15***
Horizontal merger	26848	0.45	0	2241	0.53	1	0.08***	1***
Cash	26568	0.55	1	2222	0.36	0	-0.19***	-1***
Common	26568	0.21	0	2222	0.37	0	0.16***	0***
Mix	26568	0.24	0	2222	0.27	0	0.03***	0***
Premium	8597	5.52	1.33	1602	9.70	2.25	4.18***	0.92***
Relative size	3603	0.45	0.172	679	0.57	0.24	0.12	0.07***
Earnout	26848	0.08	0	2241	0.05	0	-0.03***	0***
IB-advisor	26848	0.32	0	2241	0.72	1	0.4***	1***
Bubble	26848	0.13	0	2241	0.20	0	0.07***	0***
Firm characteristics								
Public target	26848	0.13	0	2241	0.57	1	0.44***	1***
Subsidiary target	26848	0.33	0	2241	0.10	0	-0.23***	0***
Private target	26848	0.55	1	2241	0.34	0	-0.21***	-1***
Target total assets (mil.)	6856	644.40	65.05	1495	4937.88	147.60	4293.48***	82.55***
Acquirer total assets (mil.)	14843	5553.24	178.30	1095	17405.04	203.80	11851.80***	25.50***
Target net assets (mil.)	6049	58.61	13.10	1309	132.13	51.50	73.52***	38.40***
Acquirer size (log value)	14755	4.95	5.20	1092	5.40	5.32	0.45***	0.12***
Target size (log value)	6821	3.98	4.19	1493	5.08	5.00	1.1***	0.81***
Tobin's Q	1104	0.98	0.59	815	1.83	1.06	0.85***	0.47***
Analyst coverage	1104	1.59	1.61	815	1.98	1.95	0.39***	0.34***
High tech target	26848	0.27	0	2241	0.71	1	0.44***	1***
Tech bubble	26848	0.06	0	2241	0.13	0	0.07***	0***
VC- backing	26848	0.07	0	2241	0.41	0	0.34***	0***

Panel B. Alliance Characteristics for Targets with Alliance Partners before Acquisitions

Variables	N	Mean	Min	Std.	Median	Max
Total alliances, 5 years	2241	2.468	1	3.554	1	71
Alliance duration (in days)	2241	763.287	1	460.244	716	1825
Partner acquisition	2241	0.080	0	0.278	0	1
Brokerage acquisition	2241	0.065	0	0.247	0	1
Alliance-acquisition align	2241	0.364	0	0.480	0	1
Public alliance partner	2241	0.477	0	0.500	0	1
Total alliances	2241	1.548	1	0.648	1	3
Alliance duration	2240	2.259	1	0.812	2	3
Public involved alliance	2241	0.823	0	0.382	1	1
Private only alliance	2241	0.171	0	0.377	0	1
Subsidiary only alliance	2241	0.023	0	0.151	0	1
Private involved alliance	2241	0.704	0	0.457	1	1
Subsidiary involved alliance	2241	0.339	0	0.473	0	1
Public only alliances	2241	0.383	0	0.486	0	1
Horizontal alliances	2241	0.583	0	0.493	1	1
Cross Tech Transfer	2241	0.188	0	0.391	0	1
Licensing agreement	2241	0.271	0	0.445	0	1
Manufacturing agreement	2241	0.149	0	0.357	0	1
Marketing agreement	2241	0.411	0	0.492	0	1
R&D alliance	2241	0.238	0	0.426	0	1
Supply agreements	2241	0.044	0	0.205	0	1
Exploration agreement	2241	0.014	0	0.119	0	1
Funding agreement	2241	0.014	0	0.117	0	1
Strategic alliance	2241	0.888	0	0.316	1	1
Joint venture	2241	0.188	0	0.391	0	1
JV only	2241	0.112	0	0.316	0	1

Table 1.2: Target Premiums by Target, Acquirer, Deal and Alliance Characteristics

The target premiums are defined as the transaction value to sales ratio (*Premium***)**, following Brau et al. (2010). The transaction value is the amount paid for the target firms, and the sales value is the targets sales in the year prior to the takeover announcement. *Allied targets* include those that make at least one alliance in 5 years preceding the acquisition announcements. The *unlisted targets* include both private targets and subsidiary targets. *Cash* indicates that the acquisition is paid predominantly by cash; *stock* indicates that the acquisition is paid predominantly by stock; and *mix* indicates that the acquisition is paid by some combination of cash and stock. *Target SDC high-tech industry* classification is constructed using SDC special high-tech classification codes following Kohers and Kohers (2001). *The public alliance partner* is defined as being public both as of alliance announcement dates (based on SDC alliance data) and as of acquisition announcement dates (based on Compustat and CRSP data). *Brokerage acquisition* is defined as the common alliance partner shared by the acquirers and targets. All other variables are defined in Appendix 1.A: Variable definitions. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A. Target premium by target, acquirers, and deal characteristics

	Non-allied Targets			Allied Targets			Differences in	
	N	Mean	Median	N	Mean	Median	Mean	Median
All	8598	5.51	1.33	1603	9.68	2.25	4.17***	0.92***
Public targets	3042	3.99	1.87	1249	7.68	2.21	3.70***	0.34***
IPO targets	494	5.45	2.40	312	13.44	3.78	7.98***	1.38***
Mature public targets	603	3.52	2.18	497	4.88	2.31	1.37*	0.13**
Private targets	3998	7.04	1.18	267	21.11	2.93	14.07***	1.74***
Subsidiary targets	1558	4.53	0.94	87	3.25	1.53	-1.28	0.59***
Unlisted targets	5556	6.34	1.10	354	16.72	2.49	10.38***	1.40***
High-tech targets	2652	10.38	1.58	1155	11.83	2.74	1.45	1.16***
Non-High-tech targets	5946	3.33	1.24	448	4.14	1.40	0.81	0.16
Horizontal-merger	4083	5.89	1.60	876	12.39	2.63	6.50***	1.03***
Non-Horizontal-merger	4515	5.16	1.15	727	6.42	1.91	1.26	0.76***

Method of payment	N	Mean	Median	N	Mean	Median	Mean	Median
Cash	3447	3.92	1.03	496	6.52	1.91	2.60***	0.88***
Stock	2445	8.57	2.04	643	15.20	2.77	6.63***	0.73***
Mixed	2632	4.78	1.23	451	5.48	2.08	0.70	0.85***

Panel B. Target premium by alliance duration and partner public status (within allied targets)

Alliance duration effects	N	Mean	Median
(1) Targets w/ alliances within 1 year	330	19.9	2.85
(2) Targets w/ alliances within 1-2 years	425	10.1	2.39
(3) Targets w/ alliances within 2-5 years	846	5.53	1.97
Diff (1-2)		9.82***	0.46**
Diff (2-3)		4.56***	0.42***
Diff (1-3)		14.40***	0.88***
Public alliance partner effect	N	Mean	Median
(1) Targets w/ other partners	806	9.91	2.07
(2) Targets w/ public partners	797	9.45	2.44
Diff (2-1)		-0.47	0.36**
	N	Mean	Median
(1) Public targets with other partners	609	6.87	2.00
(2) Public targets with public partners	640	8.46	2.39
Diff (2-1)		1.60	0.39**
	N	Mean	Median
(1) Other targets with other partners	1491	9.09	2.21
(2) Private targets with public partners	112	17.59	3.41
Diff (2-1)		8.50***	1.20***
	N	Mean	Median
(1) Subsidiary targets with other partners	42	3.36	1.54
(2) Subsidiary targets with public partners	45	3.16	1.53
Diff (2-1)		-0.20	-0.01

Panel C. Target premium by acquirer, target and partner relationships (within allied targets)

Partner acquisition effect	N	Mean	Median
(1) Non-partner acquisition	1490	9.48	2.23
(2) Partner acquisition	113	12.33	2.46
Diff (2-1)		2.85	0.23*
Brokerage acquisition effect	N	Mean	Median
(1) Acquirer & target do not share partners	1483	9.91	2.22
(2) Acquirer & target share partners	120	6.83	2.66
Diff (2-1)		-3.08*	0.45
Alliance alignment effect	N	Mean	Median
Non-horizontal alliances	659	6.70	1.87
Horizontal alliances	944	11.76	2.60
Diff (2-1)		5.05***	0.74***
Alliance-acquisition align	N	Mean	Median
Alliance-acquisition non-align	1007	6.67	1.92
Alliance-acquisition align	596	14.76	2.98
Diff (2-1)		8.08***	1.05***

Table 1.3: OLS Regressions of Target Premiums

The dependent variable is the ratio of the transaction value to the sales value (*Premium*). The sample includes all targets, except for *partner acquisitions* and *brokerage acquisitions*. *Partner acquisition* is defined as the acquisitions where acquirers acquire targets who were the acquirers' alliance partner prior to the acquisitions. *Brokerage acquisition* is defined as the acquisitions where acquirers and targets share common alliance partner. *Allied target* is an indicator variable which takes the value one if at least one alliance has been made between the target and another company in 5 years preceding the acquisition announcement, and zero otherwise. The *public alliance partner* is defined as alliance partners being public as of alliance announcement dates based on SDC alliance data) and as of acquisition announcement dates (based on Compustat and CRSP data). Industry fixed effects are based on Fama-French 12 industry classifications. All variables are defined in Appendix 1.A: Variable definitions. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Variables	(1) *premium*	(2) *premium*	(3) *premium*	(4) *premium*	(5) *premium*	(6) *premium*	(7) *premium*	(8) *premium*	(9) *premium*	(10) *premium*	(11) *premium*
Alliance duration	-6.12***	-5.76***	-3.20***	-1.67***	-6.18***	-6.16***	-2.63***	-0.84**	-0.45	-0.80**	-0.52
	(-7.17)	(-6.72)	(-5.06)	(-3.83)	(-7.23)	(-7.19)	(-4.45)	(-2.05)	(-1.19)	(-2.11)	(-1.43)
VC-backing	3.95***	3.95***	3.88***	4.22***	3.96***	3.97***	3.88***	4.11***	4.19***	4.08***	4.22***
	(4.66)	(4.67)	(4.56)	(4.98)	(4.68)	(4.69)	(4.56)	(4.83)	(4.93)	(4.80)	(4.96)
Private target	2.14***	1.35*	2.03***	2.07***	2.20***	2.20***	2.09***	2.01***	2.03***	2.04***	2.02***
	(2.80)	(1.72)	(2.66)	(2.71)	(2.88)	(2.89)	(2.73)	(2.62)	(2.64)	(2.66)	(2.64)
Stock	6.13***	6.11***	6.24***	6.27***	6.12***	6.14***	6.30***	6.37***	6.37***	6.35***	6.37***
	(8.33)	(8.30)	(8.46)	(8.50)	(8.32)	(8.35)	(8.54)	(8.62)	(8.62)	(8.60)	(8.63)
Mix	0.98	0.92	1.08	1.08	0.96	1.00	1.21*	1.14	1.11	1.13	1.10
	(1.33)	(1.26)	(1.47)	(1.47)	(1.31)	(1.36)	(1.65)	(1.56)	(1.52)	(1.54)	(1.50)
Target size	-2.04***	-2.00***	-2.09***	-2.00***	-2.02***	-2.00***	-1.98***	-2.00***	-1.98***	-1.98***	-1.99***
	(-11.29)	(-11.05)	(-11.46)	(-11.03)	(-11.17)	(-11.03)	(-10.96)	(-11.02)	(-10.92)	(-10.93)	(-10.96)
IB-Advisor	2.88***	2.83***	3.09***	3.06***	2.87***	2.88***	3.00***	3.08***	3.10***	3.08***	3.10***
	(3.67)	(3.61)	(3.93)	(3.89)	(3.66)	(3.68)	(3.81)	(3.92)	(3.94)	(3.91)	(3.93)
Horizontal merger	0.77	0.72	0.79	0.58	0.17		0.76	0.71	0.72	0.70	0.72
	(1.32)	(1.24)	(1.36)	(1.00)	(0.28)		(1.30)	(1.21)	(1.22)	(1.19)	(1.23)
Allied target	15.74***	13.51***			13.71***	13.56***					
	(7.33)	(6.14)			(6.14)	(6.07)					
Allied*private		10.73***									
		(4.63)									
Total alliances			4.85***								
			(5.30)								
Horizontal alliance				6.33***	0.80						
				(4.78)	(0.44)						
Alliance-acquisition align					5.24***						
					(2.71)						
Non-horizontal-ally						-5.47***					
						(-3.72)					
Diversifying						-5.18**					
						(-2.44)					
Non-horizontal-ally*diversify						5.93***					
						(2.63)					
Strategic alliance							7.33***				
							(4.67)				
Public alliance partner								2.67**			
								(2.04)			
R&D alliance									0.68		
									(0.41)		
Licensing agreement										3.89***	
										(2.58)	
Manufacturing agreement											2.17
											(1.19)
Constant	4.39	4.31	4.43	4.13	4.48	9.73	4.08	4.11	4.03	4.06	4.05
	(0.38)	(0.37)	(0.38)	(0.35)	(0.38)	(0.83)	(0.35)	(0.35)	(0.34)	(0.35)	(0.35)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100
Adjusted R^2	0.12	0.12	0.11	0.11	0.12	0.12	0.11	0.11	0.11	0.11	0.11

Table 1.4: Subsample Analyses for Public and Unlisted Targets

The dependent variable is the ratio of the transaction value to the sales value (*Premium*). *Partner acquisitions* and *brokerage acquisitions* are excluded from all the subsamples in this table. Models in Panel A include only the subsample of publicly traded targets. Models in Panel B include only *unlisted (i.e., private and subsidiary) targets*. Models in Panel C include only *IPO targets* defined as those being acquired within five years after publicly listed based on Compustat and CRSP database. Models in Panel D include mature public targets defined as those being acquired after publicly listed for more than five years. Tobin's Q is calculated following Chung and Pruitt (1994). Analyst coverage is the logarithm of one plus the number of analysts covering the targets within one year prior to the acquisitions. Industry fixed effects are based on Fama-French 12 industry classifications. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A. Public Targets

Variables	(1) *premium*	(2) *premium*	(3) *premium*	(4) *premium*	(5) *premium*	(6) *premium*	(7) *premium*	(8) *premium*	(9) *premium*
Alliance duration	-1.94**	-1.92***	-0.75*	-0.95	-0.59	-0.45	-0.53	-0.31	-0.25
	(-2.26)	(-3.00)	(-1.68)	(-1.62)	(-1.38)	(-1.12)	(-1.30)	(-0.80)	(-0.56)
VC-backing	-0.45	-0.61	-0.33	-0.50	-0.51	-0.43	-0.48	-0.45	-0.41
	(-0.45)	(-0.61)	(-0.33)	(-0.50)	(-0.51)	(-0.42)	(-0.47)	(-0.45)	(-0.40)
Tobin's Q	5.46***	5.42***	5.49***	5.48***	5.51***	5.54***	5.50***	5.54***	5.54***
	(18.80)	(18.68)	(19.02)	(18.82)	(19.07)	(19.22)	(19.03)	(19.21)	(19.20)
Analyst Coverage	-1.32*	-1.35*	-1.33*	-1.27*	-1.24*	-1.26*	-1.24*	-1.25*	-1.25*
	(-1.81)	(-1.86)	(-1.82)	(-1.74)	(-1.70)	(-1.73)	(-1.70)	(-1.71)	(-1.72)
Stock	0.48	0.49	0.39	0.56	0.59	0.50	0.54	0.57	0.56
	(0.43)	(0.44)	(0.35)	(0.50)	(0.52)	(0.44)	(0.48)	(0.51)	(0.50)
Mix	-1.15	-1.10	-1.21	-1.00	-1.04	-1.08	-1.03	-1.08	-1.10
	(-0.96)	(-0.92)	(-1.01)	(-0.84)	(-0.87)	(-0.90)	(-0.86)	(-0.90)	(-0.91)
Target size	-0.05	-0.16	-0.02	-0.04	-0.09	-0.06	-0.06	-0.05	-0.03
	(-0.15)	(-0.43)	(-0.04)	(-0.10)	(-0.24)	(-0.16)	(-0.15)	(-0.13)	(-0.09)
Horizontal merger	2.64***	2.74***	2.51***	2.64***	2.57***	2.61***	2.60***	2.62***	2.60***
	(3.14)	(3.26)	(2.97)	(3.13)	(3.05)	(3.10)	(3.09)	(3.11)	(3.09)
IB-Advisor	2.98	2.90	2.90	3.03	2.85	2.98	2.92	3.04	3.01
	(1.34)	(1.31)	(1.31)	(1.36)	(1.28)	(1.34)	(1.31)	(1.36)	(1.35)
Allied target	4.98**								
	(2.23)								
Total alliances		3.00***							
		(3.27)							
Horizontal alliance			2.96**						
			(2.19)						
Strategic alliance				2.58					
				(1.63)					
Public alliance partner					2.36*				
					(1.81)				
R&D alliance						2.58			
						(1.62)			
Licensing agreement							2.95**		
							(1.97)		
Cross tech transfer								1.45	
								(0.83)	
Marketing agreement									0.17
									(0.13)
Constant	-3.01	-1.95	-3.10	-3.60	-2.48	-2.97	-2.85	-3.32	-3.49
	(-0.39)	(-0.25)	(-0.40)	(-0.46)	(-0.32)	(-0.38)	(-0.36)	(-0.42)	(-0.45)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777	1,777
Adjusted R^2	0.29	0.30	0.29	0.29	0.29	0.29	0.29	0.29	0.29

Panel B. Unlisted Targets

The allied unlisted targets sample and non-allied unlisted targets control group are formed using the matched-sample method. For each allied unlisted target, I match it with on average around five non-allied targets based on size (75% to 125% of the size of the allied unlisted targets), industry (based on four-digit SIC code), VC-backing status, high-tech status, and in the vicinity of 5 years around the acquisition announcement of allied unlisted target.

Variables	(1) *premium*	(2) *premium*	(3) *premium*	(4) *premium*	(5) *premium*	(6) *premium*	(7) *premium*	(8) *premium*	(9) *premium*	(10) *premium*	(11) *premium*
Alliance duration	-13.77***	-13.97***	-6.45**	-3.41*	-7.33**	-1.36	-0.43	-0.76	-0.24	-0.62	-0.45
	(-3.89)	(-3.95)	(-2.43)	(-1.70)	(-2.44)	(-0.76)	(-0.28)	(-0.48)	(-0.15)	(-0.41)	(-0.26)
VC-backing	9.29***	9.48***	9.18***	9.84***	9.02***	9.22***	9.30***	9.21***	9.45***	9.28***	9.29***
	(2.73)	(2.79)	(2.68)	(2.86)	(2.63)	(2.68)	(2.70)	(2.67)	(2.74)	(2.69)	(2.70)
Stock	12.40***	12.47***	13.09***	13.69***	12.93***	13.37***	13.66***	13.58***	13.74***	13.58***	13.60***
	(3.33)	(3.35)	(3.50)	(3.65)	(3.45)	(3.55)	(3.63)	(3.61)	(3.65)	(3.62)	(3.62)
Mix	0.39	0.37	0.96	1.23	0.90	1.08	1.01	1.04	1.04	1.08	1.07
	(0.13)	(0.12)	(0.31)	(0.40)	(0.29)	(0.35)	(0.33)	(0.34)	(0.34)	(0.35)	(0.35)
Target size	-1.96**	-1.99**	-2.30**	-2.16**	-1.85*	-2.14**	-2.12**	-2.11**	-2.17**	-2.11**	-2.11**
	(-2.00)	(-2.04)	(-2.34)	(-2.19)	(-1.87)	(-2.17)	(-2.15)	(-2.14)	(-2.19)	(-2.14)	(-2.14)
IB-advisor	1.36	1.42	2.46	2.71	1.92	2.64	2.68	2.67	2.76	2.63	2.65
	(0.46)	(0.48)	(0.83)	(0.91)	(0.64)	(0.88)	(0.89)	(0.89)	(0.92)	(0.88)	(0.88)
Horizontal merger	2.34		2.53	1.99	2.08	2.54	2.47	2.47	2.52	2.48	2.46
	(0.86)		(0.92)	(0.72)	(0.76)	(0.92)	(0.90)	(0.90)	(0.92)	(0.90)	(0.90)
Allied target	33.87***	36.25***									
	(4.08)	(4.20)									
Allied*diversifying		-6.33									
		(-0.89)									
Diversifying		-1.21									
		(-0.36)									
Total alliances			10.23***								
			(2.63)								
Horizontal alliance				11.74**							
				(2.04)							
Strategic alliance					18.61**						
					(2.55)						
Public alliance partner						4.03					
						(0.73)					
R&D alliance							-2.68				
							(-0.33)				
Licensing agreement								1.81			
								(0.24)			
Cross tech transfer									-5.09		
									(-0.68)		
Manufacturing agreement										0.30	
										(0.03)	
Marketing agreement											-0.96
											(-0.16)
Constant	12.74	14.73	13.01	12.14	13.15	12.00	11.50	11.35	11.18	11.27	11.12
	(0.94)	(1.08)	(0.95)	(0.89)	(0.96)	(0.88)	(0.84)	(0.83)	(0.82)	(0.82)	(0.81)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	828	828	828	828	828	828	828	828	828	828	828
Adjusted R^2	0.10	0.10	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08

Panel C. IPO Targets

Variables	(1) *premium*	(2) *premium*	(3) *premium*	(4) *premium*	(5) *premium*	(6) *premium*	(7) *premium*	(8) *premium*	(9) *premium*
Alliance duration	-5.66***	-3.79***	-1.90*	-3.53***	-1.63*	-0.90	-0.77	-0.91	-0.92
	(-3.40)	(-2.81)	(-1.86)	(-2.71)	(-1.74)	(-0.98)	(-0.85)	(-1.01)	(-0.96)
VC-backing	-0.12	-0.25	0.00	-0.30	-0.42	-0.09	-0.62	-0.08	-0.51
	(-0.06)	(-0.13)	(0.00)	(-0.16)	(-0.21)	(-0.05)	(-0.32)	(-0.04)	(-0.27)
Tobin's Q	5.32***	5.34***	5.50***	5.36***	5.52***	5.58***	5.55***	5.57***	5.57***
	(11.15)	(11.13)	(11.56)	(11.19)	(11.61)	(11.74)	(11.82)	(11.71)	(11.92)
Analyst Coverage	-2.68*	-2.50*	-2.64*	-2.60*	-2.47*	-2.61*	-2.60*	-2.62*	-2.69*
	(-1.81)	(-1.68)	(-1.77)	(-1.75)	(-1.65)	(-1.74)	(-1.77)	(-1.75)	(-1.83)
Stock	-0.22	-0.14	-0.12	-0.02	0.27	0.16	0.83	0.17	0.74
	(-0.10)	(-0.06)	(-0.05)	(-0.01)	(0.12)	(0.07)	(0.39)	(0.08)	(0.35)
Mix	-4.36*	-3.87	-4.23*	-3.45	-3.62	-3.87	-2.12	-3.87	-2.16
	(-1.73)	(-1.54)	(-1.67)	(-1.37)	(-1.43)	(-1.53)	(-0.85)	(-1.53)	(-0.86)
Target size	0.20	0.07	0.28	0.24	0.24	0.31	0.36	0.31	0.32
	(0.26)	(0.09)	(0.35)	(0.31)	(0.30)	(0.40)	(0.47)	(0.39)	(0.41)
Horizontal merger	3.27*	3.10*	2.93*	3.09*	2.93*	3.14*	3.16*	3.14*	3.17*
	(1.87)	(1.77)	(1.66)	(1.77)	(1.66)	(1.79)	(1.83)	(1.78)	(1.84)
IB-Advisor	4.48	4.48	4.68	4.65	4.39	4.79	4.28	4.83	4.39
	(1.12)	(1.12)	(1.17)	(1.16)	(1.09)	(1.19)	(1.10)	(1.20)	(1.13)
Allied target	13.14***								
	(3.34)								
Total alliances		4.55***							
		(2.77)							
Horizontal alliance			4.85*						
			(1.78)						
Strategic alliance				8.61***					
				(2.67)					
Public alliance partner					4.67*				
					(1.79)				
R&D alliance						0.57			
						(0.18)			
Licensing agreement							2.66		
							(0.90)		
Cross tech transfer								0.76	
								(0.23)	
Marketing agreement									2.87
									(1.03)
Constant	-0.99	0.96	-0.95	-2.94	-1.43	-3.42	-4.43	-3.39	-3.79
	(-0.06)	(0.06)	(-0.06)	(-0.18)	(-0.09)	(-0.21)	(-0.28)	(-0.21)	(-0.24)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	797	797	797	797	797	797	778	797	778
Adjusted R^2	0.29	0.29	0.28	0.29	0.28	0.28	0.28	0.28	0.28

Panel D. Mature Public Targets

Variables	(1) *premium*	(2) *premium*	(3) *premium*	(4) *premium*	(5) *premium*	(6) *premium*	(7) *premium*	(8) *premium*	(9) *premium*
Alliance duration	0.76	-0.58	-0.20	0.39	-0.08	-0.19	-0.23	0.03	0.34
	(0.77)	(-0.83)	(-0.45)	(0.63)	(-0.17)	(-0.47)	(-0.54)	(0.06)	(0.74)
VC-backing	-0.54	-0.64	-0.46	-0.50	-0.55	-0.54	-0.66	-0.61	-0.46
	(-0.46)	(-0.54)	(-0.39)	(-0.42)	(-0.47)	(-0.47)	(-0.56)	(-0.52)	(-0.39)
Tobin's Q	5.24***	5.20***	5.20***	5.24***	5.19***	5.18***	5.16***	5.22***	5.22***
	(13.20)	(13.13)	(13.15)	(13.18)	(13.08)	(13.14)	(13.06)	(13.21)	(13.19)
Analyst Coverage	-0.20	-0.33	-0.33	-0.21	-0.24	-0.32	-0.25	-0.22	-0.22
	(-0.26)	(-0.42)	(-0.41)	(-0.27)	(-0.30)	(-0.40)	(-0.31)	(-0.28)	(-0.28)
Stock	-0.29	-0.23	-0.44	-0.33	-0.27	-0.45	-0.25	-0.26	-0.25
	(-0.22)	(-0.18)	(-0.34)	(-0.25)	(-0.21)	(-0.35)	(-0.20)	(-0.20)	(-0.19)
Mix	-1.41	-1.40	-1.45	-1.45	-1.37	-1.39	-1.35	-1.37	-1.35
	(-1.11)	(-1.11)	(-1.15)	(-1.14)	(-1.08)	(-1.10)	(-1.07)	(-1.08)	(-1.06)
Target size	-0.26	-0.33	-0.25	-0.27	-0.30	-0.32	-0.33	-0.31	-0.26
	(-0.63)	(-0.79)	(-0.59)	(-0.66)	(-0.73)	(-0.77)	(-0.81)	(-0.74)	(-0.63)
Horizontal merger	2.12**	2.23**	2.07**	2.11**	2.13**	2.13**	2.16**	2.16**	2.12**
	(2.38)	(2.50)	(2.32)	(2.37)	(2.39)	(2.39)	(2.43)	(2.42)	(2.37)
IB-Advisor	1.68	1.64	1.70	1.68	1.64	1.89	1.52	1.65	1.57
	(0.59)	(0.58)	(0.60)	(0.59)	(0.57)	(0.67)	(0.53)	(0.58)	(0.55)
Allied target	-1.89								
	(-0.71)								
Total alliances		1.33							
		(1.23)							
Horizontal alliance			2.12						
			(1.46)						
Strategic alliance				-0.97					
				(-0.56)					
Public alliance partner					1.31				
					(0.95)				
R&D alliance						4.52***			
						(2.70)			
Licensing agreement							3.87**		
							(2.44)		
Cross tech transfer								1.84	
								(1.01)	
Marketing agreement									-1.34
									(-0.94)
Constant	-1.74	-1.16	-1.86	-1.52	-1.08	-0.89	-0.59	-1.26	-1.36
	(-0.22)	(-0.14)	(-0.23)	(-0.19)	(-0.13)	(-0.11)	(-0.07)	(-0.16)	(-0.17)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,019	1,019	1,019	1,019	1,019	1,019	1,019	1,019	1,019
Adjusted R^2	0.19	0.20	0.20	0.19	0.20	0.20	0.20	0.20	0.20

Table 1.5: IPO Valuation Regressions

The dependent variable, *Log(IPO market cap.) or imcapd*, is the logarithm of the IPO's market capitalization at the end of its first day trading. All other variables are defined in Appendix 1.A: Variable definitions. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Variables	(1) *imcapd*	(2) *imcapd*	(3) *imcapd*	(4) *imcapd*	(5) *imcapd*	(6) *imcapd*	(7) *imcapd*	(8) *imcapd*	(9) *imcapd*	(10) *imcapd*
VC-backing	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.06***	0.05***	0.06***	0.06***
	(3.69)	(3.79)	(3.91)	(3.76)	(3.89)	(3.99)	(4.02)	(3.98)	(4.03)	(4.03)
Offer price	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(2.83)	(2.85)	(2.77)	(2.88)	(2.66)	(2.74)	(2.79)	(2.81)	(2.75)	(2.76)
Log (proceeds)	0.92***	0.92***	0.93***	0.92***	0.92***	0.93***	0.93***	0.92***	0.93***	0.93***
	(81.68)	(81.69)	(81.89)	(81.95)	(81.88)	(81.90)	(81.87)	(81.83)	(81.83)	(81.89)
Share overhang	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***	0.18***
	(68.93)	(68.79)	(68.91)	(68.92)	(69.08)	(69.08)	(69.17)	(69.21)	(69.18)	(69.16)
Alliance duration	-0.02	-0.01	0.01	-0.01	0.01*	0.02**	0.02***	0.02**	0.02***	0.02**
	(-1.14)	(-0.59)	(1.53)	(-0.72)	(1.71)	(2.07)	(2.64)	(2.40)	(3.20)	(2.10)
Underpricing	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***	0.15***
	(15.84)	(15.82)	(15.81)	(15.80)	(15.87)	(15.96)	(15.93)	(15.91)	(15.95)	(15.96)
Partial adjustment	0.35***	0.35***	0.35***	0.35***	0.35***	0.36***	0.35***	0.36***	0.36***	0.35***
	(11.46)	(11.40)	(11.51)	(11.38)	(11.51)	(11.60)	(11.49)	(11.55)	(11.57)	(11.44)
Top tier underwriter	0.06***	0.06***	0.06***	0.05***	0.06***	0.06***	0.06***	0.06***	0.06***	0.06***
	(3.72)	(3.68)	(3.73)	(3.61)	(3.73)	(3.69)	(3.71)	(3.74)	(3.77)	(3.69)
Market return	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.06	0.05	0.05
	(0.35)	(0.39)	(0.39)	(0.38)	(0.41)	(0.44)	(0.36)	(0.42)	(0.38)	(0.40)
Log (Age)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(-1.27)	(-1.32)	(-1.45)	(-1.30)	(-1.48)	(-1.50)	(-1.52)	(-1.47)	(-1.52)	(-1.51)
Hot IPO market	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(3.22)	(3.29)	(3.31)	(3.29)	(3.33)	(3.29)	(3.32)	(3.36)	(3.32)	(3.31)
Biotech	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.03
	(1.07)	(1.21)	(1.43)	(1.17)	(1.34)	(0.94)	(1.47)	(1.29)	(1.48)	(1.38)
Computer equipment	0.09***	0.08***	0.09***	0.08***	0.09***	0.09***	0.09***	0.09***	0.09***	0.09***
	(4.62)	(4.45)	(4.74)	(4.29)	(4.76)	(4.93)	(4.93)	(4.96)	(5.08)	(4.73)
Electronics	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	(0.93)	(0.93)	(1.04)	(0.93)	(0.93)	(0.92)	(1.00)	(0.95)	(1.01)	(0.93)
Communications	-0.03	-0.03	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
	(-1.41)	(-1.35)	(-1.14)	(-1.38)	(-1.18)	(-1.02)	(-1.11)	(-1.03)	(-1.06)	(-1.13)
Other high-tech	0.07	0.08	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.09
	(0.75)	(0.81)	(0.90)	(0.79)	(0.89)	(0.83)	(0.87)	(0.84)	(0.87)	(0.87)
Allied IPO	0.10***									
	(3.38)									
Log(Total alliances)		0.08***								
		(3.46)								
Log(Horizontal alliances)			0.05**							
			(2.27)							
Log(Strategic alliances)				0.09***						
				(4.01)						
Log(Public alliances)					0.05**					
					(2.26)					
Log(R&D alliances)						0.05**				
						(2.02)				
Log(Cross tech transfers)							0.05			
							(1.61)			
Log(Licensing agreements)								0.04*		
								(1.72)		
Log(Manufacturing agreements)									-0.00	
									(-0.07)	
Log(Marketing agreements)										0.05*
										(1.90)
Constant	7.74***	7.78***	7.74***	7.74***	7.74***	7.74***	7.74***	7.74***	7.74***	7.74***
	(166.08)	(65.18)	(165.85)	(166.26)	(165.84)	(165.77)	(165.76)	(165.76)	(165.65)	(165.77)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,427	663	2,427	2,427	2,427	2,427	2,427	2,427	2,427	2,427
Adjusted R^2	0.95	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Table 1.6: Logistic Regressions of Choice on IPO vs. Acquisition

The dependent variable (*ipo*) is one if the firm goes public and zero if the firm is acquired. All variables are defined in Appendix 1.A: Variable definitions. Industry fixed effects are based on Fama-French 12 industry classifications. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Variables	(1) *ipo*	(2) *ipo*	(3) *ipo*	(4) *ipo*	(5) *ipo*	(6) *ipo*	(7) *ipo*	(8) *ipo*	(9) *ipo*	(10) *ipo*
Alliance duration	-0.62***	-0.10	0.17**	0.14**	-0.36***	0.26***	0.26***	0.32***	0.25***	0.33***
	(-5.37)	(-1.25)	(2.48)	(2.16)	(-3.54)	(4.42)	(4.38)	(5.84)	(4.03)	(6.10)
Log(Assets)	0.36***	0.35***	0.35***	0.35***	0.36***	0.35***	0.35***	0.35***	0.36***	0.36***
	(10.56)	(10.49)	(10.72)	(10.56)	(10.73)	(10.70)	(10.77)	(10.77)	(10.82)	(10.82)
Log (Age)	-0.10	-0.16*	-0.19**	-0.19**	-0.13	-0.20**	-0.20**	-0.20**	-0.20**	-0.20**
	(-1.21)	(-1.92)	(-2.31)	(-2.38)	(-1.55)	(-2.44)	(-2.46)	(-2.48)	(-2.44)	(-2.51)
Leverage	-0.81***	-0.80***	-0.81***	-0.81***	-0.82***	-0.80***	-0.80***	-0.81***	-0.81***	-0.81***
	(-5.53)	(-5.52)	(-5.60)	(-5.58)	(-5.61)	(-5.57)	(-5.58)	(-5.60)	(-5.58)	(-5.61)
Market return	-0.99	-0.92	-0.93	-0.79	-0.98	-0.73	-0.81	-0.76	-0.75	-0.77
	(-1.39)	(-1.33)	(-1.35)	(-1.15)	(-1.40)	(-1.05)	(-1.18)	(-1.11)	(-1.09)	(-1.12)
Industry M/B	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05*	0.05*	0.04*
	(1.25)	(1.44)	(1.50)	(1.56)	(1.41)	(1.62)	(1.61)	(1.70)	(1.67)	(1.65)
Industry return	0.64**	0.63**	0.65**	0.60**	0.65**	0.57*	0.62**	0.59**	0.60**	0.59*
	(2.04)	(2.05)	(2.15)	(1.98)	(2.10)	(1.90)	(2.06)	(1.97)	(1.99)	(1.96)
Industry DER	0.12	0.12	0.06	0.10	0.15	0.11	0.10	0.09	0.11	0.09
	(0.61)	(0.62)	(0.31)	(0.48)	(0.73)	(0.56)	(0.49)	(0.46)	(0.55)	(0.45)
Industry NPM	-0.00	-0.00	-0.00	-0.00	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00
	(-0.35)	(-0.14)	(-0.03)	(-0.18)	(-0.41)	(-0.30)	(-0.22)	(-0.20)	(-0.29)	(-0.16)
Industry ROA	0.20**	0.17*	0.18*	0.17*	0.19**	0.15	0.16*	0.15	0.16*	0.16*
	(2.03)	(1.76)	(1.89)	(1.76)	(1.97)	(1.63)	(1.70)	(1.62)	(1.67)	(1.67)
Industry RDS	-0.01	0.00	0.01	0.01	-0.01	-0.00	0.00	0.01	0.00	0.01
	(-0.21)	(0.12)	(0.24)	(0.18)	(-0.18)	(-0.12)	(0.10)	(0.16)	(0.08)	(0.22)
Allied firm	2.43***									
	(9.24)									
Total alliances		0.68***								
		(6.69)								
Horizontal alliance			0.66***							
			(3.86)							
Public alliance partner				0.88***						
				(5.26)						
Strategic alliance					1.84***					
					(7.85)					
R&D alliance						0.54***				
						(2.71)				
Licensing agreement							0.60***			
							(3.04)			
Manufacturing agreement								0.42		
								(1.38)		
Marketing agreement									0.53***	
									(2.92)	
Supply agreement										0.22
										(0.53)
Constant	-0.81	-0.78	-0.73	-0.75	-0.81	-0.74	-0.70	-0.74	-0.73	-0.73
	(-0.97)	(-0.93)	(-0.86)	(-0.90)	(-0.96)	(-0.87)	(-0.84)	(-0.88)	(-0.87)	(-0.87)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,362	2,362	2,362	2,362	2,362	2,362	2,362	2,362	2,362	2,362
Pseudo R^2	0.299	0.288	0.274	0.279	0.290	0.272	0.273	0.270	0.272	0.270
Log Likelihood	-1098	-1115	-1137	-1130	-1112	-1140	-1139	-1143	-1140	-1144

Table 1.7: Hazard Rate Analysis of Time to IPO vs. Time to Acquisition

The dependent variable is the hazard rate of an unlisted firm going public in a given year after it is founded. The firm's founding date is from SDC VentureXpert database. Following the sampling procedure in Ozmel et al. (2013), I include only venture-backed firms in the tests to minimize the scope for heterogeneity in firm quality. Robust standard errors are in parentheses. All variables are defined in Appendix 1.A: Variable definitions. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Variables	(1) *hr_iva*	(2) *hr_iva*	(3) *hr_iva*	(4) *hr_iva*	(5) *hr_iva*	(6) *hr_iva*	(7) *hr_iva*	(8) *hr_iva*	(9) *hr_iva*	(10) *hr_iva*	(11) *hr_iva*
Allied firm	2.101***	4.261***									
	(0.123)	(0.513)									
Alliance duration		0.646***	0.801***	1.074**	1.027	0.977	1.072**	1.082***	1.126***	1.113***	1.096***
		(0.036)	(0.038)	(0.035)	(0.034)	(0.043)	(0.032)	(0.031)	(0.031)	(0.030)	(0.033)
High tech firm		1.434***	1.459***	1.556***	1.549***	1.538***	1.546***	1.569***	1.566***	1.563***	1.558***
		(0.108)	(0.110)	(0.115)	(0.114)	(0.115)	(0.114)	(0.116)	(0.115)	(0.114)	(0.114)
Bubble		1.190*	1.232**	1.246**	1.225**	1.235**	1.280***	1.250**	1.261**	1.258**	1.254**
		(0.111)	(0.112)	(0.113)	(0.112)	(0.113)	(0.117)	(0.114)	(0.114)	(0.114)	(0.114)
Log(Assets)		1.172***	1.172***	1.182***	1.179***	1.180***	1.180***	1.182***	1.184***	1.183***	1.184***
		(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Leverage		0.753***	0.752***	0.743***	0.745***	0.744***	0.744***	0.742***	0.739***	0.739***	0.740***
		(0.027)	(0.025)	(0.025)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
Market return		0.884	0.924	1.047	1.020	0.991	1.026	1.056	1.065	1.069	1.069
		(0.269)	(0.283)	(0.319)	(0.312)	(0.304)	(0.314)	(0.323)	(0.324)	(0.325)	(0.326)
Industry M/B		1.030***	1.035***	1.036***	1.035***	1.036***	1.036***	1.036***	1.038***	1.038***	1.037***
		(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Industry return		1.256	1.229	1.164	1.181	1.183	1.197	1.172	1.166	1.172	1.168
		(0.175)	(0.173)	(0.165)	(0.166)	(0.168)	(0.169)	(0.166)	(0.164)	(0.165)	(0.165)
Industry DER		1.080*	1.074*	1.053	1.062	1.058	1.059	1.055	1.048	1.050	1.053
		(0.046)	(0.047)	(0.046)	(0.047)	(0.047)	(0.046)	(0.046)	(0.047)	(0.047)	(0.047)
Industry NPM		1.023***	1.025***	1.026***	1.026***	1.026***	1.025***	1.026***	1.026***	1.026***	1.025***
		(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Industry ROA		1.710***	1.695***	1.742***	1.698***	1.723***	1.678***	1.705***	1.723***	1.713***	1.713***
		(0.141)	(0.139)	(0.147)	(0.137)	(0.143)	(0.135)	(0.138)	(0.141)	(0.139)	(0.140)
Industry RDS		1.082***	1.090***	1.095***	1.094***	1.095***	1.084***	1.090***	1.093***	1.092***	1.093***
		(0.018)	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Log(Total alliances)			2.478***								
			(0.231)								
Log(Horizontal alliances)				1.212**							
				(0.114)							
Log(Public alliances)					1.551***						
					(0.151)						
Log(Strategic alliances)						1.417***					
						(0.132)					
Log(R&D alliances)							1.377***				
							(0.148)				
Log(Licensing agreements)								1.331**			
								(0.157)			
Log(Cross tech transfers)									0.962		
									(0.137)		
Log(Manufacturing agreements)										1.260	
										(0.220)	
Log(Marketing agreements)											1.158
											(0.120)
N	2,888	2,801	2,801	2,801	2,801	2,801	2,801	2,801	2,801	2,801	2,801
χ^2	159.98	579.74	586.11	495.48	548.21	500.31	504.01	517.56	503.29	512.16	508.26
Prob. > χ^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Log Likelihood	-9057.41	-8514.76	-8536.99	-8575.70	-8567.89	-8569.97	-8573.42	-8574.25	-8578.17	-8577.42	-8577.05

FOR BETTER OR FOR WORSE:

THE SPILLOVER EFFECT OF INNOVATION EVENTS ON ALLIANCE PARTNERS

1. INTRODUCTION

The search for the source of innovations has triggered a prolific new stream of literature in finance. Innovations are not generated with one unified model. While many firms develop their innovations in house through their own R&D labs, other firms outsource innovative ideas externally by acquiring innovations or forming strategic alliance partners. Prior research has examined acquisitions of innovative firms and found mixed evidence regarding the impact of these acquisitions on the productivity of acquiring firms[12]. The role of strategic alliances, especially R&D alliances, has predominantly been associated with increasing innovative outputs, as measured by patent activity (see Sampson (2005) and Danzon et al. (2005)). While patent-related innovations can potentially be a source of value for shareholders, the direct link between patents and their financial wealth consequence is not clear. For example, for biotech firms, Pharmaceutical Research and Manufacturers of America, PhRMA, (2013) estimates the probability of a patented compound entering and making it through the drug discovery process to eventual FDA approval is as low as 0.01% (1 in 10,000). It takes an average of 10-15 years and costs an average of $1.2 billion to develop a new drug (DiMasi and Grabowski, 2007), and only two in ten FDA approved drugs generate revenues that exceed average R&D costs. Chandy et al. (2006) also document that some

[12] See, for example, Higgins and Rodriguez (2006); Atanassov, 2013; Seru (2013); and Sevilir and Tian, 2012, among others.

firms are significantly better at converting patented ideas into launched commercial products (drugs). Given the substantial risks and potential benefits associated with innovation, little is known about how investors of these innovative firms react to commercialized innovations. Furthermore, despite the growing recognition of strategic alliances as a source of value creation for partnering firms, the impact of breakthrough innovations on the shareholder wealth of alliance partners is not clear. This paper is the first attempt to provide systematic evidence on the stock market reactions on breakthrough innovations by firms with strategic alliance partners, and the spillover effect of innovations on their alliance partners. [13]

Another unsettled issue in strategic alliance research is the divisions of gains captured by different alliances partners. Based on shareholders returns at the alliance announcements, research has documented asymmetric value creation for different types of alliances and individual partner characteristics. For example, Chan et al. (1997) find that smaller strategic alliance partners have higher abnormal stock returns at the alliance announcements than larger alliance partners, albeit the dollar gains for two parties are similar. Moreover, their research finds that horizontal technological alliances receive larger abnormal returns than non-horizontal and non-technological alliances. On the other side, Das et al. (1998) and Kalaignanam et al. (2007) find asymmetric gains to the larger and smaller alliance partners. All the prior research along this line addresses the divisions of gains among alliance partners by examining the abnormal returns around alliance announcements. No research to date has attempted to investigate this important issue in another setting such as innovation announcements. This paper contributes to the current literature by providing evidence on the spillover gains to partners during major innovation announcements, and sheds new light on the issue of division of gains among alliance partners.

[13] Related to our paper is a case study by Huberman and Regev (2001), which provides a good illustrative example for our study. However, their paper focuses on contagious market speculation caused by a "non-event", instead of real innovation events.

To test the effects of innovation on firms and their alliance partners, I use a comprehensive data set from the Food and Drug Administration (FDA) website. I find economically and statistically significant gains for shareholders of pharmaceutical companies at the announcements of FDA drug approvals, consistent with Liu (2006) who examines stock market reactions to innovations news such as FDA approvals based on a sample of news reports during 1983-1993. The gains vary for different types of innovations-- from breakthrough innovations to incremental innovations. More importantly, I find direct stock market evidence that the shareholders of these innovative firms' strategic alliance partners also significantly benefit from spillovers effect of these innovations. Cross-sectional multivariate analyses further reveal that young and newly listed innovators generate larger stock market response. Innovators with more growth opportunities make innovation announcements that cause bigger spillover effects on young, newly listed partners with more growth opportunities. Furthermore, I explore the risks associated with these innovators and their alliance partners by examining the stock market reactions to the FDA regulatory actions on some of drugs that cause adverse reactions for some customers. I find significant wealth loss for shareholders of these pharmaceutical companies and their alliance partners when the FDA issues warning letters regarding some of the adverse drug events and drug withdrawals. The wealth loss to innovators and their alliance partners around these negative events highlights the risk associated with innovations and also lends further support to the important roles of strategic alliance partnerships in innovations.

Our findings specifically contribute to the current literature on innovations in the following ways. First, I test the value effects of innovation in a new setting by extending the concept beyond patent data to commercialized products. Second, I provide evidence that investors of innovative firms recognize the upside, as well as the dark side, of innovations in a sophisticated way, as shown by the different scales of abnormal returns around various types of innovation-related events. Third, our findings on the spillover effects of innovations on strategic alliance partners provide direct

evidence on the important role of strategic alliances on the R&D process of innovative firms. As such, I contribute to the literature on the external boundaries of firms in highly R&D intensive industries. Fourth, I shed light on an ongoing debate on asymmetric gains among alliance partners in a setting distinctive from prior research.

The remainder of the paper proceeds as follows. I discuss the relevant literature on innovations and strategic alliances and develop a few propositions in the next section. Section 3 explains the empirical settings and methods, and section 4 introduces the basic data sources and defines the main variables. Section 5 presents several sets of event study results on innovations and adverse events. I conduct tests for some conjectures regarding information leakage/anticipation and return reversal in Section 6, and cross-sectional multivariate analyses in Section 7. Section 8 concludes the paper.

2. PRIOR LITERATURE ON INNOVATIONS AND STRATEGIC ALLIANCES

Our paper relates and contributes to a few areas of the literature on innovations. The first and most closely related literature is on the market value of innovations. How do innovations create value for shareholders? Although theoretical work has established that innovation is a major driver of economic growth (Solow, 1957; Romer, 1987, 1990), there is limited evidence on the stock market value of innovations measured by patents. Some researchers find that the cross-sectional variation in firms' stock market value has little to do with firms' inventive endeavors measured by its R&D and patent output (Pakes, 1985). Furthermore, the economic value of some patents is extremely high, whereas many other patents are worth relatively little (Austin, 1993). Chan, Lakonishok, and Sougiannis (2001) find that "…evidence does not support a direct link between R&D spending and future stock returns." However, using Tobin's Q as a metric for shareholder

value, Hall, Jaffe, and Trajtenberg (2005) find that the ratios of R&D to assets, patents to R&D, and citations to patents, as well as the number of patents and patent citations positively affect firms' stock market valuations. Following this methodology, Hirshleifer et al. (2013) find that innovation efficiency, patents or citations scaled by R&D, predicts future market returns after controlling for firm characteristics and risk. Most of the research along this line examines the stock market valuation on innovations within a longer time framework. I attempt to make a contribution to research alone this line by providing some systematic evidence on investors' interpretation of innovation announcements using event study methodology in a relatively short-term framework.

The second stream of related literature is on the issue of external boundaries for firms conducting innovations. In the theoretical framework of incomplete contracts, Aghion and Tirole (1994) show that, due to the inefficiency of allocating property rights to the customers of innovations (big manufacturers who commercialize the innovations), it might be optimal for a firm to allocate property rights to the research unit and choose co-financing between the customers and investors. Taking the issue of firm boundaries to a slightly distinct framework, Rhodes-Kropf and Robinson (2008) propose that mergers and acquisitions (M&A) bring together firms with complementary assets and are more likely to enhance innovations. Subsequent empirical research, such as Higgins and Rodriguez (2006) and Sevilir and Tian (2012), documents that established firms can obtain valuable innovations and enhance firm value through M&A. However, from a corporate governance perspective, Atanassov (2013) document that antitakeover legislations stifle innovations. In a similar view, Seru (2013) shows that moral hazard problems stifle innovations in conglomerates. Thus, the effect of M&A on corporate innovations is still inconclusive and unsettled in the literature.

An alternative mechanism for more efficient corporate innovations is a collaborative partnership between two firms, such as strategic alliances and joint ventures. Instead of a simple one-shot transaction deal or a complete integration by acquisitions, alliance partnerships are set by

two or more parties to last for a few years to achieve a specific purpose. Alliances are widely used in many industries, especially in highly innovative and R&D-intensive industries (Robinson, 2008).

There is a robust literature on the value-enhancing benefits of this partnership arrangement. For example, McConnell and Nantell (1985), Chan, et al. (1997) find significant positive stock market abnormal returns for firms entering a joint ventures or strategic alliance partnerships. In a paper about block ownership by corporations and product market relationships, Allen and Phillips (2000) document that when there is a preexisting strategic alliance or other collaboration relationship between the purchasing and target firms, the target firms experience the largest increases in stock prices, investment, and profitability. More recently, Lindsey (2008) finds that strategic alliances among venture backed firms increase the chance of these firms' exit via either IPOs or acquisitions. Bodnaruk, Massa and Simonov (2013) argue that alliances improve corporate governance by enhancing firm operating flexibility and reducing agency costs related to free cash flows and capital allocation within the firm. Ozmel, Robinson, and Stuart (2013) show that strategic alliances for bio-tech startups provide an alternative source of funding to venture capital for these early stage high-tech firms.

On the impact of strategic alliances and innovations, there is some evidence that inter-firm alliances promote knowledge flows between alliance partners. For example, Sampson (2005) provides evidence on the significant value of strategic alliance experience on R&D output measured by patents. Also using patent data as proxies for knowledge flow, Gomes-Casseres et al. (2006) demonstrate that sharing technological knowledge happens more frequently between allied firms than two non-allied firms. Examining productivity in the biopharmaceutical industry, Danzon et al. (2005) find that products developed in alliances are more likely to be a commercial success, especially if one of the partners is a large firm.

This paper is also related to studies that investigate the stock market reactions to innovation events and alliance announcements. Using the short-term cumulative returns, a handful of papers have examined the market reactions to new product introductions (e.g., Chaney et al. 1991), good news in R&D (Liu, 2006), delays in new product introductions (Hendricks and Singhal, 1997), as well as product recalls (Jarrell and Peltzman, 1985) and drug withdrawals (Ahmed et al. 2002). Another related paper by Boone and Ivanov (2012) examines the spillover effect of corporate bankruptcy on strategic alliance partners and find that non-bankrupt partners experience a negative stock price reaction around their alliance partners' bankruptcy filing announcements. However, none of the prior research has looked at the spillover effect of breakthrough innovation on alliance partners (except for the case study by Huberman and Regev (2001)). Given the recent research on innovation based on NBER patent data, this paper provides an alternative perspective by investigating the market perception of both positive and negative innovation events using FDA data.

Furthermore, it is unclear in the current literature how the shareholder wealth gains are divided among the alliance partners. Based on shareholder returns at the alliance announcement, Chan et al. (1997) find that larger and smaller strategic alliance partners have quite different abnormal stock returns, although the dollar gains for two parties are similar. Yet other papers by Das et al. (1998) and Kalaignanam et al. (2007) find asymmetric gains to the larger and smaller alliance partners. Moreover, some research also suggests that different types of alliance partnerships are associated with various benefits for alliance partners and should have varying stock market valuations. Most prior research addressing the divisions of gains among alliance partners examine the abnormal returns at alliance announcements. Our paper takes a different perspective by investigating the spillover gains to partners at major innovation announcements.

3. EMPIRICAL SETTING

I set up our empirical tests in the U.S. pharmaceutical industry, which is one of the most highly research-intensive industries in the U.S. According a report by Congressional Budget Office (CBO), "...Pharmaceutical firms invest as much as five times more in research and development, relative to their sales, than the average U.S. manufacturing firm."[14] In 2012, it is estimated that PhRMA member companies invested $48.5 billion in biopharmaceutical R&D (PhRMA, 2013). A number of notable prior research papers have studied innovation related issues in this industry[15]. The most appealing characteristic of the pharmaceutical industry for the purpose of this study is that the FDA has a fairly comprehensive and carefully compiled documentation of the history of the innovative drug development. FDA is a government regulatory agency and its various announcements regarding the drug innovations and adverse events related to drugs have large impact on both the customers and the financial market investors. Thus, it provides a relatively clean lab for testing the value and risk of significant innovations.

Another very attractive feature of the pharmaceutical industry is that the FDA drug data make it possible to differentiate between incremental innovations, breakthrough innovations, and radical innovations in the sense of Chandy and Tellis (2000). An incremental innovation is one that makes only minor advancement on technology and minor improvement on customer benefit. A breakthrough innovation is a one that involves significant new scientific principles or elements that are substantially different from the existing innovations, or provide substantially greater customer

[14] in "*Research and Development in the Pharmaceutical Industry*." Washington, DC: CBO, October 2006. http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/76xx/doc7615/10-02-drugr-d.pdf.

[15] Just to name a few from a long list of recently published papers in the pharmaceutical industry setting: Huberman and Regev (2001), Acemoglu and Linn (2004), Nicholson, Danzon, and McCullough (2005), Higgins and Rodriguez (2006), Gomes-Casseres, Jaffe, and Hagedoorn (2006), Lerner and Malmendier (2010), and Ozmel, Robinson, and Stuart (2013).

benefits than existing products. A radical innovation is an innovation that is a substantial technology breakthrough and a significant market breakthrough.

In this paper, I define the FDA approval for Abbreviated New Drug Application (ANDA) as an incremental innovation. An ANDA is an application for FDA approval of a generic drug product, which is similar to the brand name drug in its biochemical ingredients and treatment effect,, but costs much less than the brand name drug for the customers. A FDA approval for New Drug Application (NDA) is defined as a breakthrough innovation. In a NDA application, the companies sponsoring the drug innovation submit their clinical trial data to the FDA for review. As Appendix 2.B shows, there are seven chemical types for these NDAs; except for the first chemical type (New Molecular Entity), all the other chemical types are defined as breakthrough innovations[16]. A small portion of these NDAs are Biologic License Application (BLA) for FDA licenses of some Biological products. I define two types of FDA approvals as radical innovations, FDA approvals for New Molecular Entity (NME), which is an active ingredient that has never before been marketed in the U.S. in any form; and FDA approvals for orphan drugs, which are drugs and biologics "…intended for the safe and effective treatment, diagnosis or prevention of rare diseases/disorders that affect fewer than 200,000 people in the U.S."[17] These two types of FDA approvals are defined as radical innovations for two main reasons along the definitions of radical innovations. First, they are proved by the FDA agency and a wider scientific community as technology breakthroughs in finding safe and effective medical treatments for some commonly known difficult diseases such as various types of cancers, diabetes, AIDS, and Alzheimer's Disease, etc. Secondly, these two types of FDA approvals for manufacturing and marketing usually bring large amount of revenues for the innovating firms. According to the drug.com website, about sixty drugs have a yearly sales value

[16] These six chemical types include: 1- New ester, new salt, or other noncovalent derivative; 2 - New formulation; 3 - New combination; 4 - New manufacturer; 5 - New indication (Beginning in 1994, Type 6 NDAs were tracked as efficacy supplements); 6 - Drug already marketed, but without an approved NDA. See Appendix 2.B for more details.
[17] See FDA website: http://www.fda.gov/ForIndustry/DevelopingProductsforRareDiseasesConditions/default.htm.

above 1 billion[18]. For the orphan drugs, even though the market size is relatively small[19], the revenues from these drugs are quite substantial. Over 50%, sometimes over 70%, of leading biotech-pharmaceutical companies' revenues comes from orphan drugs (Lazonick and Tulum, 2011).

Not all innovations related news is good news. Sometimes the FDA approved drugs cause adverse drug reactions or even deaths for customers, and the FDA responds to these kinds of reports by issuing warning letters to the relevant pharmaceutical companies that manufacture or market these drugs. A small percentage of these warning letters result in the eventual withdrawals of these drugs. I examine the stock market reactions for these two types of adverse events related to pharmaceutical companies and their alliance partners.

4. DATA AND METHODS

4.1. Innovation sample

The main samples of FDA approvals are from the FDA website, cross-checked with news reports about FDA approvals from the *Wall Street Journal*, *New York Times, PR Newswire, Business Wire, The Associated Press, and Pharmaceutical Newsletter*, etc. I keep all approvals sponsored by U.S. public pharmaceutical firms that have data on the Center for Research in Security Prices (CRSP). The time periods for different innovation samples vary slightly due to the data availability of these different FDA approvals. More specifically, FDA Orphan Drug (OD) approvals are from the FDA Orphan Drug Product designation database from 1983 to 2013. Fewer than ten orphan drugs are developed by the industry in almost a decade between 1973 and 1983. After the enactment of the Orphan Drug

[18] See http://www.drugs.com/stats/top100/2012/sales.

[19] Not small in absolute sense: about 7000 rare diseases are afflicting a total of 25 million Americans (1 in 12 of the total population), according to the 2005 report by Genetic and Rare Disease Center of the NIH. The average annual cost of Amgen's Epogen and Neupogen (for anemia) is $5000 to $20,000; Genentech's Rituxan (for rheumatoid arthritis), $15,000–20,000; Genzyme's Cerezyme (for Gaucher's disease), 150,000–225,000 (Lazonick and Tulum 2011).

Act of 1983, about 400 orphan drugs have been developed by pharmaceutical companies. The NME innovators are all U.S. pharmaceutical companies that received FDA NME drug approvals from 1980 to 2013. The time period from 1980 to 1990 has fewer strategic alliances because the number of strategic alliance partnerships starts really to grow at a much faster rate since the 1990s. This explains the reason that fewer than half of companies with innovation announcements have alliance partners. For FDA NME approvals, I also search news reports for approvals and employ major news report dates for FDA approvals as a robustness check. The breakthrough innovation sample includes all FDA Original New Drug Approvals (NDAs and BLAs) from 1990 to 2013[20]. Table 2.1 summarizes the number of NDA applications and FDA approvals, as wells as NME approvals by year. Overall, about 71.64% of the NDA applications are approved, and about 28.28% of NDA approvals are NME approvals. The applications and approvals seem to follow a quite even path over the years, with no apparent peak in any single year.

4.2. Alliances sample

The Strategic Alliances and Joint Venture section of the Thomson Financial Securities Data Company (SDC) database is the source for our original alliance sample. I keep strategic alliances and joint ventures with all alliance partners being domestic firms. The alliance sample is merged with the various innovation samples , to get alliance characteristics of these innovator firms. Based on the previous research (Chan et al., 1997), I infer that alliances formed within five years and above five years are likely to result in different spillover effects. Therefore, I define alliances formed within five years as short-term alliances and those formed above five years as long-term alliances.

I also examine the effect of alliance characteristics by differentiating alliance types such as *horizontal alliances, strategic alliances, joint ventures, research and development agreements, licensing agreements, and*

[20] See Appendix 2.A and 2.B for the distributions of NDAs and definitions of other FDA terms.

manufacturing agreements. Specifically, *strategic alliances* are collaborative agreements for some common goals among two or more distinctive firms whereas *join ventures* involve creating an independent legal entity that operating separately from original cooperative partners. *Horizontal alliance* is defined as alliance where two partners have same three-digit SIC code, *R&D Alliances* indicates that the pharmaceutical firm has a research and development agreement with the partners. Likewise, *licensing alliances* indicates that the pharmaceutical firm has a licensing agreement with the partners. *Manufacturing agreements* indicates that the pharmaceutical firm has a manufacturing agreement with the partners.

4.3. Event study method

Following Brown and Warner's (1985) standard event study methodology, I measure stock market abnormal returns as cumulative abnormal returns (CARs) for the eleven-day period (-5, +5), five-day period (-2, +2), and three-day period (-1, +1) around the announcement dates. The abnormal return for security i on day t (AR_{it}) is the actual return, R_{it} , less the security's expected return, $(\hat{\alpha}_i + \hat{\beta}_i R_{mt})$,

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt}) ,$$

where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are constant and coefficient obtained from the Ordinary Least Square regression of security returns on market returns during the estimation period, and R_{mt} is the return on the market index for day t. The CRSP value-weighted market index return is estimated over the days -50 to -200, where day zero denotes the day on which FDA approval or other news is declared.

5. THE VALUE OF INNOVATIONS AND SPILLOVER ON ALLIANCE PARTNERS

In this section, I examine the wealth effects of innovation announcements as well as the spillover effect on alliance partners for the following types of innovations: radical innovations (FDA orphan drug and NME drug approvals), breakthrough innovations (NDA and BLA approvals), and incremental innovations (ANDA approvals). I also examine the wealth effects of negative innovation-related announcements, i.e., FDA warning letters and NME drug withdrawals, for announcing firms and their alliance partners.

5.1. Wealth effect on strategic alliance announcements

As a prelude to the innovation spillover effect on alliance partners, I first examine the abnormal returns around alliance partnership announcements to show that how investors gauge the value-enhancing effect of various collaborative agreements among pharmaceutical companies and their partners. Table 2.2 shows the stock market reactions on alliance announcements on three event windows: (-5, +5), (-2, +2), (-1, +1). I focus on the three day event window in this section, since almost all of the event windows display similar patterns. The mean initial alliance announcement abnormal return is 1.87% for the whole sample, 1.90% for strategic alliances, and 1.50% for joint ventures. This result is higher than the abnormal returns in Boone and Ivanov (2012), but is consistent with the announcement returns for subsample of high-tech alliances (Chan et al. 1997). The three-day mean CAR for long-term strategic alliance announcements, although positive, is not statistically significant, possibly due to the market's uncertainty about the value of strategic alliances formed in the earlier years of the sample. Given that alliances really started to grow exponentially after the 1980's, the market may have taken a while to recognize the value-increasing role of alliance

partnerships. This result that short-term alliances with eventual duration greater than five years have higher announcement returns is consistent with Boone and Ivanov (2012) who use four years as a cut off point for long term and short term distinction. For other types of alliances, horizontal alliances fare a little better than the overall sample, which confirms that the market perceives alliances formed in the same industry have higher potential value for partnering firms. Manufacturing alliances also have slightly higher announcement returns (2.45%), whereas R&D alliances have the highest abnormal return (2.80%) among all types of alliances. As I will see in later sections, the alliance announcement returns indeed have some degree of predictability for the spillover effects of innovations on alliance partners.

5.2. Wealth effect and spillover on alliance partners around radical innovations

In this section, I start to examine the announcement returns of radical innovations, defined as the FDA orphan drug approvals and NME drug approvals. Panel A of Table 2.3 shows the results for the wealth effect of FDA orphan drug approvals and the spillover effect on alliance partners. The overall sample of orphan drug innovators gains an abnormal return of 2.81% in a three day event window, statistically significant at the 1% level. If I use the average market capitalization ($10,782 million) of the pharmaceutical companies as Nicholson et al. (2005) calculated for a sample of 421 publicly traded firms between 1991 and 2000, the 2.81% gain translates into $302 million dollar wealth creation. The orphan drug innovators with strategic alliance partners have a slightly lower average abnormal return of 2.39%, which possibly indicates that the investors are sophisticated enough to know that these radical innovations are not accomplished solely by these innovators and attribute some of the wealth to their alliance partners. Indeed, the strategic alliance partners of the innovators also experience positive stock market reactions for different types of alliances, although the significant announcement returns appear mainly in a wider

event window and are relatively smaller than the CARs for the innovators. More specifically, the average spillover effect on strategic alliance partners of orphan drug innovators is 1.79% in the five-day event window, which is statistically significant at a 5% level, translating into a $193 million wealth gain. The shorter three-day event window also have a positive return of 1.56%, although not statistically significant ($p = 0.14$). The spillover effect on horizontal alliance partners of orphan drug innovators follow a similar pattern, but is larger in scale (2.79% for a five-day event widow), consistent with prior literature showing that the market perceives within-industry alliance partnerships as more valuable. Overall, the results in Panel A of Table 3 provide strong support for the positive market perception of radical innovations for innovative firms as well as the spillover effect on alliance partners.

Turning to Panel B, C and D of Table 2.3, I present the announcement returns of the FDA NME approvals. Panel B shows the announcement CARs for of FDA NME approvals before deleting confounding effects; Panel C presents the wealth effect of FDA NME approvals after deleting confounding effects; and Panel D shows the results using news report dates. The examples of confounding events are litigation and lawsuits, unfavorable analyst coverage, uneven stock season, small stocks under alliance termination threats, etc.[21] The abnormal returns for NME innovators and their alliance partners largely follow a similar patterns as orphan drug innovators, but vary in scale and statistical significance to different degrees. For all NME innovators, the abnormal returns range from 4.14% to 4.30% in a three-day event window, which is much higher than the wealth creation for orphan drug innovators. For NME innovators with alliance partners, the abnormal return is again lower than that of the overall sample, ranging from 1.74% to 3.76%, depending on the exclusion of firms with apparent confounding events. Furthermore, the statistical significance varies quite a bit for different sample selection criteria and announcement dates. For the alliance

[21] I currently only consider the confounding events for the innovators, not for alliance partners.

partners of the NME innovators, although the announcement returns follow a similar pattern as in the orphan drug innovations, the significance levels vary for different situations as well. There are three possible explanations for the above results.

The first possibility is that there are other confounding events for NME innovators and their alliance partners around the radical innovation announcements. If a pharmaceutical company gets a FDA approval for NME drug and has a large negative stock return on the announcement day, it would be very likely that this company has some other negative news happening during the event window or the stock market does not like this particular drug for some reason. For example, on July 16, 1998, Celgene Corp. was approved by FDA for a brand name drug called "Thalomid", and *PR Newswire* reported this exciting approval news on the same day, but also stated that this drug is controversial and potentially dangerous, and numerous other news reports also caution the risk associated with this drug[22]. In the three-day event window, Celgene Corp.'s stock return is about -11%, a huge wealth loss resulted from seemingly good news.

The second possible reason is that for these radical innovations, there are hundreds of news reports about the various stages of clinical trial results, expert opinions, and FDA reviews and so on prior the FDA approvals. The informational content of FDA approvals is therefore greatly mitigated by all these earlier news reports. The EntreMed featured in Huberman and Regev (2001) paper is a good example in this respect: "A Sunday *New York Times* article on a potential development of new cancer-curing drugs caused EntreMed's stock price to rise from 12.063 at the Friday close, to open at 85 and close near 52 on Monday." Although this is a non-innovative event, from this example, I can get an idea how the stock price would react to real innovative events prior to FDA approvals.

[22] *USA Today* reported on July 17, 1998 the FDA approval with a title "Infamous thalidomide approved FDA's limits on distribution aim to prevent birth defects"; earlier in January, 1998, *New York Times* covered this drug and stated that it is "…the world's most notorious agent of birth defects". Surprisingly, this drug has not been withdrawn from the U.S. market despite hundreds of negative news reports and warnings, and most recently is trying to get Canadian drug agency approval for marketing it in Canada. See, for example, "Thalidomide users are warned about clot risk", *Nanaimo Daily News (British Columbia), May 2, 2013*.

Another example is Eli Lilly & Co.'s Humalog, which was approved by the FDA on June 17, 1996, but a Lexis-Nexis search on this drug shows that there are about thirty good news reports about the blockbuster drug prior to the final approval date.

The third possible reason for the difference in statistical significance associated with abnormal returns around FDA NME drug approvals is insider trading which makes the drug stock very volatile around FDA approvals of the blockbuster drugs. Both popular press and academic research has shown that there are severe information leaks on drug stocks and R&D-intensive firms. A Wall Street Journal article states that "...So many drug stocks are moving on rumors about the inner workings of the Food and Drug Administration that the federal agency has hired a law firm to help it guard against leaks."[23] However, there is no sign of actually stopping insider trading on drug stocks, as indicated in the more recent Wall Street Journal reports on this issue[24]. In a large sample of insider-trading events, Coff and Lee (2003) find that insider trading is used as to appropriate rent from R&D intensive firms. Our subsequent tests on information leakage/anticipation and return reversals in Section 6 provide supports for these conjectures.

Overall, the results in Panel B, C, and D of Table 2.3 display that there are substantial abnormal returns from radical innovations for these innovating firms and also various degrees of spillovers on the alliance partners of the innovators as well.

5.3. Wealth effect and spillover on partners around breakthrough innovations

The issues discussed above for NME radical innovations are much less severe for the more "ordinary" breakthrough innovations such as NDAs. For the FDA NDA approvals, the innovation announcement returns are smaller in the three-day event window: 1.23% for overall NDA approval sample ($p = 0.001$); and 1.14% for the NDA innovators with alliance partners ($p = 0.001$). There are

[23] See "FDA Looks to Stop Leaks on Drug Stocks", *Wall Street Journal*, June 19, 1991.
[24] See, for example, "Probe Deepens of Alleged Inside Trades at FDA", *Wall Street Journal*, June 03, 2011.

also significant spillover effects on alliance partners, 0.62% in a three-day event window, which is roughly half of the abnormal return of that of the innovators ($p = 0.07$). Strategic alliance partners gain a 0.59% of the abnormal returns in a three-window, with a p value of 0.03. Short-term as well as long-term strategic alliance partners both have significant announcement returns from their partners' NDA approvals, while it takes relatively more time for long-term alliance partners to realize the gains (eleven-day event window). Taken together, the results in Table 2.4 show that the wealth effect of breakthrough innovations is large for the innovators and this wealth effect also benefits the innovators' alliance partners.

5.4. Wealth effect and spillover on partners around incremental innovations

Table 2.5 presents the results on the abnormal returns around incremental innovations announcements, i.e. FDA ANDA approvals. The pattern of abnormal returns and spillover effect resembles those of breakthrough innovation announcements, whereas smaller in scale. The average three-day CAR is 0.56% ($p = 0.001$) for all ANDA innovators, and 0.38% ($p = 0.001$) for ANDA innovators with alliance partners. Strategic alliance partners have a spillover of 0.22% ($p = 0.08$), whereas long-term alliance partners have a spillover of 0.49% ($p= 0.01$) in a three-day event window. Surprisingly, the joint ventures partners of the ANDA innovators have a significant negative spillover from these incremental innovation announcements, which could possibly result from some confounding events such as litigations or other negative issues among the partners. To summarize, the results in Table 2.5 once again reinforce the similar conclusion from previous sections: incremental innovations also result in substantial financial gains for innovators and their alliance partners, although alliance partners gain less in all situations, highlighting the asymmetric gains from alliance partnerships.

5.5. Wealth loss and spillover on partners around FDA warning letters

In this section and the next section, I examine the wealth loss caused by some adverse events related to pharmaceutical innovations and test if our premise of spillover effect on alliance partners still holds in these events. Panel A of Table 2.6 shows the results for wealth loss for pharmaceutical companies and their alliance partners around FDA posted warning letters. In a three-day event window and five-day event window, there are significant negative abnormal returns of -0.43% ($p = 0.08$) and -0.59% ($p = 0.05$) respectively around the FDA warning letter posted dates for the overall sample of 462 observations. For FDA warned firms with alliance partners, the negative CAR is -0.48% in the three-day even window, although not statistically significant ($p = 0.12$). For five-day and eleven-day event windows, the wealth losses are -0.84% ($p = 0.04$) and -1.42% ($p = 0.01$) respectively. Therefore, there is substantial wealth loss for firms getting FDA warning letters. Interestingly, alliance partners of these FDA warned firms lose almost the same amount from the bad news: -0.46% ($p = 0.10$) for a three-day window and -0.74% ($p = 0.05$) for a five-day event window. As a robustness check, I also examined the cross-sectional mean abnormal returns of all alliance partners in Panel B of Table 2.6, instead of only looking at the portfolios formed by firms getting FDA warning letters. The results are largely similar to that of Panel A. Collectively, the results in Table 2.6 demonstrate that innovation is a risky business with many uncertainties, and there could be the substantial wealth loss associated with both innovations and alliance partnerships.

5.6. Wealth loss and spillover on partners around NME drug withdrawals

Another adverse event related to drug development is the possibility of drug withdrawals. Popular press has featured some high profile drug withdrawals that caused the huge loss of wealth for some pharmaceutical companies. For example, Bristol Myers Squibb (BMS)'s withdrawal of application for Vanlev caused its stock price to plummet by $15, or 23%, a total wealth loss of $30

billion for the drug giant[25]. Ahmed et al. (2002) find that shareholders suffer massive wealth losses around the drug withdrawals and also positive CARs for the competitors of the firms that have drug withdrawals. I hand collect a sample of 39 NME drug withdrawals from *Wall Street Journal* (37 cases) and *New York Times* (2 cases) and test the spillover effect of the drug withdrawals on alliance partners. The results in Table 2.7 demonstrate that the shareholder wealth loss is consistent with Ahmed et al. (2005), but is even slightly larger (9.27%, p = 0.01) because their sample also contains other drug withdrawals other than NME drugs, which cause relatively smaller damage for affected firms. There are 18 firms that have NME drug withdrawals and also have strategic alliance partners. The wealth loss for shareholders of these firms is relatively smaller: - 3.69%, p = 0.02. Looking at Panel A for alliance partners formed portfolios based the firms withdrawn drugs, the spillover effects are negative in most cases, although not statistically significant in general. The lack of statistical significance is possibly due to the small sample size and the fact that withdrawn drugs are usually approved a few years ago and the drug withdrawal may not affect the partner much if the partnership is not based on that particular drug since their partnership could be based on a different drug development. Turning to Panel B of Table 2.7 which examines the cross-sectional mean abnormal return of alliance partners, I find some evidence of significant negative spillover on horizontal alliance partners in a three-day window: -1.37%, p = 0.10. Moreover, in a eleven-day window, short-term strategic alliances suffer a large -5.23% wealth loss from their partners' drug withdrawals. Jointly, Table 2.7 shows that there are sometimes large wealth losses from alliance partners' extreme adverse events.

[25] See "IBM, Intel Drop on Profit News As Rally in Stocks Comes to a Halt", *Wall Street Journal*, April 20, 2000.

6. TESTS FOR INFORMATION LEAKAGE/ANTICIPATION AND RETURN REVERSALS

As I discuss in Section 5.2, there are various news reports about the different stages of clinical trial results, expert opinions, and FDA reviews prior to the FDA approvals. Therefore, there might be some anticipation in the stock market regarding these FDA approvals. Moreover, the possibility of information leakage for the purpose of insider trading also exists for the drug stocks, given the documented larger insider gains of R&D intensive firms (Aboody and Lev, 2000).

At the same time, it is also of interest to examine if there is any return reversal after these innovation events. Liu (2006) finds evidence of a negative drift after R&D news events and attributes the drift to investors' expectation errors on these news events. That is, given the inherent uncertainty in risky new endeavors, it is difficult for investors to precisely evaluate the economic value of these innovative events. Mispricing for innovation events is more likely for firms with a weak technology base, high B/M ratio, and larger size. I therefore test for the possibilities of information leakage/anticipation prior to various innovation events and return reversals after these events by looking at CARs with different event windows.

To conduct these tests, I use the same market model and daily stock returns from CRSP files to calculate cumulative abnormal returns (CARs) for various pre-event windows such as (-10,-2), (-20,-2), (-30,-2), (-60,-2), (-90,-2), (-120,-2), (-20,-11), (-60,-11), and (2,10) for information leakage/anticipation effects, and post-event windows such as (2,30), (2,60), (2,90), (2,120), (31,60), (61,90), and (91,120) for return reversal effect. The significance test statistics include Patell Z, Cross-sectional t-stat as well as its standardized counterpart a.k.a. Boehmer's et al. (1991) t-stat.

The tests results for all Orphan Drug announcements are presented in Panel A of Table 2.8. There is little evidence of either information leakage/anticipation effect or return reversal effects.

The only exception is during event window ((61, 90)), where the CAR is negative and significant, which possibly indicates either some return reversal or some other negative events. Since the CARs for different event windows, such as (31, 60), (31, 60), and (91, 120), are not consistently significant and negative, I cannot make any meaningful inference regarding the return reversals for Orphan drug announcements. I also test the subsample of OD innovators with alliance partners to see if there is any different pattern since those OD innovators with partners might share information with their alliance partners and therefore are more likely to have information leakage effect prior to the announcements. As I can see from Panel B of Table 2.8, the CARs and their statistical significances for pre-event windows and post-event windows are not that different from those for all OD innovators. Thus, I conclude that OD innovation announcements do not have discernable pre-announcement information leakage or post-announcement return reversals. The lack of consistent evidence on information leak/anticipation and return reversals for these OD innovators suggests that the stock market reaction is generally well captured during the announcement period. It provides further support for the wealth effect and spillover on partners I find in Panel A of Table 2.3.

In Table 2.9, I provide results for the similar tests for NME drug announcements. The information leakage/anticipation effect for this type of innovation news is more noticeable. During the event windows (-10, -2) and (-20, -2), the CARs are 0.77%, and 0.99%, and statistically significant at the 5% level. The difference between NME drug announcements and Orphan drug announcements is that the former has a relatively longer and established history, and has a larger number of announcements per year. It is quite likely that investors, especially insiders, pay more attention to this kind of announcement than an OD announcement, since OD news tends to be more uncertain with more unpredictable outcomes. So the stock market reaction to NME announcements is not as concentrated on the announcement period, consistent with the lower

statistical significance in Panel B of Table 2.3. Furthermore, there is evidence of return reversals for the NME drug announcements, which is consistent with the findings in Liu (2006), who uses different types of innovation announcements. The return reversals could be attributed to the investors' expectation errors due to overoptimism for some of these drug announcements. It may also relate to some subsequent negative news announcements regarding these NME drugs. Panel B of Table 2.9 presents the results for the subsample of NME innovators with alliance partners to see if there is any different pattern. The CARs and their statistical significances for pre-event windows and post-event windows are similar to those for all NME innovators. In sum, NME innovation announcements do have some discernable pre-announcement information leakage/anticipation or post-announcement return reversals.

Table 2.10 shows the results for the similar tests for NDA drug announcements. As I discussed earlier in the paper, these NDA drugs are breakthrough innovations, but are more "ordinary" innovations in nature and much larger in terms of the number of approvals per year. Presumably, the gains from insider trading on these drugs might not be large enough to provide high incentives for insiders to gather insider information. Not surprisingly, I do not see any significant information leakage and anticipation for this type of innovation announcements. There is, however, some consistent evidence of return reversals on these drug approvals, possibly for the similar reason of expectation errors or other subsequent negative news.

Tables 2.11 and 2.12 present the results for the test of information leakage/anticipation and return reversals for the FDA warnings and NME withdrawals. Both types of adverse news events demonstrate some information leakage/anticipation effects. For FDA warnings, the event windows (-30, -2) and (-60, -2) have CARs of -1.53% and -1.29% and are statistically significant at the 1% and 5% levels, respectively, based on the Boehmer's et al (1991) t-statistics. For NME withdrawals, evidence of the information leakage/anticipation is relatively weaker. The CARs for event windows

(-90, -2) and (-120, -2) are -5.70% and -12.2%, but the statistical significance level are lower and not that consistent across different test statistics. The possible reason is that for the FDA warnings, the sample size is much larger, and there are various formal communications, such as Form 483, regarding the adverse events related to the eventual warning letters[26]. Some of the communications in Form 483 might contain quite damaging information for the firms receiving these letters. On the other hand, I do not find consistent evidence of return reversals for both FDA warning letters and NME withdrawals, which means that all the stock market reaction on these negative news events for the innovators is captured by the announcement period CARs.

Overall, the tests for information leakage/anticipation and return reversals show that the effects depend on the types of the innovation events. Some of the events have more information leakage/anticipation effect because of the higher information-gathering incentives brought by larger insider gains, whereas other events are more likely to cause return reversals due to investors' expectation errors on these drug stocks.

7. CROSS-SECTIONAL ANALYSES OF INNOVATION ABNORMAL RETURNS AND SPILLOVERS

To gain further insight into the cross-sectional variation in the stock market response to innovation events, I conduct regression analyses of the innovation abnormal returns for innovators and spillover effects on their alliance partners in this section.

In Table 2.13, I regress the cumulative abnormal returns for each innovator firm measured from a three-day event window (-1, +1) against innovation event variables, innovator firm characteristics, and alliance characteristics variables. The innovation events variables tested in this

[26] See http://www.linkedin.com/groups/What-s-difference-between-Form-3826946.S.107029617 for the discussion regarding FDA Form 483.

table include dummy variables *radical innovation*, *radical innovation 1 (OD drug),* and *radical innovation 2 (NME drug). Radical innovation* indicates that the innovation announcement is a FDA Orphan Drug (OD) or NME drug approval. The other two dummy variables, *radical innovation 1 (OD drug)* and *radical innovation 2 (NME drug),* indicate the innovation announcements fall into the subcategories of two types of radical innovations. The innovator firm characteristics of interest are newly listed innovator firm (*IPO innovator*), *innovator size*, *Tobin's Q*, and innovator with only one alliance partner (*single alliance innovator*). The alliance characteristics variables capture the various types of contracts or agreements between innovator firms and their alliance partners. The variables include *strategic alliance*, *R&D agreement*, *horizontal alliance*, *joint venture*, *public alliance*, among others. All variables are defined in Appendix 2.A: Variable definitions. The sample for Table 2.13 includes announcements events for radical innovations (FDA Orphan Drug approvals and FDA NME drug approvals), and breakthrough innovations (FDA Original New Drug Approvals). These innovation events generate larger abnormal returns and have relatively larger spillover effect than incremental innovation events such as FDA ANDA approvals.

Panel A of Table 2.13 shows descriptive statistics and Panel B presents the cross-sectional regression analysis of the innovator's cumulative abnormal return (CAR) during the three-day event window (*Innovator CAR (3-day),* or *icar3*). One of the main results in this table is that radical innovations, especially FDA NME approvals, generate substantially larger abnormal returns than other types of more "ordinary" innovations. The regression coefficients for the variable *radical innovation* are positive and statistically significant at the 5% level in most regression models. When I separate the radical innovations into OD drug and NME drug approvals in regression models 7 to 11, I see that the larger abnormal returns mainly come from the latter. Secondly, innovators that are publicly listed for 5 or less years and smaller innovators experience higher stock market gains when they announce innovation events. In particular, in models 1 to 4, the coefficients for innovator size

are negative and statistically significant at the 1% level. In models 5 to 11, the coefficients for *IPO innovator* are positive and statistically significant in most models. Third, consistent with the univariate results, innovators with alliance partners experience smaller abnormal returns, suggesting that the alliance partners may be sharing in some of the gain from the innovation event. The coefficients for all kinds of alliance characteristics are negative and many are statistically significant.

I now turn to the regression analyses of the innovation spillover effect on alliance partners. In Table 2.14, Panel A is the descriptive statistics and Panel B presents the cross-sectional regression analysis of the average partners' cumulative abnormal returns (*partner CAR(3-day)*, or *pmcar3*) during the three-day event window[27]. The main independent variables are similar to those for the regressions of the innovators' abnormal returns. However, since the goal is to investigate the spillover effect of innovation events on alliance partners, I include the innovators' CARs in the regressions to test the degree of surprise contained in the innovation announcements, following the previous literature such as Kohers and Kohers (2004), Oxley, Sampson, and Silverman (2009), and Chen, Ho, and Ik (2005). The coefficients for innovators' abnormal returns (*Innovator CAR (3-day)*) are positive and highly statistically significant at the 1% level for all regression models in Panel B. The spillover effect on alliance partners is even stronger for radical innovations with a large degree of surprise, as shown by the significant, positive interaction between radical innovations and innovator CAR. In addition, I control for some other variables, such as size, Tobin's Q, and alliance characteristics. As far as partner characteristics are concerned, IPO partners tend to experience larger spillover; partners' Tobin's Q contributes to larger spillover; and newly listed partners tend to experience larger spillover gains. The innovators' Tobin's Q is also positively associated with the spillover effect for partners. Moreover, the more partners the innovator has (*Log(Num ptn per*

[27] I also use 5-day and 11-day event window CARs as dependent variables and find similar results, although there is slight difference in statistical significance levels, which is consistent with the univariate results in Table 3. The innovator CARs, partners CARs, Tobin's Q, and size variables are all winsorized at 1% and 99% percent level to reduce the impact of outliers.

innovator)), the less spillover there is for each partner. Along the same lines, partners who only have one alliance (with the innovator) also get larger spillover during the 3-day event window (Model 3). Finally, the negative and statistically significant (1%) coefficients for the variable *Log(Alliance duration)* in all models show that short-term, or more recent alliance partners experience larger spillover effects..

Taken together, the cross-sectional analyses further support the univariate results regarding the abnormal returns to innovators and spillover effect to their alliance partners around the innovation announcements. The results in this section also shed light on some other important variables, such as firm age, firm size, and Tobin's Q in leading to the stock market response of innovation events for innovators and their alliance partners.

8. CONCLUSION

This paper explores the relationship of firm boundaries and the market value of innovations. I advance the proposition that firms reap large stock market wealth from their innovation announcements. I take the proposition to a novel setting with comprehensive innovation documentation. I classify the innovations in the pharmaceutical industry as radical, breakthrough, and incremental innovations based on their scientific and technological achievements and customer benefit enhancements. I find corresponding abnormal announcement returns for these three types of innovations. More importantly, I provide direct stock market evidence that the alliance partners of these pharmaceutical innovators also benefit from the spillover effect of these innovations, although the gains are smaller than that for the innovators. Cross-sectional analyses of the abnormal returns to innovators and spillover effect on partners demonstrate that young and newly listed innovators with better growth opportunities play a more important role in leading to greater degree

of surprises and associated spillover effect. I also examine the risk associated with these innovations by looking at the wealth losses and spillover to alliance partners around two sets of adverse events related to the pharmaceutical innovators, and found substantial wealth loss for them and their alliance partners.

Our findings make significant contributions to the current literature on innovations by shifting the setting of innovations from patent data to pharmaceutical drug development. I find that the stock market highly values strategic alliance partnership among high-tech industries such as biopharmaceutical industry. I also differentiate the innovations along the technological breakthrough and market breakthrough dimensions and find that investors value these innovations accordingly. The spillover effects of innovations on strategic alliance partners provide direct evidence on the close relationship between innovations and alliance partnerships. I also examine the division of gains among alliance partners in a new setting and find evidence supporting the asymmetric gains hypothesis between commercializing pharmaceutical firms and their research partners.

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Table 2.1: Summary of New Drug Applications and Approvals by Year

The data on New Drug Application (NDA) received and approved is from the FDA website. A FDA NDA approval involves submitting data from specific technical viewpoints for review, including chemistry, pharmacology, medical, biopharmaceutics, and statistics. New Molecular Entity (NME) is an active ingredient that has never before been marketed in the U.S. in any form.

Year	NDAs Received	NDAs Approved	NMEs Approved
1980	162	114	12
1981	129	96	27
1982	202	116	28
1983	269	94	14
1984	217	142	22
1985	148	100	30
1986	120	98	20
1987	142	69	21
1988	126	67	21
1989	118	87	22
1990	98	64	23
1991	112	63	30
1992	100	91	26
1993	99	70	25
1994	114	62	22
1995	121	82	28
1996	120	131	53
1997	128	121	39
1998	121	90	30
1999	139	83	35
2000	115	98	27
2001	98	66	24
2002	105	78	17
2003	109	72	21
2004	115	119	36
2005	116	80	20
2006	124	101	22
2007	123	78	18
2008	140	89	24
2009	146	90	26
2010	103	93	21
2011	105	99	30
2012	102	96	34
Total	4168	2999	848

Table 2.2: Market Reaction to Strategic Alliances Announcements

The alliance announcement dates are from the Strategic Alliances and Joint Venture section of the Securities Data Company (SDC) database. The strategic alliances and joint ventures are formed between two or more U.S. firms, of which at least one pharmaceutical company received FDA NME approvals during the period of 1980 to 2013.

Type of alliances	Event window	N	Mean CARs	T Statistics	P Value
All alliance announcements	(-5,+5)	493	1.75***	3.00	0.003
All alliance announcements	(-2,+2)	493	1.63***	3.43	0.001
All alliance announcements	(-1,+1)	493	1.87***	4.58	0.000
Horizontal alliances	(-5,+5)	335	1.96***	2.71	0.007
Horizontal alliances	(-2,+2)	335	1.66***	2.84	0.005
Horizontal alliances	(-1,+1)	335	2.02***	4.01	0.000
Strategic alliances	(-5,+5)	450	1.54***	2.48	0.013
Strategic alliances	(-2,+2)	450	1.69***	3.29	0.001
Strategic alliances	(-1,+1)	450	1.90***	4.31	0.000
Short term strategic alliances	(-5,+5)	325	1.97***	2.89	0.004
Short term strategic alliances	(-2,+2)	325	2.36***	3.90	0.000
Short term strategic alliances	(-1,+1)	325	2.27***	4.32	0.000
Long term strategic alliances	(-5,+5)	125	0.42	0.31	0.758
Long term strategic alliances	(-2,+2)	125	-0.06	-0.06	0.950
Long term strategic alliances	(-1,+1)	125	0.93	1.16	0.247
Joint ventures	(-5,+5)	43	3.99**	2.45	0.018
Joint ventures	(-2,+2)	43	1.02	1.06	0.297
Joint ventures	(-1,+1)	43	1.50***	2.01	0.051
R & D alliances	(-5,+5)	271	2.91***	3.38	0.001
R & D alliances	(-2,+2)	271	2.50***	3.57	0.000
R & D alliances	(-1,+1)	271	2.80***	4.53	0.000
Licensing alliances	(-5,+5)	226	-0.13	-0.17	0.866
Licensing alliances	(-2,+2)	226	0.40	0.59	0.556
Licensing alliances	(-1,+1)	226	1.02*	1.67	0.096
Manufacturing alliances	(-5,+5)	91	2.73***	2.04	0.045
Manufacturing alliances	(-2,+2)	91	2.71***	2.40	0.019
Manufacturing alliances	(-1,+1)	91	2.45**	2.43	0.017

Table 2.3: Wealth Effect of Radical Innovation and Spillover on Partners

Panel A presents the wealth effect and spillover effect of FDA Orphan Drug (OD) approvals, which are from FDA Orphan Drug Product designation database (1983-2013). Panel B and C presents the wealth effect and spillover effect of NME innovators which are all U.S. pharmaceutical companies that received FDA NME drug approvals from 1980 to 2013. The alliance sample includes all strategic alliance partners among U.S. public firms in the same time period.

Panel A. Wealth Effect and Spillover Effect of FDA OD Approvals

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All OD Innovators	(-5,+5)	174	2.79***	3.42	0.001
All OD Innovators	(-2,+2)	174	2.23***	3.38	0.001
All OD Innovators	(-1,+1)	174	2.81***	4.07	0.000
OD Innovators with alliances	(-5,+5)	97	2.00**	2.26	0.026
OD Innovators with alliances	(-2,+2)	97	1.80***	2.72	0.008
OD Innovators with alliances	(-1,+1)	97	2.39***	3.17	0.002
All alliance partners	(-5,+5)	97	2.34**	2.16	0.033
All alliance partners	(-2,+2)	97	1.79**	1.81	0.073
All alliance partners	(-1,+1)	97	1.56	1.50	0.137
Horizontal alliances	(-5,+5)	87	3.79***	2.50	0.014
Horizontal alliances	(-2,+2)	87	2.79**	2.28	0.025
Horizontal alliances	(-1,+1)	87	1.88	1.54	0.127

Panel B. Wealth Effect of FDA NME Approvals before Deleting Confounding Effects

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All NME Innovators	(-5,+5)	388	4.43**	2.27	0.024
All NME Innovators	(-2,+2)	388	4.37**	2.38	0.018
All NME Innovators	(-1,+1)	388	4.14**	2.29	0.023
NME Innovators with alliances	(-5,+5)	135	3.69**	1.99	0.049
NME Innovators with alliances	(-2,+2)	135	3.89*	1.74	0.083
NME Innovators with alliances	(-1,+1)	135	3.76*	1.67	0.097
All alliance partners	(-5,+5)	135	0.94	1.58	0.117
All alliance partners	(-2,+2)	135	0.47	1.01	0.312
All alliance partners	(-1,+1)	135	0.32	0.86	0.390
Horizontal alliances	(-5,+5)	121	0.98	1.42	0.158
Horizontal alliances	(-2,+2)	121	0.18	0.35	0.729
Horizontal alliances	(-1,+1)	121	0.15	0.37	0.712

Panel C. Wealth Effect of FDA NME Approvals after Deleting Confounding Effects

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All NME Innovators	(-5,+5)	380	4.57**	2.30	0.022
All NME Innovators	(-2,+2)	380	4.49**	2.39	0.017
All NME Innovators	(-1,+1)	380	4.30**	2.33	0.021
NME Innovators with alliances	(-5,+5)	113	2.28***	3.27	0.001
NME Innovators with alliances	(-2,+2)	113	1.91***	3.30	0.001
NME Innovators with alliances	(-1,+1)	113	1.74***	4.85	0.000
All alliance partners	(-5,+5)	113	0.83	1.06	0.293
All alliance partners	(-2,+2)	113	0.17	0.32	0.752
All alliance partners	(-1,+1)	113	0.17	0.43	0.671
Horizontal alliances	(-5,+5)	102	1.01	1.10	0.274
Horizontal alliances	(-2,+2)	102	0.09	0.15	0.883
Horizontal alliances	(-1,+1)	102	0.16	0.35	0.728

Panel D. Wealth Effect of FDA NME Approvals (News Report Dates)

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
NME Innovators with alliances	(-5,+5)	124	3.67*	1.82	0.072
NME Innovators with alliances	(-2,+2)	124	3.79	1.57	0.119
NME Innovators with alliances	(-1,+1)	124	3.67	1.50	0.137
All alliance partners	(-5,+5)	124	1.25***	2.54	0.012
All alliance partners	(-2,+2)	124	0.90***	2.82	0.006
All alliance partners	(-1,+1)	124	0.52**	1.95	0.053
Horizontal alliances	(-5,+5)	96	1.30**	2.04	0.044
Horizontal alliances	(-2,+2)	96	0.82*	1.87	0.065
Horizontal alliances	(-1,+1)	96	0.62*	1.77	0.080

Table 2.4: Wealth Effect of Breakthrough Innovation and Spillover on Partners

The breakthrough innovation sample includes all FDA *Original New Drug Approvals (NDAs and BLAs)* approvals from 1990 to 2013; the alliance sample includes all strategic alliances partners among U.S. public firms in the same time period.

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All NDA innovators	(-5,+5)	969	1.71***	2.56	0.011
All NDA innovators	(-2,+2)	969	1.64***	2.56	0.011
All NDA innovators	(-1,+1)	969	1.23***	5.05	0.000
NDA Innovators with alliances	(-5,+5)	384	1.44***	3.35	0.001
NDA Innovators with alliances	(-2,+2)	384	1.10***	3.87	0.000
NDA Innovators with alliances	(-1,+1)	384	1.14***	4.09	0.000
All alliance partners	(-5,+5)	384	0.91*	1.79	0.075
All alliance partners	(-2,+2)	384	0.61*	1.67	0.096
All alliance partners	(-1,+1)	384	0.62*	1.85	0.066
Horizontal alliances	(-5,+5)	175	0.82	1.15	0.252
Horizontal alliances	(-2,+2)	175	0.22	0.56	0.573
Horizontal alliances	(-1,+1)	175	0.26	0.94	0.351

Table 2.5: Wealth Effect of Incremental Innovation and Spillover on Partners

The incremental innovation sample includes all FDA Abbreviated New Drug Application (ANDA) approvals from 1990 to 2013; the alliance sample includes all strategic alliances partners among U.S. public firms in the same time period.

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All ANDA innovators	(-5,+5)	3268	0.73***	3.14	0.002
All ANDA innovators	(-2,+2)	3268	0.82***	3.96	0.000
All ANDA innovators	(-1,+1)	3268	0.56***	5.69	0.000
ANDA Innovators with alliances	(-5,+5)	1160	0.59***	2.58	0.010
ANDA Innovators with alliances	(-2,+2)	1160	0.50***	3.32	0.001
ANDA Innovators with alliances	(-1,+1)	1160	0.38***	2.83	0.005
All alliance partners	(-5,+5)	1160	-0.07	-0.30	0.765
All alliance partners	(-2,+2)	1160	0.05	0.31	0.757
All alliance partners	(-1,+1)	1160	0.02	0.19	0.852
Horizontal alliances	(-5,+5)	2300	-0.26	-1.10	0.271
Horizontal alliances	(-2,+2)	2300	-0.08	-0.46	0.647
Horizontal alliances	(-1,+1)	2300	-0.01	-0.11	0.914

Table 2.6: Wealth Loss of FDA Warning Letters and Spillover on Partners

The sample of FDA warned firms includes all U.S. pharmaceutical firms getting FDA warning letters from 1997 to 2013; the alliance sample includes all strategic alliances partners among U.S. public firms in the same time period.

Panel A. Alliance Partners as Portfolios Formed By Firms Getting Warning Letters

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All FDA warned firms	(-5,+5)	462	-0.83	-1.47	0.143
All FDA warned firms	(-2,+2)	462	-0.59**	-1.98	0.048
All FDA warned firms	(-1,+1)	462	-0.43*	-1.79	0.075
FDA warned firms with alliances	(-5,+5)	222	-1.42***	-2.48	0.014
FDA warned firms with alliances	(-2,+2)	222	-0.84**	-2.09	0.037
FDA warned firms with alliances	(-1,+1)	222	-0.48	-1.55	0.121
All alliance partners	(-5,+5)	222	-0.96	-1.60	0.110
All alliance partners	(-2,+2)	222	-0.74**	-1.94	0.053
All alliance partners	(-1,+1)	222	-0.46*	-1.68	0.094
Horizontal alliances	(-5,+5)	193	-1.52*	-1.79	0.075
Horizontal alliances	(-2,+2)	193	-0.83	-1.53	0.127
Horizontal alliances	(-1,+1)	193	-0.62	-1.45	0.150

Panel B. Alliance Partners Cross-Sectional Mean

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All FDA warned firms	(-5,+5)	462	-0.83	-1.47	0.143
All FDA warned firms	(-2,+2)	462	-0.59**	-1.98	0.048
All FDA warned firms	(-1,+1)	462	-0.43*	-1.79	0.075
FDA warned firms with alliances	(-5,+5)	222	-1.42***	-2.48	0.014
FDA warned firms with alliances	(-2,+2)	222	-0.84**	-2.09	0.037
FDA warned firms with alliances	(-1,+1)	222	-0.48	-1.55	0.121
All alliance partners	(-5,+5)	1315	-0.84***	-2.16	0.031
All alliance partners	(-2,+2)	1315	-0.72***	-2.80	0.005
All alliance partners	(-1,+1)	1315	-0.42**	-2.12	0.034
Horizontal alliances	(-5,+5)	1009	-0.88*	-1.95	0.051
Horizontal alliances	(-2,+2)	1009	-0.59**	-1.97	0.049
Horizontal alliances	(-1,+1)	1009	-0.35	-1.50	0.134

Table 2.7: Wealth Loss of NME Drug Withdrawals and Spillover on Partners

The sample of NME drug withdrawn firms includes all U.S. pharmaceutical firms that withdrew NME drugs from 1990 to 2013; the dates for drug withdrawals are collected from Wall Street Journal (37 cases) and New York Times (2 cases); the alliance sample includes all strategic alliances partners among U.S. public firms in the same time period.

Panel A. Alliance Partners as Portfolios Formed by Firms Withdrew NME Drugs

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All NME drug withdrawn firms	(-5,+5)	39	-10.80***	-2.91	0.006
All NME drug withdrawn firms	(-2,+2)	39	-8.96***	-3.35	0.002
All NME drug withdrawn firms	(-1,+1)	39	-9.27***	-3.46	0.001
NME drug withdrawn firms with alliances	(-5,+5)	18	-2.39	-1.70	0.107
NME drug withdrawn firms with alliances	(-2,+2)	18	-4.09**	-2.67	0.016
NME drug withdrawn firms with alliances	(-1,+1)	18	-3.69**	-2.51	0.022
All alliance partners	(-5,+5)	18	-1.74	-0.84	0.414
All alliance partners	(-2,+2)	18	-0.51	-0.47	0.641
All alliance partners	(-1,+1)	18	-0.41	-0.48	0.641
Horizontal alliances	(-5,+5)	17	-2.75	-1.42	0.174
Horizontal alliances	(-2,+2)	17	-0.59	-0.55	0.590
Horizontal alliances	(-1,+1)	17	0.01	0.01	0.994

Panel B. Alliance Partners Cross-Sectional Mean

Type of innovators and alliances	Event window	N	Mean CARs	T Statistics	P Value
All NME drug withdrawn firms	(-5,+5)	39	-10.80***	-2.91	0.006
All NME drug withdrawn firms	(-2,+2)	39	-8.96***	-3.35	0.002
All NME drug withdrawn firms	(-1,+1)	39	-9.27***	-3.46	0.001
NME drug withdrawn firms with alliances	(-5,+5)	18	-2.39	-1.70	0.107
NME drug withdrawn firms with alliances	(-2,+2)	18	-4.09**	-2.67	0.016
NME drug withdrawn firms with alliances	(-1,+1)	18	-3.69**	-2.51	0.022
All alliance partners	(-5,+5)	114	-1.47	-0.95	0.344
All alliance partners	(-2,+2)	114	-0.38	-0.32	0.751
All alliance partners	(-1,+1)	114	-1.01	-1.09	0.278
Horizontal alliances	(-5,+5)	87	-1.58	-1.02	0.309
Horizontal alliances	(-2,+2)	87	-0.96	-0.99	0.326
Horizontal alliances	(-1,+1)	87	-1.37*	-1.71	0.092

Table 2.8: Tests for Anticipation/Leakage and Reversal for Orphan Drug Announcements

FDA Orphan Drug (OD) approvals ((radical innovation sample)) are from the FDA Orphan Drug Product designation database (1983-2013). Panel A is for all OD innovators and Panel B is for all OD innovators with at least one alliance partner. The alliance partners are identified based on the alliance sample including all strategic alliances partners among U.S. public firms in the same time period.

Panel A. For All OD Innovators

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	164	3.30%	2.73%	0.582	0.659	4.061	7.456	4.374	4.351
(-10,-2)	164	2.02%	0.80%	0.114	0.506	0.156	1.457	1.271	1.379
(-20,-2)	164	3.43%	0.55%	0.090	0.506	0.156	1.154	0.547	1.096
(-30,-2)	164	5.54%	1.08%	0.138	0.518	0.469	**1.762**	0.955	**1.777**
(-60,-2)	164	7.69%	0.05%	0.103	0.506	0.156	1.315	0.029	1.294
(-90,-2)	164	10.70%	0.53%	0.109	0.524	0.625	1.393	0.261	1.277
(-120,-2)	162	16.00%	3.74%	0.119	0.512	0.312	1.509	1.545	1.272
(-20,-11)	164	1.29%	-0.18%	0.027	0.488	-0.312	0.341	-0.266	0.348
(-60,-11)	164	5.79%	-0.67%	0.066	0.445	-1.406	0.844	-0.442	0.793
(2,10)	164	0.26%	-0.80%	-0.037	0.470	-0.781	-0.478	-1.365	-0.484
(2,30)	163	1.69%	-1.75%	-0.063	0.442	-1.488	-0.807	**-1.666**	-0.678
(2,60)	162	3.92%	-2.57%	-0.041	0.475	-0.629	-0.520	-1.669	-0.408
(2,90)	159	4.10%	-5.43%	-0.116	0.459	-1.031	-1.460	**-2.683**	-1.146
(2, 120)	158	9.01%	-5.05%	-0.065	0.462	-0.955	-0.818	**-1.974**	-0.603
(31,60)	162	2.42%	-1.44%	-0.033	0.488	-0.314	-0.416	-1.321	-0.358
(61,90)	158	0.61%	-3.59%	-0.203	0.424	-1.909	**-2.550**	**-3.120**	**-2.401**
(91, 120)	157	4.80%	0.30%	0.006	0.522	0.559	0.073	0.266	0.066

Panel B. For OD Innovators With Partners

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	94	3.00%	2.30%	0.372	0.638	2.682	3.606	3.064	3.137
(-10,-2)	94	1.69%	0.87%	0.058	0.479	-0.413	0.561	0.974	0.519
(-20,-2)	94	3.83%	1.48%	0.101	0.532	0.619	0.977	0.959	0.848
(-30,-2)	94	6.22%	2.56%	0.180	0.511	0.206	**1.748**	**1.584**	**1.701**
(-60,-2)	94	8.85%	1.84%	0.155	0.521	0.413	1.502	0.936	1.435
(-90,-2)	94	10.30%	1.12%	0.116	0.532	0.619	1.126	0.402	0.983
(-120,-2)	93	16.60%	6.75%	0.205	0.521	0.413	**1.978**	**2.150**	**1.547**
(-20,-11)	94	1.90%	0.58%	0.083	0.511	0.206	0.809	0.572	0.785
(-60,-11)	94	7.11%	1.07%	0.141	0.436	-1.238	1.365	0.606	1.274
(2,10)	94	-0.15%	-0.72%	-0.033	0.479	-0.413	-0.322	-0.960	-0.335
(2,30)	94	1.04%	-1.20%	0.005	0.489	-0.206	0.044	-1.125	0.041
(2,60)	93	3.86%	-1.62%	0.078	0.505	0.104	0.752	-0.861	0.578
(2,90)	92	3.55%	-4.96%	-0.022	0.489	-0.209	-0.214	**-2.059**	-0.170
(2, 120)	92	6.85%	-4.90%	-0.007	0.500	0.000	-0.070	-1.638	-0.054
(31,60)	93	2.98%	-1.25%	0.057	0.505	0.104	0.546	-0.862	0.432
(61,90)	91	0.15%	-4.16%	-0.203	0.462	-0.734	**-1.935**	**-2.815**	**-1.848**
(91, 120)	91	4.04%	-0.07%	-0.080	0.505	0.105	-0.762	-0.048	-0.692

Table 2.9: Tests for Anticipation/Leakage and Reversal for NME Drug Announcements

The NME innovators ((radical innovation sample)) are all U.S. pharmaceutical companies that received FDA NME drug approvals from 1980 to 2013. Panel A is for all NME innovators and Panel B is for all NME innovators with at least one alliance partner. The alliance partners are identified based on the alliance sample including all strategic alliances partners among U.S. public firms in the same time period.

Panel A. For All NME innovators

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	359	4.87%	4.41%	0.724	0.641	5.331	13.713	2.258	3.585
(-10,-2)	359	1.76%	0.77%	0.066	0.540	1.531	1.241	**2.307**	1.232
(-20,-2)	359	3.31%	0.99%	0.053	0.532	1.214	0.998	**1.890**	0.973
(-30,-2)	359	3.83%	0.52%	0.028	0.490	-0.369	0.532	0.804	0.480
(-60,-2)	359	7.19%	1.50%	0.078	0.518	0.686	1.478	1.458	1.336
(-90,-2)	356	10.40%	3.30%	0.155	0.565	**2.481**	**2.932**	**2.425**	**2.422**
(-120,-2)	353	12.10%	1.44%	0.101	0.507	0.264	**1.901**	0.790	1.474
(-20,-11)	359	1.47%	0.24%	0.016	0.487	-0.475	0.305	0.706	0.312
(-60,-11)	359	5.30%	0.68%	0.050	0.501	0.053	0.949	0.748	0.905
(2,10)	359	0.35%	-0.55%	-0.032	0.448	-1.953	-0.601	-1.232	-0.555
(2,30)	359	2.02%	-1.16%	-0.103	0.460	-1.531	-1.953	-1.523	-1.771
(2,60)	358	3.71%	-2.44%	-0.139	0.453	**-1.797**	**-2.634**	**-2.147**	**-2.223**
(2,90)	356	5.52%	-3.36%	-0.152	0.444	**-2.120**	**-2.865**	**-2.468**	**-2.400**
(2, 120)	355	7.67%	-4.76%	-0.170	0.439	**-2.282**	**-3.209**	**-2.669**	**-2.587**
(31,60)	357	1.61%	-2.08%	-0.117	0.448	**-1.958**	**-2.206**	**-2.527**	**-1.861**
(61,90)	351	1.90%	-1.76%	-0.094	0.444	**-2.082**	**-1.755**	**-2.225**	**-1.601**
(91, 120)	349	1.69%	-2.07%	-0.102	0.481	-0.696	**-1.907**	**-2.255**	**-1.756**

Panel B. For NME Innovators With Partners

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	110	2.10%	1.87%	0.503	0.664	3.432	5.278	4.662	5.624
(-10,-2)	110	1.18%	0.62%	0.111	0.582	**1.716**	1.168	1.063	1.114
(-20,-2)	110	1.90%	0.23%	-0.017	0.491	-0.191	-0.180	0.290	-0.171
(-30,-2)	110	2.82%	-0.36%	-0.041	0.482	-0.381	-0.425	-0.361	-0.378
(-60,-2)	110	6.78%	1.45%	0.089	0.536	0.763	0.937	0.967	0.874
(-90,-2)	110	10.30%	4.06%	0.246	0.573	1.526	**2.585**	**2.348**	**2.307**
(-120,-2)	110	9.75%	1.10%	0.114	0.509	0.191	1.197	0.454	0.953
(-20,-11)	110	0.69%	-0.34%	-0.115	0.427	-1.526	-1.207	-0.718	-1.331
(-60,-11)	110	5.49%	0.86%	0.046	0.527	0.572	0.486	0.671	0.491
(2,10)	110	0.77%	0.58%	0.022	0.464	-0.763	0.232	1.078	0.211
(2,30)	110	0.83%	-1.21%	-0.179	0.482	-0.381	**-1.874**	-1.212	-1.640
(2,60)	110	1.84%	-2.97%	-0.254	0.400	**-2.098**	**-2.662**	**-2.138**	**-2.436**
(2,90)	109	3.71%	-3.82%	-0.234	0.404	**-2.011**	**-2.447**	**-2.050**	**-2.173**
(2, 120)	109	4.94%	-4.52%	-0.228	0.431	**-1.437**	**-2.385**	**-1.760**	**-2.030**
(31,60)	110	1.42%	-2.52%	-0.228	0.391	**-2.288**	**-2.387**	**-2.395**	**-2.199**
(61,90)	109	2.05%	-1.26%	-0.056	0.459	-0.862	-0.580	-1.143	-0.548
(91, 120)	109	1.13%	-1.10%	-0.073	0.468	-0.670	-0.758	-0.952	-0.745

Table 2.10: Tests for Anticipation/Leakage and Reversal for NDA Drug Announcements

The NDA Drug Announcements (breakthrough innovation sample) includes all FDA *Original New Drug Approvals (NDAs and BLAs)* approvals from 1990 to 2013.

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	928	1.50%	1.21%	0.279	0.556	3.414	8.501	5.020	6.149
(-10,-2)	928	1.34%	0.66%	0.032	0.499	-0.066	0.962	1.041	0.719
(-20,-2)	928	2.39%	0.70%	0.028	0.499	-0.066	0.858	1.046	0.715
(-30,-2)	928	3.26%	0.73%	0.023	0.508	0.460	0.690	1.062	0.583
(-60,-2)	928	5.22%	0.36%	0.012	0.489	-0.657	0.374	0.430	0.328
(-90,-2)	927	7.64%	0.40%	0.023	0.497	-0.197	0.709	0.393	0.609
(-120,-2)	923	9.82%	1.32%	-0.011	0.485	-0.919	-0.331	0.666	-0.243
(-20,-11)	928	1.04%	0.05%	0.010	0.484	-0.985	0.314	0.215	0.315
(-60,-11)	928	4.13%	-0.28%	-0.006	0.481	-1.182	-0.186	-0.494	-0.177
(2,10)	926	0.73%	0.02%	0.023	0.496	-0.263	0.690	0.079	0.697
(2,30)	922	1.35%	-0.98%	-0.083	0.478	-1.317	**-2.527**	**-2.411**	**-2.387**
(2,60)	918	3.40%	-1.64%	-0.077	0.455	**-2.706**	**-2.344**	**-2.585**	**-2.041**
(2,90)	916	5.32%	-2.50%	-0.090	0.473	-1.652	**-2.732**	**-2.965**	**-2.299**
(2, 120)	909	7.87%	-2.69%	-0.060	0.483	-1.028	**-1.816**	**-2.477**	**-1.452**
(31,60)	913	2.04%	-0.98%	-0.034	0.460	**-2.416**	-1.039	**-2.185**	-0.957
(61,90)	906	1.68%	-0.99%	-0.055	0.466	-2.060	-1.661	**-2.225**	-1.507
(91, 120)	893	2.42%	-0.35%	0.011	0.502	0.100	0.318	-0.720	0.273

Table 2.11: Tests for Anticipation/Leakage and Reversal for FDA Warnings

The sample of FDA warned firms includes all U.S. pharmaceutical firms getting FDA warning letters from 1997 to 2013.

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	462	-0.17%	-0.38%	-0.077	0.461	-1.675	-1.661	-1.602	-1.475
(-10,-2)	462	0.59%	0.09%	-0.044	0.498	-0.093	-0.935	0.239	-0.895
(-20,-2)	462	1.52%	-0.29%	-0.082	0.478	-0.930	-1.759	-0.468	-1.536
(-30,-2)	462	1.22%	-1.53%	-0.151	0.422	**-3.350**	**-3.244**	**-2.020**	**-2.801**
(-60,-2)	461	4.22%	-1.29%	-0.120	0.472	-1.210	**-2.587**	-1.141	**-2.206**
(-90,-2)	458	8.11%	-1.00%	-0.067	0.476	-1.024	-1.441	-0.682	-1.200
(-120,-2)	458	10.70%	-0.22%	0.016	0.489	-0.465	0.349	-0.117	0.289
(-20,-11)	462	0.99%	-0.35%	-0.067	0.470	-1.303	-1.449	-0.691	-1.246
(-60,-11)	461	3.75%	-1.37%	-0.114	0.461	-1.675	**-2.450**	-1.322	**-2.164**
(2,10)	462	0.12%	-0.40%	-0.050	0.444	**-2.419**	-1.083	-0.892	-0.965
(2,30)	462	1.49%	-0.27%	-0.057	0.481	-0.837	-1.228	-0.348	-1.163
(2,60)	462	2.31%	-0.38%	-0.042	0.474	-1.117	-0.893	-0.344	-0.827
(2,90)	462	2.57%	-1.23%	-0.068	0.476	-1.024	-1.469	-0.875	-1.328
(2, 120)	462	5.36%	-1.63%	-0.100	0.461	**-1.675**	**-2.157**	-0.930	**-1.901**
(31,60)	457	1.02%	-0.12%	0.015	0.505	0.234	0.316	-0.177	0.299
(61,90)	455	0.48%	-0.44%	-0.032	0.488	-0.516	-0.686	-0.607	-0.637
(91, 120)	453	2.98%	-0.10%	-0.029	0.490	-0.423	-0.613	-0.142	-0.593

Table 2.12: Tests for Anticipation/Leakage and Reversal for NME withdrawals

The sample of NME drug withdrawn firms includes all U.S. pharmaceutical firms withdrew NME drug from 1990 to 2013; the dates for drug withdrawals are collected from Wall Street Journal and New York Times.

Time period	Number of events in the portfolio	Mean Cumulative Raw Return	Mean Cumulative Abnormal Return	Mean Cumulative Standardized Abnormal Return	Percent of positive abnormal returns	Sign-test statistic	Patell's t-stat	Cross-sectional t-stat	Boehmer's et al. (1991) t-stat
(-1,+1)	34	-10.80%	-10.70%	-3.038	0.118	-4.459	-17.712	-3.556	-3.744
(-10,-2)	34	-1.47%	-1.31%	-0.289	0.471	-0.343	**-1.686**	-0.575	-0.778
(-20,-2)	34	-1.37%	-1.43%	-0.190	0.471	-0.343	-1.108	-0.571	-0.692
(-30,-2)	34	-0.61%	-0.30%	0.011	0.412	-1.029	0.064	-0.080	0.025
(-60,-2)	34	2.60%	2.34%	0.388	0.500	0.000	2.260	0.489	0.808
(-90,-2)	34	-1.78%	-5.70%	0.123	0.353	**-1.715**	0.717	-0.926	0.219
(-120,-2)	34	-2.99%	-12.20%	0.012	0.324	**-2.058**	0.067	**-2.167**	0.017
(-20,-11)	34	0.39%	0.00%	-0.034	0.500	0.000	-0.198	0.003	-0.152
(-60,-11)	34	4.24%	3.92%	0.505	0.559	0.686	**2.946**	0.953	1.154
(2,10)	34	-1.60%	-0.90%	-0.016	0.471	-0.343	-0.093	-0.732	-0.083
(2,30)	34	0.24%	1.77%	-0.048	0.559	0.686	-0.280	0.621	-0.165
(2,60)	33	0.64%	3.11%	0.010	0.485	-0.174	0.056	0.604	0.033
(2,90)	33	1.12%	4.60%	0.006	0.485	-0.174	0.033	0.766	0.020
(2, 120)	33	7.75%	11.50%	0.233	0.636	1.567	1.340	**1.646**	0.945
(31,60)	33	0.73%	2.86%	0.121	0.485	-0.174	0.695	0.786	0.702
(61,90)	32	0.82%	2.35%	0.135	0.438	-0.707	0.766	0.725	0.859
(91, 120)	31	7.76%	6.92%	0.322	0.548	0.539	**1.791**	**2.351**	1.416

Table 2.13: Innovator Announcements CARs Cross-sectional Analysis

The sample includes announcements events for radical innovations (FDA Orphan Drug approvals and FDA NME drug approvals), and breakthrough innovations (FDA Original New Drug Approvals). The alliance sample includes strategic alliances partners among U.S. firms in the same time period. All variables are defined in Appendix 2.A: Variable definitions. Panel A is the descriptive statistics and Panel B presents the cross-sectional regression analysis of the innovator's cumulative abnormal return (CAR) during the three-day event window (*Innovator CAR (3-day)).* T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A. Descriptive Statistics

Variables	N	Mean	SD	Min	Max
Innovator CAR (3-day) (%)	903	1.506***	5.940	-10.11	34.22
Radical innovation	903	0.313	0.464	0	1
Radical Innovation 1 (OD drug)	903	0.111	0.314	0	1
Radical Innovation 2 (NME drug)	903	0.203	0.402	0	1
Tobin's Q	877	2.818	2.130	0.23	10.78
Innovator size	897	8.251	2.259	2.24	11.67
Firm age	903	21.770	14.170	1	50
Log(Firm age)	903	2.742	0.966	0	3.91
IPO innovator	903	0.163	0.369	0	1
Allied innovator	903	0.869	0.337	0	1
Allied*Radical innovation	903	0.288	0.453	0	1
Single alliance innovator	903	0.059	0.235	0	1
Total alliances pre-event	903	2.279	1.051	0	3
JV only	903	0.020	0.140	0	1
Joint venture	903	0.523	0.500	0	1
Alliance duration	903	1.245	1.331	0	3
Public only	903	0.785	0.411	0	1
Manufacturing agreement	903	0.578	0.494	0	1
Marketing agreement	903	0.802	0.399	0	1
R&D agreement	903	0.739	0.440	0	1
Log(Horizontal allies)	903	1.960	1.463	0	6.18
Log(Total alliances)	903	2.315	1.466	0	6.85
Log(Strategic alliances)	903	2.213	1.465	0	6.70

Panel B. Cross-sectional Regression Analysis of the Innovator's Cumulative Abnormal Returns

Variables	(1) *icar3*	(2) *icar3*	(3) *icar3*	(4) *icar3*	(5) *icar3*	(6) *icar3*	(7) *icar3*	(8) *icar3*	(9) *icar3*	(10) *icar3*	(11) *icar3*
Radical innovation	0.85**	0.78*	0.86**	0.76*	5.01***	1.03**					
	(2.03)	(1.86)	(2.05)	(1.79)	(3.20)	(2.39)					
Radical Innovation 1 (OD drug)							1.00	1.04	0.91	1.09*	1.05
							(1.55)	(1.62)	(1.42)	(1.72)	(1.63)
Radical Innovation 2 (NME drug)							0.95*	1.01**	0.91*	1.08**	1.05**
							(1.86)	(1.98)	(1.79)	(2.14)	(2.04)
IPO innovator					1.60***	1.20**	1.50***	1.10*	1.45**	0.44	1.13*
					(2.73)	(2.08)	(2.64)	(1.88)	(2.56)	(0.74)	(1.88)
Innovator size	-0.65***	-0.70***	-0.63***	-0.72***							
	(-7.12)	(-7.14)	(-6.97)	(-7.51)							
Tobin's Q	-0.08	-0.11	-0.09	-0.11	0.06	0.07	0.05	0.08	0.08	0.08	0.07
	(-0.90)	(-1.12)	(-0.97)	(-1.20)	(0.60)	(0.72)	(0.55)	(0.83)	(0.80)	(0.81)	(0.78)
R&D agreement	-0.91*										
	(-1.95)										
Log(Horizontal allies)		-0.03									
		(-0.18)									
Joint venture			-1.18***								
			(-2.92)								
Allied innovator				0.17	-0.41						
				(0.27)	(-0.57)						
Allied*Radical innovation					-4.36***						
					(-2.67)						
Log(Strategic alliances)						-0.53***					
						(-3.46)					
Single alliance innovator						-1.51*					
						(-1.71)					
Public only							-1.00*				
							(-1.95)				
Log(Total alliances)								-0.48***			
								(-3.26)			
Manufacturing agreement									-0.97**		
									(-2.27)		
Marketing agreement										-3.06***	
										(-5.54)	
Alliance duration											-0.09
											(-0.57)
Total alliances pre-event											-0.55**
											(-2.48)
Constant	7.59***	7.44***	7.38***	7.42***	1.20	2.10***	1.64***	1.96***	1.37***	3.39***	2.20***
	(8.91)	(8.62)	(8.71)	(8.48)	(1.59)	(4.12)	(2.97)	(3.89)	(3.14)	(5.78)	(3.54)
Observations	877	877	877	877	877	877	877	877	877	877	877
Adjusted R^2	0.0745	0.0705	0.0795	0.0706	0.0239	0.0262	0.0162	0.0238	0.0178	0.0456	0.0192

Table 2.14: Partner Announcements CARs Cross-sectional Analysis

The sample includes announcements events for radical innovations (FDA Orphan Drug approvals and FDA NME drug approvals), and breakthrough innovations (FDA Original New Drug Approvals). The alliance sample includes strategic alliances partners among U.S. public firms in the same time period. All variables are defined in Appendix 2.A: Variable definitions. Panel A is the descriptive statistics and Panel B presents the cross-sectional regression analysis of the average partners' cumulative abnormal returns (CAR) during the three-day event window. T-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A. Descriptive Statistics

Variables	N	Mean	SD	Min	Max
Partner CAR (3-day) (%)	2,433	0.277***	5.369	-13.20	18.40
Partner Tobin's Q	2,433	2.532	2.073	0.14	11.53
Partner size	2,433	6.195	2.544	2.01	11.82
Log(Partner firm age)	2,433	2.508	0.822	0	3.91
IPO partner	2,433	0.170	0.375	0	1
Single alliance partner	2,433	0.225	0.418	0	1
Innovator size	2,433	9.266	1.673	3.58	12.18
Innovator Tobin's Q	2,433	3.249	2.136	0.35	9.94
Radical Innovation	2,433	0.258	0.437	0	1
Radical Innovation 1 (OD drug)	2,433	0.126	0.332	0	1
Radical Innovation 2 (NME drug)	2,433	0.132	0.338	0	1
Breakthrough Innovation (NDA drug)	2,433	0.742	0.437	0	1
Innovator CAR (3-day) (%)	2,433	0.799	3.731	-7.29	16.88
Log(Num ptn per innovator)	2,433	1.981	0.938	0	4.49
Log(Alliance duration)	2,433	7.050	1.131	0.69	9.09
Horizontal allies	2,433	0.681	0.466	0	1
Strategic alliance	2,433	0.952	0.213	0	1
Licensing agreement	2,433	0.323	0.468	0	1
Manufacturing agreement	2,433	0.162	0.369	0	1
R&D agreement	2,433	0.695	0.460	0	1
Supply agreement	2,433	0.002	0.041	0	1
Funding agreement	2,433	0.090	0.286	0	1
Joint venture	2,433	0.048	0.213	0	1
Marketing agreement	2,433	0.353	0.478	0	1

Panel B. Cross-sectional Regression Analysis of the Average Partners' CARs

Variables	(1) *pmcar3*	(2) *pmcar3*	(3) *pmcar3*
Innovator CAR(3-day)	0.16***	0.09***	0.16***
	(10.64)	(4.87)	(10.51)
Radical Innovation 1 (OD drug)	0.23		
	(1.36)		
Radical Innovation		-0.14	0.03
		(-1.04)	(0.22)
Innovator CAR(3-day)*Radical		0.18***	
		(5.84)	
IPO partner		0.35**	0.28*
		(2.34)	(1.79)
Partner Tobin's Q	0.06**	0.07***	0.07***
	(2.39)	(2.77)	(2.65)
Log(Partner firm age)	-0.23***		
	(-3.13)		
Innovator Tobin's Q	0.19***	0.20***	0.19***
	(6.95)	(7.55)	(7.01)
Innovator Size			-0.05
			(-1.35)
Relative Size	0.00		
	(0.85)		
Log(Num ptn per innovator)	-0.15**	-0.14**	-0.11
	(-2.40)	(-2.32)	(-1.55)
Log(Alliance duration)	-0.14***	-0.14***	-0.15***
	(-2.77)	(-2.82)	(-2.87)
Strategic alliance	0.40		
	(1.52)		
Manufacturing agreement		0.14	
		(0.95)	
Funding agreement			0.22
			(1.10)
Single alliance partner			0.28**
			(2.01)
Constant	0.83*	0.55	0.97*
	(1.84)	(1.36)	(1.87)
Observations	2,433	2,433	2,433
Adjusted R^2	0.0797	0.0899	0.0788

APPENDICES

APPENDIX 1.A: VARIABLE DEFINITIONS

Variables	Definitions
Acquirer size	Log value of acquirer total assets ($ millions)
Alliance-acquisition align	Dummy variable indicating that targets have horizontal alliances and also the acquisitions are horizontal based on three-digit SIC code
Alliance duration (in days)	Number of days from the target's alliance announcement to the acquisition announcement date
Alliance duration	Categorical variable that is transformed based on the number of years from the target's alliance announcement to the acquisition announcement date: 0 if no alliance; 1 if alliances are within one year on average; 2 if alliances are within two year on average; 3 if alliances are within two to five years on average
Allied firm	Alliance indicator for IPOs or targets
Allied IPO	IPOs with alliances in 5 years prior to public offerings
*Allied*private*	Interaction term between allied target and private firm
Allied target	Dummy variable which takes the value 1 if the target makes at least one alliance in 5 years preceding the acquisition announcement, zero otherwise.
Analyst coverage	Logarithm of one plus the number of analysts covering the targets within one year prior to the acquisitions
Brokerage acquisition	Indicator variable which takes the value of 1 for acquisitions where acquirers and targets share common alliance partner, and zero otherwise
Biotech	Biotech industry category (100s) based on SDC special high-tech classification code
Book value per share	Book value per share from SDC
Bubble	Indicator variable which takes the value of 1 if the merger was announced during the stock market bubble period of 1999-2000, and zero otherwise
Cash	Dummy variable which takes the value 1 if the acquisition is paid purely by cash, and zero otherwise.
Cash-Asset	Ratio of cash to total assets
Computer equipment	Computer equipment industry category (200s) based on SDC special high-tech classification code
Communications	Communications industry category (400s) based on SDC special high-tech classification code
Cross Tech Transfer	Dummy variable indicating that the target makes at least one cross technology transfer agreement with their alliance partners in the last 5 years
Diversifying	Dummy variable indicating that the acquirers and the targets have different three-digit SIC codes
Industry DER	Industry long-term debt to market value of equity ratio by three-digit SIC code
Earnout	Dummy variable indicating that the acquisition uses earnout contracts
EBITDA	Earnings before taxes plus amortization and depreciation
Electronics	Electronics industry category (300s) based on SDC special high-tech classification code
Exploration agreement	Dummy variable indicating that the target makes at least one exploration agreement with their alliance partners in the last 5 years
Funding agreement	Dummy variable indicating that the target makes at least one funding agreement with their alliance partners in the last 5 years
High tech firm	Indicator variables for high-tech targets or IPOs
High tech IPO	Dummy variable that equals one if the IPO is classified as high-tech, zero otherwise
High tech target	Dummy which takes the value 1 if the target is in the high-tech industry, and zero otherwise.
Horizontal alliance	Dummy variable indicating that the target has at least one alliance partner that share the same 3-digit SIC code with the target

Horizontal merger	Dummy variable indicating that the target and acquirer share the same 3-digit SIC code
Hot IPO market	A time-varying covariate defined as the monthly average change between the offer price and the closing bid price on the first day of aftermarket trading during 1990 to 2010, following Ritter (1984)
IB-advisor	Dummy variable which takes the value 1 if the target hires any investment bank advisor, and zero otherwise.
Industry NPM	Industry net (after-tax) profit margin by three-digit SIC code
Industry return	Lagged six-month industry return by three-digit SIC code
Insider	Insider ownership after public offering
Joint venture	Dummy variable indicating that the target makes at least one joint venture agreement with their alliance partners in the last 5 years
JV only	Dummy variable indicating that the target makes at least one joint venture agreement and no strategic alliance with their alliance partners in the last 5 years
Leverage	Total debt scaled by total assets
Licensing agreement	Dummy variable indicating that the target makes at least one licensing contract with their alliance partners in the last 5 years
Liquidity	Cash payments to selling insiders
Log (Age)	Logarithm of one plus the number of years since the target or IPO firms founded.
Log (Assets)	Log value of total assets
Log(Cross Tech Transfer)	Logarithm of one plus the number of cross tech transfer alliances the target or IPO makes in the last 5 years
Log(Horizontal alliances)	Logarithm of one plus the number of alliance partners in the last 5 years that share the same 3-digit SIC code with the target or IPO
Log(IPO market cap.)	Logarithm of the IPO's market capitalization at the end of its first day trading—the total number of shares outstanding multiplied by the closing price at the end of the first trading day.
Log(Licensing agreements)	Logarithm of one plus the number of licensing alliances the target or IPO makes in the last five years
Log(Manufacturing agreements)	Logarithm of one plus the number of manufacturing alliances the target or IPO makes in the last five years
Log(Private only alliances)	Logarithm of one plus the number of alliances with only private firm involved in the last five years
Log (Proceeds)	Log value of the amount of IPO proceeds ($ millions)
Log(Public alliance partners)	Logarithm of one plus the number of public alliance partners, where alliance partners' public status is defined as both as of alliance announcement dates (based on SDC alliance data) and as of acquisition announcement dates (based on Compustat and CRSP data).
Log(Public involved alliances)	Logarithm of one plus the number of alliances with public firm involved in the last five years
Log(R&D alliances)	Logarithm of one plus the number of R&D alliances the target or IPO makes in the last five years
Log(Strategic alliances)	Logarithm of one plus the number of strategic alliances the target or IPO makes in the last five years
Log(Total alliances)	Logarithm of one plus the total number of alliances the target makes in the last five years
Industry M/B	Industry average market to book ratio from CRSP & Compustat
Manufacturing agreement	Dummy variable indicating that the target makes at least one manufacturing agreement with its alliance partners.
Market return	Lagged six-month CRSP market index return
Non-horizontal ally	Dummy variable indicating that the target has alliance partner that do not share the same 3-digit SIC code with the target
*Non-horizontal ally*diversify*	Interaction term between non-horizontal ally and diversifying acquisition, indicating that the target has alliance partner(s) that do not share the same 3-digit SIC code with the target, and the target later is acquired in a diversifying acquisition
Offer price	IPO offer price from SDC
OPMAD-mean	Industry operating profit margin after depreciation by three-digit SIC code
Other high-tech	Other high-tech industry category (500s) based on SDC special high-tech classification code
Partner acquisition	Dummy variable indicating that the target is acquired by its previous alliance partner
Private only alliance	Dummy variable indicating that the target has at least one alliance with only private firm involved in the last fives
Price book value	Price book value from SDC
Private involved alliances	Dummy variable indicating that the target has at least one alliance with private firm involved in the last 5 years

Private target	Dummy which takes the value 1 if the target is a private company, and zero otherwise.
Proceeds	Amount of proceeds in the market ($ millions) from SDC
Public alliance partner	Indicator variable which takes the value 1 if the firm has at least one an alliance partner that is publicly listed both as of alliance announcement dates (based on SDC alliance data) and as of acquisition announcement dates (based on Compustat and CRSP data)
Public Involved alliance	Dummy variable indicating that the target has at least one alliance with public firm involved in the last 5 years
Public only alliance	Dummy variable indicating that the target has at least one alliance with only public firm involved in the last 5 years
Public target	Dummy variable which takes the value 1 if the target is a listed company, and zero otherwise.
R&D alliance	Dummy variable indicating that the target makes at least one research and development contract with their alliance partners in the last 5 years
Industry RDS	Industry R&D intensity by three-digit SIC code
Relative size	Target total assets scaled by acquirers total assets (both from SDC)
Partial adjustment	Percentage difference from offer price to the midpoint of the file range
ROA	Return on total assets from SDC
Industry ROA	Industry return on average assets by three-digit SIC code
Share Overhang	Pre-IPO shares retained for all classes divided by shares filed (including primary and secondary shares)
Stock	Dummy variable which takes the value 1 if the acquisition is paid purely by stock, and zero otherwise.
Strategic alliance	Dummy variable indicating that the target makes at least one strategic alliance agreement with its alliance partners in the last 5 years
Subsidiary involved alliance	Dummy variable indicating that the target has at least one alliance with one subsidiary firm involved in the last five years
Subsidiary only alliance	Dummy variable indicating that the target has at least one alliance with only subsidiary firms involved in the last five years
Supply agreement	Dummy variable indicating that the target makes at least one supply agreement with its alliance partners in the last 5 years
Target premium	Acquisition transaction value to sales ratio: the amount paid for the sell-out firm, divided by the sell-out firm's sales in the year prior to the takeover announcement
Target size	Log value of target total assets ($ millions)
Tech bubble	High-tech targets that are acquired during the bubble period
Tobin's Q	The Q of the target is based on the Chung and Pruitt (1994) estimation: Approximate q = (MV + PS + DEBT) / TA, where: MV = the market value of equity; PS = the liquidating value of the firm's outstanding preferred stock; DEBT = the value of the firm's current liabilities minus current assets plus the book value of long-term debt; and TA = the book value of total assets of the firm
Top tier underwriter	Dummy variable for IPOs that were taken public by an investment bank with a Carter-Manaster ranking of 8 or above on a 1-9 point scale.
Total alliances, 5 years	Total number of alliances the target makes in the last five years
Total alliances	Categorical variable that measures the total number of alliances the target or IPO makes in the last five years: 0 if no alliance in last five years; 1 if one alliance partner; 2 if 2 to 5 alliance partners; 3 if more than five alliance partners
Underpricing	Percentage change in price from the initial offer price to the first-day market price
VC-backing	Dummy variable if the target is backed by venture capital, and zero otherwise

APPENDIX 2.A: VARIABLE DEFINITIONS

Variables	Definitions
Allied innovator	Alliance indicator for innovators
Breakthrough Innovation (NDA drug)	Dummy variable indicating that the innovation is a FDA Original New Drug (NDA) approval
Cross Tech Transfer	Dummy variable indicating that the innovator makes at least one cross technology transfer agreement with their alliance partners in the past
Exploration agreement	Dummy variable indicating that the innovator makes at least one exploration agreement with their alliance partners in the past
Funding agreement	Dummy variable indicating that the innovator makes at least one funding agreement with their alliance partners in the past
Horizontal alliance	Dummy variable indicating that the innovator has at least one alliance partner that share the same 3-digit SIC code with the innovator
Innovator size	Log value of acquirer total assets ($ millions)
Innovator CAR (3-day)	Innovator's cumulative abnormal return (CAR) during the three-day event window
*Innovator CAR(3-day)*OD*	Interaction variable between Innovator CAR (3-day) and Radical Innovation 1 (OD drug)
*Innovator CAR(3-day)*NME*	Interaction variable between Innovator CAR (3-day) and Radical Innovation 2 (NME drug)
*Innovator CAR(3-day)*Radical*	Interaction variable between Innovator CAR (3-day) and Radical Innovation
IPO innovator/partner	Innovators or partners that have innovation events within five years after publicly listed based on Compustat and CRSP database
Joint venture	Dummy variable indicating that the innovator makes at least one joint venture agreement with their alliance partners in the past
JV only	Dummy variable indicating that the innovator makes at least one joint venture agreement and no strategic alliance with their alliance partners in the past
Licensing agreement	Dummy variable indicating that the innovator makes at least one licensing contract with their alliance partners in the past
Log(Alliance duration)	Logarithm of the number of days from alliance formation to innovation event
Log(Firm Age)	Logarithm of one plus the number of years since the innovator firms listed on CRSP&Compustat.
Log(Cross Tech Transfer)	Logarithm of one plus the number of cross tech transfer alliances the innovator makes in the past
Log(Horizontal alliances)	Logarithm of one plus the number of alliance partners in the past that share the same 3-digit SIC code with the innovator.
Log(Licensing agreements)	Logarithm of one plus the number of licensing alliances the innovator makes in in the past
Log(Manufacturing agreements)	Logarithm of one plus the number of manufacturing alliances the innovator makes in in the past
Log(Num ptn per innovator)	Logarithm of the number of partners per innovator on one innovation event
Log(R&D alliances)	Logarithm of one plus the number of R&D alliances the innovator makes in in the past
Log(Strategic alliances)	Logarithm of one plus the number of strategic alliances the innovator makes in in the past
Log(Total alliances)	Logarithm of one plus the total number of alliances the innovator makes in in the past
Manufacturing agreement	Dummy variable indicating that the innovator makes at least one manufacturing agreement with its alliance partners.
Partner CAR(3-day)	Average partner cumulative abnormal return (CAR) during the three-day event window for each innovation event
Radical Innovation	Dummy variable indicating that the innovation is a FDA Orphan Drug (OD) or NME drug approval
Radical Innovation 1 (OD drug)	Dummy variable indicating that the innovation is a FDA Orphan Drug (OD) approval
Radical Innovation 2 (NME drug)	Dummy variable indicating that the innovation is a FDA NME drug approval
R&D agreement	Dummy variable indicating that the innovator makes at least one research and development contract with their alliance partners in the past
Relative size	Partner market equity capitalization scaled by innovator market equity capitalization (both from Compustat) at the end of the year of the innovation event
Single alliance innovator	Dummy variable indicating that an innovator have only one alliance partner
Single alliance partner	Dummy variable indicating that an alliance partner have only one innovator as partner
Strategic alliance	Dummy variable indicating that the innovator makes at least one strategic alliance agreement with its alliance partners in the past
Supply agreement	Dummy variable indicating that the innovator makes at least one supply agreement with its alliance partners in the past
Innovator/Partner Tobin's Q	The Q of the innovator or Partner is based on the Chung and Pruitt (1994) estimation: Approximate q = (MV + PS + DEBT) / TA, where: MV = the market value of equity; PS = the

	liquidating value of the firm's outstanding preferred stock; DEBT = the value of the firm's current liabilities minus current assets plus the book value of long-term debt; and TA = the book value of total assets of the firm
Total alliances pre-event	Categorical variable that measures the total number of alliances the innovator makes in the past: 0 if no alliance in last five years; 1 if one alliance partner; 2 if 2 to 5 alliance partners; 3 if more than five alliance partners

APPENDIX 2.B: NDA APPROVALS BY THERAPEUTIC POTENTIAL AND CHEMICAL TYPE

The following table gives a snapshot of the distribution of different types of NDA approvals. Source: FDA website: "NDA Approvals by Therapeutic Potential and Chemical Type" http://www.fda.gov/Drugs/DevelopmentApprovalProcess/HowDrugsareDevelopedandApproved/DrugandBiologicApprovalReports/ucm121102.htm

Year	Therapeutic Potential - Priority Review* and Chemical Type***								Therapeutic Potential - Standard Review** and Chemical Type***								Total Approvals
	1	2	3	4	5	6	7	Total	1	2	3	4	5	6	7	Total	
1990	12	0	8	0	0	0	0	**20**	11	2	23	2	2	4	0	**44**	**64**
1991	14	0	5	0	0	0	0	**19**	16	1	15	2	10	0	0	**44**	**63**
1992	11	0	5	0	1	0	0	**17**	15	1	30	5	21	1	1	**74**	**91**
1993	13	0	6	0	0	0	0	**19**	12	0	18	1	18	2	0	**51**	**70**
1994	13	0	4	0	0	-	0	**17**	9	0	23	5	8	-	0	**45**	**62**
1995	9	1	5	0	0	-	0	**15**	19	5	30	2	11	-	0	**67**	**82**
1996	18	0	10	0	1	-	0	**29**	35	5	50	4	7	-	1	**102**	**131**
1997	9	1	6	1	3	-	0	**20**	30	2	52	12	4	-	1	**101**	**121**
1998	16	0	9	0	0	-	0	**25**	14	0	46	4	0	-	1	**65**	**90**
1999	19	1	7	1	0	-	0	**28**	16	2	32	3	2	-	0	**55**	**83**
2000	9	1	9	1	0	-	0	**20**	18	0	48	7	3	-	2	**78**	**98**
2001	7	1	1	0	1	-	0	**10**	17	1	23	9	5	-	1	**56**	**66**
2002	7	0	3	1	0	-	0	**11**	10	2	44	5	6	-	0	**67**	**78**
2003	9	0	4	1	0	-	0	**14**	12	5	31	7	3	-	0	**58**	**72**
2004	17	0	4	1	3	-	0	**25**	14	1	59	5	8	-	1	**88**	**113**

*__Priority Review__ - Significant improvement compared to marketed products in the treatment, diagnosis, or prevention of a disease;
**__Standard Review -__ The drug appears to have therapeutic qualities similar to those of one or more already marketed drugs;
***__Chemical Types__:

1 - New molecular entity
2 - New ester, new salt, or other noncovalent derivative
3 - New formulation
4 - New combination
5 - New manufacturer
6 - New indication (Beginning in 1994, Type 6 NDAs were tracked as efficacy supplements)
7 - Drug already marketed, but without an approved NDA

APPENDIX 2.C: FDA GLOSSARY OF TERMS FOR DRUGS

Abbreviated New Drug Application (ANDA)
An Abbreviated New Drug Application (ANDA) contains data that, when submitted to FDA's Center for Drug Evaluation and Research, Office of Generic Drugs, provides for the review and ultimate approval of a generic drug product. Generic drug applications are called "abbreviated" because they are generally not required to include preclinical (animal) and clinical (human) data to establish safety and effectiveness. Instead, a generic applicant must scientifically demonstrate that its product is bioequivalent (i.e., performs in the same manner as the innovator drug). Once approved, an applicant may manufacture and market the generic drug product to provide a safe, effective, low cost alternative to the American public.

Active Ingredient
An active ingredient is any component that provides pharmacological activity or other direct effect in the diagnosis, cure, mitigation, treatment, or prevention of disease, or to affect the structure or any function of the body of man or animals.

Biologic License Application (BLA)
Biological products are approved for marketing under the provisions of the Public Health Service (PHS) Act. The Act requires a firm who manufactures a biologic for sale in interstate commerce to hold a license for the product. A biologics license application is a submission that contains specific information on the manufacturing processes, chemistry, pharmacology, clinical pharmacology and the medical affects of the biologic product. If the information provided meets FDA requirements, the application is approved and a license is issued allowing the firm to market the product.

Brand Name Drug
A brand name drug is a drug marketed under a proprietary, trademark-protected name.

Chemical Type
The Chemical Type represents the newness of a drug formulation or a new indication for an existing drug formulation. For example, Chemical Type 1 is assigned to an active ingredient that has never before been marketed in the United States in any form. (list of Chemical Types and their meanings).

Company
The company (also called applicant or sponsor) submits an application to FDA for approval to market a drug product in the United States.

Generic Drug
A generic drug is the same as a brand name drug in dosage, safety, strength, how it is taken, quality, performance, and intended use. Before approving a generic drug product, FDA requires many rigorous tests and procedures to assure that the generic drug can be substituted for the brand name drug. The FDA bases evaluations of substitutability, or "therapeutic equivalence," of generic drugs on scientific evaluations. By law, a generic drug product must contain the identical amounts of the same active ingredient(s) as the brand name product. Drug products evaluated as "therapeutically equivalent" can be expected to have equal effect and no difference when substituted for the brand name product.

New Drug Application (NDA)
When the sponsor of a new drug believes that enough evidence on the drug's safety and effectiveness has been obtained to meet FDA's requirements for marketing approval, the sponsor submits to FDA a new drug application (NDA). The application must contain data from specific technical viewpoints for review, including chemistry, pharmacology, medical, biopharmaceutics, and statistics. If the NDA is approved, the product may be marketed in the United States. For internal tracking purposes, all NDA's are assigned an NDA number.

New Molecular Entity (NME)
A New Molecular Entity is an active ingredient that has never before been marketed in the United States in any form.