

The influence of firm and industry characteristics on returns from technology licensing deals: evidence from the US computer and pharmaceutical sectors

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This study examines the relationships between firm and industry characteristics and firms' abnormal stock market returns accompanying the announcement of technology licensing deals. In particular, I examine the fit among firms' licensing activities, their resource endowments, and their industry context, and develop hypotheses on its impact on abnormal stock market returns after licensing deals. Analyzing 11 years of inward and outward licensing transactions in the US computer and pharmaceutical industries between 1990 and 2000, I find support for my argument that while firms profit from both inward and outward licensing, the magnitude of such profits is determined by licensing firms' resource endowments, and that these determinants have a different impact in different industry contexts. Understanding these relationships helps explain when firms should use licensing to exploit their proprietary technologies and make better predictions about the impact of licensing transactions on firm performance.

1. Introduction

Technology licensing agreements are one of the most frequently observed interfirm relationships in high-technology industries, and one of the most important options available for exchanging technology and facilitating research and development (R&D) collaboration (Anand and Khanna, 2000b; Arora and Fosfuri, 2003; Fosfuri, 2006; Tidd and Trewhella, 1997). A licensing agreement is constituted by a sourcing firm purchasing the rights to another firm's patents or technology for a lump sum

payment and/or royalties (McDonald and Leahey, 1985; Hagedoorn and Heslen, 2007). The literature has identified numerous benefits of technology licensing, ranging from reducing product development risks and costs (Lowe and Taylor, 1999), and extracting the remaining value from a mature technology (Telesio, 1979), to more proactive, strategic advantages such as achieving rapid market penetration (Lei and Slocum, 1991), leveraging competitive advantages (Kollmer and Dowling, 2004), and yielding higher returns on the firm's investment in innovation (McDonald and Leahey, 1985).

Not surprisingly, then, there is evidence that licensing agreements create a substantial amount of value for participating firms. Between 1985 and 1997, Arora et al. (2001) identified more than 15,000 reported technology licensing transactions worldwide, with a total value of over \$320 billion. In the United States alone, technology licensing revenues are estimated to account for \$45 billion annually, while the worldwide figure is around \$100 billion (The Economist, 2005). There is also anecdotal evidence of firms becoming successful brokers in their industries' technology flow networks by actively managing their portfolio of inward and outward licensing agreements (Lichtenthaler, 2011). IBM, for instance, had licensing revenues of over \$1 billion in 1998, accounting for over 10% of its net profits (Rivette and Kline, 1999), and Texas Instruments earned more than \$1.8 billion in royalties between 1986 and 1993, which is comparable with its cumulative net income during that period (Grindley and Teece, 1997).

In spite of its unquestioned popularity and revenue potential, several studies have raised concerns about firms relying on technology licensing. Licensing *from* another firm (i.e., inward licensing) may leave the sourcing firm with low morale among internal R&D staff, limited comprehension of and control over the obtained technology, and therefore an increasing dependence on the licensor for the maintenance of the technology (Sen and Rubenstein, 1989; Lowe and Taylor, 1999). Licensing *to* another firm (i.e., outward licensing) entails a trade-off between royalties and lower price-cost margins and/or reduced market share due to increased competition (Fosfuri, 2006). Focusing on licensing out technology instead of being actively involved in product markets not only risks the erosion of a firm's innovative capabilities, but also tends to be less financially rewarding than developing and commercializing new technologies (Grindley and Teece, 1997).

Given these advantages and disadvantages of technology licensing, it is surprising that very few studies have empirically examined the impact of licensing agreements on firm performance. The only large-sample empirical study of the performance impact of licensing I am aware of, Anand and Khanna (2000a), found that over a 14-day window surrounding the event day, licensing agreements generate an average cumulative abnormal returns (CARs) of 3.13%. However, even this study did not distinguish between different types of licensing (inward versus outward), nor did it find any significant determinant of abnormal returns from licensing other than licensing experience.

My study extends prior research by examining the relationships between firm and industry characteristics and firms' abnormal stock market returns from their technology licensing activities in US pharmaceutical and computer industries. I intend to make three contributions. First, complementing previous empirical studies that focused on either inward (e.g., Killing, 1978; Tsai and Wang, 2007; Leone and Reichstein, 2012) or outward licensing (e.g., Fosfuri, 2006; Lichtenthaler and Ernst, 2008a; Bianchi et al., 2011), I investigate both inward and outward licensing transactions simultaneously, and present empirical insights into their distinct potential to generate abnormal stock market returns for the involved companies. Second, I explicitly incorporate the fit of firms' licensing activities with their resource endowment by arguing that a number of strategic motives for both inward and outward technology licensing behavior are consistent with the firms' desires to leverage their strengths while accessing resources and competencies they do not possess from other firms, and find that it is this fit that determines licensing returns. And third, contrasting licensing activity and abnormal stock market returns in the computer and pharmaceutical industries, I find support for the argument that technology licensing motives – and their associated effects on stock market returns – have a different relevance for different industry contexts. Understanding these contingent relationships among firm characteristics, industry characteristics, and returns from licensing helps explain when firms should use this particular market option to exploit their proprietary technology, and make better predictions about what impact different types of licensing activities have on firm performance.

2. Technology licensing agreements

To obtain technological know-how, firms can choose between their own internal R&D and external methods, such as acquiring another company that already possesses the technology, or entering into a technology sourcing agreement with an outside party (Steensma and Corley, 2000). In industries where the expansion, complexity, and cross-sectoral nature of technology increase rapidly, it becomes increasingly dispersed, and it becomes more and more difficult for a single firm to possess all resources required to develop and sustain current competitive capabilities while simultaneously trying to build new ones (Dyer and Singh, 1998; Grant and Baden-Fuller, 2004). As a result, different organizations specialize in specific aspects of their field, and the locus of production lies no longer within the boundaries of a single organiza-

tion but instead at the nexus of relationships between a variety of parties that contribute to the production function (Powell et al., 1996). Licensing agreements have, therefore, become important mechanisms for exchanging technology and facilitating R&D collaboration (Anand and Khanna, 2000b; Arora and Fosfuri, 2003; Fosfuri, 2006).

2.1. Inward licensing

Developing a new technology in-house is both expensive and risky. Through licensing, a firm can acquire a technology already technically or commercially proven (Teece, 1986; Hill, 1997), and obtain it more rapidly than through internal development (Hill, 1992; Schilling and Steensma, 2002). While inward technology licensing is unlikely to be a source of sustainable competitive advantage by itself (Tsai and Wang, 2007) – because a technology that is available for license is typically available to many potential licensees – the ability to rapidly acquire needed technology can substantially reduce product development risks (Lowe and Taylor, 1999) and time (Leone and Reichstein, 2012), allow a firm to diversify into new markets (Killing, 1978), and help a firm exploit its own advantages more effectively and/or efficiently (Gold, 1987).

On the downside, licensing provides the licensee with limited control over the technology because the rights to the technology may be restricted by the contract (McDonald and Leahey, 1985),¹ and because the licensee does not control the human capital that created the technology. These conditions might lead to a loss of control over strategic decisions in the use of the licensed technology and a feeling of low morale among the licensee's internal R&D staff (Sen and Rubenstein, 1989; Atuahene-Gima and Patterson, 1993). Moreover, the licensee typically receives highly compartmentalized technology and may not fully comprehend the knowledge that supports this technology (McDonald and Leahey, 1985). As a result, the licensee may be unable to determine how that technology should change over time, and it may grow increasingly dependent upon its licensor for the maintenance of the technology (Steensma and Fairbank, 1999). Over time, however, licensees may gain valuable knowledge from working with the licensed technology that can enable them to later develop their own proprietary technologies.

2.2. Outward licensing

Firms can generate value from their innovation not only by embedding it in new products and processes, but also by generating fees through engaging in

outward licensing agreements (Grindley and Teece, 1997; Lichtenthaler and Ernst, 2008a). However, outward technology licensing is not only a means to commercialize financially unattractive projects (Kollmer and Dowling, 2004) and maintain focus on a firm's core business (Bianchi et al., 2010), but can further enable a firm to rapidly expand its technology to a wider range of markets than it could on its own (Lei and Slocum, 1991), leveraging its competitive advantages and yielding greater returns on the firm's investment in innovation (McDonald and Leahey, 1985; Kollmer and Dowling, 2004; Lichtenthaler, 2011).

Outward licensing entails a trade-off, however, as licensing revenues must be balanced against the lower price-cost margin and/or reduced market share implied by increased competition in the product market (Fosfuri, 2006; Bianchi et al., 2011). Moreover, becoming a pure licensing company – that is, a firm that is no longer directly involved in the product market and is increasingly remote from the manufacturing and design of the product itself – can be a risky strategy. Such a strategy may not only be less financially rewarding than developing and commercializing products, but may also risk the erosion of a firm's dynamic capabilities to continue innovating (Grindley and Teece, 1997; Mudambi and Tallman, 2010).

In the next section, I will build on these diverse advantages and disadvantages of inward and outward technology licensing, and theorize about their distinct effects on firms' abnormal stock market returns after licensing deals.

3. Determinants of abnormal stock market returns after licensing deals

Many of the differential advantages between firms in high-technology industries derive from firm size and R&D intensity, defined as a firm's R&D expenses in relation to its sales e.g., (Atuahene-Gima, 1993; Fu and Perkins, 1995; Kim, 2005; Fosfuri, 2006; Gopalakrishnan and Bierly, 2006; Gambardella et al., 2007). Concerning the former, there is a considerable body of research that debates whether large firms or small firms are more effective innovators. Whereas large firms have a few notable advantages in innovation, including greater economies of scale in R&D, learning curve advantages, and most importantly, complementary assets which allow them to better exploit innovations (Cohen and Levinthal, 1990; van Wijk et al., 2008), large firms also have a number of innovation disadvantages, such as rigidities and bureaucratic inertia, incentive systems unfavorable to innovation and change, and a loss of managerial

control (Cohen and Levin, 1989; Leonard-Barton, 1992). Concerning the latter, a firm's R&D intensity is a crucial factor in technology licensing as it not only generates innovative technologies and products with a potential to license out, but also determines the firm's absorptive capacity, which enables the firm to more easily assimilate, combine, and utilize technologies obtained through inward licensing (Cohen and Levinthal, 1990; Tsai and Wang, 2007; van Wijk et al., 2008).

While there are other firm-level determinants I could potentially examine (such as distribution infrastructure and global presence), for my purposes, it suffices to focus on these two factors that are arguably most crucial in determining the differential advantages of firms operating in high-technology industries, and that the licensing literature has therefore identified as the most important determinants of technology licensing (e.g., Atuahene-Gima, 1993; Kim, 2005; Fosfuri, 2006; Gopalakrishnan and Bierly, 2006; Gambardella et al., 2007). I further complement this focus with an examination of the extent that licensing partners' businesses are related. The related business experience of the licensing firm has been conceptualized as a source of complementary assets (Tripsas, 1997), affecting technology integration and further deployment, and therefore likely influencing firms' returns from licensing deals. In the next section, I will discuss these motives and their effects on abnormal stock market returns in the context of a firm's inward and outward licensing activities.

3.1. Firm size

The literature on technology licensing has maintained that there are trade-offs related to firm size when it comes to the companies' abilities to benefit from inward licensing. Echoing the resource-dependence perspective (Pfeffer and Salancik, 1978), a number of licensing researchers have argued that the innovation advantages of smaller firms – such as higher flexibility, less bureaucratic inertia, incentive systems more favorable to innovation and change, and more direct managerial control (Cohen and Levin, 1989) – can be unlocked by inward licensing, which provides access to necessary complementary resources (Lowe and Taylor, 1998; Bianchi et al., 2010). In addition to tangible resources, smaller, fledgling firms may also lack legitimacy in the marketplace (Stinchcombe, 1965), which could be mitigated by being associated with a more established player from which a smaller firm is sourcing technology (Stuart et al., 1999). These effects, however, should diminish with increasing size. At low levels of

firm size, I would thus expect a negative effect of firm size on abnormal stock market returns after inward licensing deals.

Other researchers have argued that the successful commercialization of an externally sourced technology requires the knowledge in question to be used in conjunction with other capabilities, that is, complementary resources (Teece, 1986), which are more likely to be present with increasing firm size. Smaller firms, in contrast, will either have to incur the expense of trying to build these complementary resources or have to develop coalitions with competitors/owners of specialized assets (Teece, 1986). Moreover, with increasing size, firms have a deeper pool of technical and managerial talent to draw from during the technology acquisition process, whereas even a technologically competent smaller firm may be unable to master the additional demands placed on its scarce managerial and technical manpower (Teece, 1977). Following this line of reasoning, with increasing size, firms should be more likely to profit from inward technology licensing because they are better able to commercialize the licensed technology with their significant financial, marketing, and manufacturing resources (Ford, 1985; Lowe and Taylor, 1998). At high levels of firm size, then, I would expect a positive relationship between firm size and inward licensing returns.

This interaction of countervailing effects suggests a curvilinear relationship between firm size and abnormal stock market returns after inward licensing deals. Thus, I propose:

Hypothesis 1a: All else equal, firm size has a quadratic (U-shaped) relationship with abnormal stock market returns after inward technology licensing deals.

Similar to the discussion of inward licensing, there are trade-offs with respect to size on firms' propensity to develop technologies with a licensing potential, as well as their ability to commercialize their innovative activities. Concerning innovative capabilities, numerous authors have argued that small new entrants are more likely to introduce breakthrough technologies and open up new technical subfields, often displacing larger incumbents (e.g., Tushman and Anderson, 1986; Chandy and Tellis, 2000), which would suggest a higher potential of these technologies for outward licensing. As firms get larger, they are increasingly plagued by rigidities and bureaucratic inertia, incentive systems unfavorable to innovation and change, and a loss of managerial control (Cohen and Levin, 1989). Concerning commercialization capabilities, smaller firms typically lack the complementary assets, such as well-

developed marketing and distribution capabilities, to fully leverage large innovation investments, and therefore may have no other means of benefiting from innovation than to license out their technologies (Fosfuri, 2006). Licensing out may, thus, offer smaller firms a way to leverage the larger partner's greater capital resources, distribution and marketing capabilities, or credibility, thereby leading to greater market penetration of their innovations than the small firm could achieve independently (Kotabe et al., 1996). These benefits of external versus internal technology commercialization should diminish, however, with increasing firm size, as larger firms have a better ability to commercialize technology internally due to access to complementary resources, as well as a stronger product diversification capability – that is, they are able to profitably invest their technologies in their subsidiaries rather than license to others (Shi, 1995). At low levels of firm size, I would therefore expect to see a negative effect of firm size on abnormal stock market returns after outward licensing deals.

However, with increasing size, firms are more able to take on larger scale or longer term projects because a wider range of revenue sources satisfy their cash-flow needs. They can also take on riskier projects because their development portfolios are typically larger and more diversified so that they are better able to absorb the risks of failure that are part of any new technology (Hill, 1992). With increasing size, firms are thus more likely to invest in basic research (Veugelers, 1997) and develop the kind of advanced technology that other firms seek to license. Moreover, larger firms also have resource-based advantages in handling external technology commercialization (Lichtenthaler and Ernst, 2008b). At high levels of firm size, I therefore expect a positive effect of firm size on outward licensing returns.

This interaction of countervailing effects suggests a curvilinear relationship between firm size and abnormal stock market returns from outward licensing deals. Thus, I propose:

Hypothesis 1b: All else equal, firm size has a quadratic (U-shaped) relationship with abnormal stock market returns after outward technology licensing deals.

3.2. R&D intensity

A high R&D intensity decreases technology transfer costs because it enables a firm to solve unexpected problems (Teece, 1977; Contractor, 1983), and to more easily assimilate, combine, and utilize technologies obtained from outside (Teece, 1986; Cohen

and Levin, 1989; Cohen and Levinthal, 1990), which should have a positive effect on inward licensing returns (Tsai and Wang, 2007). Strong in-house R&D further enhances the bargaining power of technology licensees by providing them with credible threat points (Gans and Stern, 2000). A high R&D intensity also develops organizational awareness about certain areas of science and technology, and how those areas relate to a firm's products and markets. This enhances a firm's ability to recognize the value of a new technology, and should therefore be beneficial for licensing that technology, both inward and outward. Similar to its impact on inward licensing returns, R&D intensity should also have a positive influence on outward licensing returns as firms with a high R&D intensity tend to be more likely to develop the kind of advanced technology that other firms seek to license (Cohen and Levinthal, 1990; Chandy and Tellis, 2000). I therefore propose:

Hypothesis 2: All else equal, R&D intensity will be positively related to abnormal stock market returns after both (a) inward and (b) outward technology licensing deals.

3.3. Business relatedness

Business relatedness is generally defined as similarities in products, markets, and technologies between two firms (Koh and Venkatraman, 1991). Prior evidence for the effects of business relatedness on partners' returns from their alliances, however, remains ambiguous. Whereas some studies found that a high level of business relatedness was positively related to partners' performances (e.g., Koh and Venkatraman, 1991; Lin et al., 2009), other studies found a negative relationship (e.g., Balakrishnan and Koza, 1993) and that high levels of business relatedness resulted in lower levels of interfirm knowledge transfer than market-spanning collaborations (e.g., Mowery et al., 1996), and yet others found no significant relationship between partners' business relatedness and their abnormal stock market returns surrounding the announcement date of their collaboration (e.g., Merchant and Schendel, 2000).

Two competing arguments help shed some light on these mixed results. On the one hand, firms with related businesses are more likely to share similar resource bases (Hannan and Freeman, 1977), which diminishes the benefits that partners can derive from exploiting each other's expertise in complementary areas (Lin et al., 2009). Moreover, such resource similarity as a result of related businesses puts firms in more direct competition with each other (Hannan and Freeman, 1977). Higher inherent competition

between two partners likely raises their concerns about making each other even stronger competitors through knowledge transfer and market access, leading to learning races, free-rider problems, and other dysfunctional behavior (Hamel, 1991), which in turn likely diminishes partners' abilities to benefit from their collaboration.

On the other hand, business relatedness also reduces information asymmetries between partners (Balakrishnan and Koza, 1993), allowing them to better assess each other's intentions, to establish common ground as a starting point for the sharing and transfer of skills and capabilities, to improve communication, to detect and mitigate opportunistic conduct, and thus to better realize their agreement's potential (Koh and Venkatraman, 1991; Merchant and Schendel, 2000; Harrigan, 2002). Moreover, due to the market and technological expertise that business relatedness entails, it likely also enhances a firm's 'descriptive capacity' (Lichtentaler and Lichtentaler, 2009; Müller-Seitz, 2012), defined as a firm's ability to identify technology transfer opportunities and to facilitate the technology's application at the recipient. In sum, whereas agreements between partners in related businesses benefit from lower transaction costs and a higher descriptive capacity, these benefits may be neutralized by the forgone gains from accessing partners' complementary skills and the higher costs of managing the potential rivalry between partners. As my analysis allows me to distinguish between source and recipient of a licensed technology, however, I would expect one of these effects to outweigh the other, depending on whether the focal partner is the licensee or licensor.

For licensees, the related business experience of the licensing partner can be seen as a source of complementary assets (Tripsas, 1997), which may affect technology integration and further deployment. In particular, a firm acquiring a technology from a company operating in a similar business tends to have a better understanding of the licensor's technology. This likely eases the technology transfer by decreasing transaction costs, such as the cost of adaptation to the licensee's operations and markets (Ford, 1985). In contrast, the more loosely related the diversification attempt through licensing, the less benefit the licensee gets from the use of resources and complementarities already in hand (Caves et al., 1983), and the higher the transaction costs are likely to be. I therefore propose:

Hypothesis 3a: All else equal, business relatedness between licensor and licensee will be positively related to abnormal stock market returns after inward technology licensing deals.

From the perspective of the licensor, licensees may develop their own proprietary technology based on the knowledge they derive from the continuous use of the licensed technology, thereby eroding the licensor's control over the technology in the long run and potentially creating a new competitor (Caves et al., 1983). Whereas competitive pressures therefore increase if a firm licenses to its direct rivals, this is not the case for licenses to firms in unrelated markets (Barnett, 1990). To avoid losing a competitive edge and creating a potential competitor when the licensing agreement and related patents expire (McDonald and Leahey, 1985), a company might thus benefit more from licensing to companies whose business is unrelated to their own (Davidson and McFetridge, 1984, 1985). I therefore propose:

Hypothesis 3b: All else equal, business relatedness will be negatively related to abnormal stock market returns after outward technology licensing deals.

4. Industry differences

Much evidence in the literature points towards industry-level differences in the preference for licensing, primarily due to differences in product complexity, concentration ratios, growth rates, patent intensities, and intellectual property rights enforcement regimes (Link and Scott, 2002; Kim, 2004; Kim and Vonortas, 2006a, b). For my comparative analysis, I chose the computer and pharmaceutical industries, as they both have one of the highest incidences of licensing transactions while, at the same time, exhibit significant differences with respect to intellectual property regimes, licensing motives, and contractual features (Anand and Khanna, 2000b; Kim and Vonortas, 2006a).

The computer industry, for instance, is an example of an industry with high product complexity, that is, new products are comprised of numerous separately patentable elements, and firms rarely have proprietary control over all the essential components (Fershtman and Kamien, 1992; Granstrand et al., 1992; Cohen et al., 2002). As the number of components that go into the end product increases, the number of companies from which the firm must license also rises (Kotabe et al., 1996). Moreover, the computer industry has a larger need for compatibility between different products than the pharmaceutical industry (Hill, 1997), which increases the necessity for firms to license in to comply with established standards (Vanhaverbeke and Noorderhaven, 2001). In their quest to develop complex products that are in line with established technological standards, firms in the

computer industry should therefore benefit equally from outward and inward licensing, with outward licensing deals representing companies' attempts to widely diffuse their technologies, and thereby establish a technological standard (Farrell and Saloner, 1985; Hill, 1997; Schilling, 1999), to preempt competitors from developing their own, competing standards (Hill, 1997) and to attract independent producers that supply complementary technologies, which in turn make the technology more attractive to potential adopters (Khazam and Mowery, 1994; Ehrhardt, 2004), and with inward licensing deals ensuring companies' access to complementary technologies as well as compliance with established standards.

Companies in the pharmaceutical industry, in contrast, are faced with a less complex product environment: a new product category comprises relatively few, separately patentable elements, with little need for compatibility between technologies and products (Cohen et al., 2002), and therefore no desire among companies to establish or comply with technological standards. While outward licensing still allows pharmaceutical companies to reap the benefits of rapidly expanding into a wide range of markets (Lei and Slocum, 1991) and of obtaining higher returns on their investment (McDonald and Leahey, 1985; Kollmer and Dowling, 2004), the benefits of inward licensing for compliance with technological standards and access to component technologies are likely less pronounced. I, therefore, expect pharmaceutical firms to benefit less from licensing in technologies compared with licensing out:

Hypothesis 4: All else equal, firms in the pharmaceutical industry will exhibit higher abnormal stock market returns after outward versus inward licensing deals, whereas firms in the computer industry will benefit equally from both types of licensing.

Moreover, explanations for licensing in the pharmaceutical industry have typically emphasized the advantage-sourcing and advantage-leveraging motives inducing cooperation between dissimilar firms (Deeds and Hill, 1996; Gopalakrishnan and Bierly, 2006). For example, large pharmaceutical firms have advantages in testing, manufacturing, and distribution, capabilities that small biotechnology firms often lack. Small biotechnology firms, on the other hand, have demonstrated advantages in generating a wide range of novel discoveries that large pharmaceutical firms covet to fill their development pipelines (Forrest and Martin, 1992). Technology licensing agreements between them enable each group to leverage their distinctive competencies while accessing those of the other (Powell et al., 1996). Therefore:

Hypothesis 5: All else equal, the quadratic (U-shaped) relationships between firm size and abnormal stock market returns after both (a) inward and (b) outward technology licensing deals will be stronger for the pharmaceutical industry than for the computer industry.

5. Methods

To test these hypotheses, I constructed a large data set of licensing activity to nonaffiliate firms in the computer (three-digit SIC code: 357) and pharmaceutical industries (SIC code: 283) in the period between 1990 and 2000, as reported in the Securities Data Corporation (SDC) database. This database provides information obtained from a wide range of publicly available sources, including Securities and Exchange Commission (SEC) filings, press releases, and other news sources. Anand and Khanna (2000a, b), and more recently Lavie and Rosenkopf (2006) and Schilling (2009), have attested to the high accuracy and reliability of the data contained in this database.

My initial sample comprised 2,118 licensing agreements in the pharmaceutical industry and 1,075 licensing agreements in the computer industry. Similar to previous empirical studies on licensing agreements (e.g., Anand and Khanna, 2000a; Somaya et al., 2011), I retained only agreements where at least one party was a publicly held, US-based firm. These restrictions facilitate obtaining stock price data from commonly available data sources to derive abnormal stock market returns measures. I also retained only those agreements in which the licensing agreement pertained to some form of technology exchange (thus eliminating agreements that were limited to, for example, trademark licenses), and I further eliminated 157 cross-licensing agreements from the analysis that do not fit my theoretical focus which differentiates between inward and outward licensing transactions. These sample attrition criteria left me with a set of 1,278 licensing agreements in the pharmaceutical industry and 609 agreements in the computer industry. I used a combination of the deal text in the SDC database and searches of news retrieval sources (e.g., Nexis Lexis, ABI/Inform) to code every sample firm as licensor or licensee. From the standpoint of my focal firms, 1,000 of the deals in my sample were inward licensing agreements (693 in the pharmaceutical and 307 in the computer industry), and 887 were outward licensing agreements (585 in the pharmaceutical and 302 in the computer industry).

5.1. Dependent variable

To measure a firm's abnormal stock market returns after a licensing transaction, I followed prior studies of licensing (Anand and Khanna, 2000a) and alliance announcements (Kale et al., 2002; Gulati et al., 2009), and extracted the residuals from a standard asset-pricing model used to calculate firms' abnormal returns surrounding event announcements. Prior studies in the alliance literature have not only attested to the high construct and convergent validity of such a market-based measure of performance (Koh and Venkatraman, 1991), but also found a positive correlation between stock market-based measures of alliance success and managerial performance assessments, and thereby provided empirical support for the efficient-markets argument by 'demonstrating that the initial stock market response to a key event positively correlates to the long-term performance and value of the event' (Kale et al., 2002, p. 747). My focus on publicly traded firms further allowed investors to access sufficient relevant information to assess likely value-creation effects of the licensing agreements.

In particular, I used daily data on stock market returns over a 150-day period until 50 days prior to the event day (i.e., the announcement of a licensing agreement at $t=0$) to estimate firms' historical returns with the market model (Fama, 1976; Brown and Warner, 1980, 1985):

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it}, \text{ with } t = -200, \dots, -51$$

In this model, r_{it} stands for the daily returns for company i on day t , r_{mt} for the corresponding daily returns on the value-weighted S&P 500, α_i and β_i are stable intercept and slope parameters (respectively) for firm i , which are estimated by the market model with an ordinary least squares (OLS) method, and ε_{it} is the firm-specific disturbance term. The estimates obtained from this model were then used to predict daily returns for each firm over a 2-day period surrounding the event day ($[-1, 0]$):

$$\hat{r}_{it} = \hat{\alpha}_i + \hat{\beta}_i r_{mt}, \text{ with } t = -1, 0$$

where \hat{r}_{it} is the predicted daily returns, and $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the model estimates. The daily abnormal returns for each firm can then be calculated as:

$$\hat{\varepsilon}_{it} = r_{it} - \hat{r}_{it}$$

To correct for possible heteroscedasticity, I standardized the abnormal returns for each company (Brown and Warner, 1985) by dividing the event

period residual by the standard deviation (SD) of the estimation period residual, corrected by the prediction error (Campbell et al., 1997). Last, I calculated the CARs for the 2-day period around the event. These abnormal returns reflect the daily, unanticipated movements in the stock price of each firm over the event period ($[-1, 0]$).

The selection of such a narrow event window represents a conservative approach that excludes unrelated events occurring in the time period around the announcement (Gulati et al., 2009). As a robustness check, I also ran my analyses with longer event windows ($[-3, 3]$ and $[-10, 3]$); however, all results remained the same. Moreover, although the use of daily stock market data could understate the abnormal returns associated with a licensing transaction, it enabled me to capture at least a lower bound estimate that could be attributed directly to a licensing announcement (Koh and Venkatraman, 1991).

5.2. Independent and control variables

I gathered yearly financial and firm data for all US publicly held firms in my sample using the Center for Research in Security Prices, Compustat, Compact Disclosure, and Hoovers databases. To create the *firm size* measure, I calculated the natural logarithms of a firm's sales and number of employees (Simonin, 1997) – two measures prior research considered a good indicator of a firm's resource base (Atuahene-Gima, 1993) – before standardizing both measures and summing them up. As a robustness test, I also used the natural logarithm of a firm's sales alone as a measure of firm size (Lichtenthaler and Ernst, 2008b); however, all results remained the same with respect to both directionality and significance. *R&D intensity* was calculated as a firm's ratio between R&D expenditures and sales (Fosfuri, 2006; Lichtenthaler and Ernst, 2008b). To account for various degrees of business relatedness between licensing partners, I applied the following weighting scheme: if the primary SIC codes of the partner firms matched, *business relatedness* was assigned a '2' at the two-digit level, a '4' at the three-digit level, and a '6' at the four-digit level (Haleblian and Finkelstein, 1999). Because it represents a more fine-grained classification of relatedness, this continuous measure was preferred over an alternative discrete measure, classifying partners as related if they had at least one three-digit SIC code in common (Haleblian and Finkelstein, 1999); however, results were the same with both measures.

Similar to prior studies on technology licensing, I controlled for the *year* a licensing transaction took place, for *industry*, which was coded '0' for comput-

ers (SIC: 357) and '1' for pharmaceuticals (SIC: 283) and for *foreign partners* in licensing deals (Anand and Khanna, 2000b; Somaya et al., 2011). Moreover, prior studies have found that exclusivity in licensing agreements not only provides the licensee with a 'hostage' that is valuable to the licensor – and therefore deters licensor opportunism and shields the licensee from direct competition in the commercialization of the licensed technology – but also encourages the licensee's contractual performance as the licensee can only realize the benefits from a licensing deal via a successful commercialization of the licensed technology (Somaya et al., 2011). I, therefore, included *exclusivity* as a control, coded '1' for exclusive deals and '0' for nonexclusive deals.

In an attempt to rule out bargaining power as a determinant of licensing returns, I followed a recent study by Adegbesan and Higgins (2011), and further controlled for a company's *licensing portfolio*, measured as the natural logarithm of a count of all prior licensing agreements – reported between 1990 and the date of the focal agreement – in which the firm was and/or is involved. The larger a firm's portfolio of licensing agreements, the less dependent it is on any one partner, and consequently the greater its bargaining ability relative to its partners (Adegbesan and Higgins, 2011).

I also controlled for whether or not the agreement involved one partner acquiring an *equity* stake in the other (Adegbesan and Higgins, 2011). Coded '0' for nonequity deals and '1' for equity deals, this variable controls for stock price reactions that are primarily due to an equity exchange between two licensing partners, and thereby mitigates this potentially confounding effect.

Last, I also included a more fine-grained classification of the technology licensing deals into my analysis. In particular, I followed prior research (Anand and Khanna, 2000a; Somaya et al., 2011) and coded whether or not a licensing deal included *R&D investments* (i.e., if the deal involved activities to complement or otherwise further develop the licensed technology), *manufacturing investments* (i.e., building a plant, modifying existing plants, or developing production technologies to produce the licensed technology), and/or *marketing investments* (i.e., advertising, sales, or distribution for products based on the licensed technology). While it is not possible to determine precisely how technology-specific these different types of investments are, 'investments in R&D and marketing [. . .] are largely in intangibles, which are inherently quite technology-specific. Manufacturing investments, by contrast, are mostly in tangible capital goods, which are arguably more redeployable despite being some-

what dedicated at the time of investment' (Somaya et al., 2011, p. 169). Extending this classification, I further distinguished between unilateral R&D investments and *joint development projects*, where the licensing partners work together to reciprocally modify, or jointly develop a new product on the basis of, the licensed technology. All codes ('0' if deals did not contain a certain type of investment, such as R&D, manufacturing, etc., and '1' if they did) were assigned independently by two raters (one of whom was blind to the hypotheses) based on SDC deal texts and corroborated with other news retrieval sources. The two raters initially agreed on about 80% of the cases, and resolved disagreements by discussion.

6. Results

Descriptive statistics and Pearson product moment correlations are provided in Table 1. I further performed a median-split of the sample based on firm size and compared the variable means with a one-way analysis of variance. The results showed that, compared with large firms, small firms (i.e., smaller than the median firm size) are more likely to engage in licensing deals with a foreign partner ($P < 0.001$), exclusive licensing deals ($P < 0.001$), deals including manufacturing investment ($P = 0.016$), and related deals ($P < 0.001$). Moreover, small firms tend to have higher R&D intensity ($P < 0.001$) but less licensing experience ($P < 0.001$) than large firms.

Over the 14-day window Anand and Khanna (2000a) used in their groundbreaking study, inward licensing deals result in an average CAR of 1.14% (SD = 31.33%) versus 2.28% (SD = 17.73%) for outward licensing transactions. Employing a more conservative, 2-day event window $[-1, 0]$, inward licensing deals result in an average CAR of 1.06% (SD = 6.77%) versus 2.00% (SD = 8.91%) for outward licensing transactions, a difference that is statistically significant ($P < 0.01$).

6.1. Hypotheses tests

To test the hypothesized relationships, I performed separate hierarchical OLS regressions for inward and outward licensing deals (see Table 2 for results). For both inward and outward licensing deals, firm size is significantly and positively associated with abnormal stock market returns (Model 2), and the squared terms for firm size are significantly and positively associated with abnormal stock market returns (Model 3). Figure 1 provides an illustration of the effect of firm size on abnormal stock market returns. While Figure 1a suggests that firm size has a positive

Table 1. Descriptive statistics and correlations for inward and outward licensing transactions

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
(a) Inward licensing transactions¹														
1. Industry	0.69	0.46												
2. Foreign partner	0.24	0.43	0.12											
3. Exclusivity	0.23	0.42	0.28	0.06										
4. Licensing portfolio	1.84	1.29	-0.14	-0.01	-0.12									
5. Equity	0.04	0.19	0.06	0.00	0.02	-0.01								
6. R&D investment	0.43	0.50	-0.04	-0.06	-0.06	-0.04	-0.03							
7. Joint development	0.13	0.34	0.07	-0.04	0.02	0.03	0.10	-0.27						
8. Manufacturing investment	0.12	0.32	0.13	0.06	0.11	-0.08	0.05	-0.10	0.05					
9. Marketing investment	0.48	0.50	0.14	0.17	0.19	0.01	0.05	-0.34	0.02	0.30				
10. Firm size	1.22	1.98	-0.33	-0.04	-0.19	0.67	0.02	-0.06	0.01	-0.05	0.02			
11. R&D intensity	3.17	20.95	0.10	0.05	0.04	-0.12	-0.02	0.04	0.02	-0.01	-0.02	-0.26		
12. Business relatedness	1.91	2.01	0.32	0.07	0.06	-0.03	0.03	-0.02	0.02	0.03	0.16	-0.07	-0.07	
13. CARs (standardized)	1000.03	1085.48	0.19	0.03	0.00	0.36	0.10	-0.12	0.08	-0.01	0.13	0.60	-0.10	0.13
(b) Outward licensing transactions²														
1. Industry	0.66	0.47												
2. Foreign partner	0.43	0.50	0.11											
3. Exclusivity	0.22	0.42	0.30	0.06										
4. Licensing portfolio	1.73	1.31	-0.31	-0.17	-0.10									
5. Equity	0.02	0.15	0.06	0.08	0.03	-0.03								
6. R&D investment	0.38	0.49	-0.09	-0.06	-0.03	0.05	0.03							
7. Joint development	0.12	0.32	0.04	-0.04	0.01	-0.02	-0.03	-0.19						
8. Manufacturing investment	0.15	0.36	0.04	0.12	0.00	-0.10	0.07	-0.12	0.03					
9. Marketing investment	0.52	0.50	0.21	0.11	0.17	-0.04	-0.01	-0.38	0.02	0.24				
10. Firm size	0.76	1.96	-0.42	-0.20	-0.16	0.68	-0.06	0.01	0.00	-0.07	-0.03			
11. R&D intensity	3.56	21.46	0.08	0.01	0.05	-0.12	0.00	0.09	0.01	-0.02	-0.03	-0.25		
12. Business relatedness	2.09	2.00	0.43	0.08	0.15	-0.16	0.06	-0.07	0.03	0.08	0.21	-0.14	-0.06	
13. CARs (standardized)	772.60	921.69	0.10	-0.11	0.02	0.29	-0.01	-0.11	0.00	-0.01	0.12	0.59	-0.08	0.04

¹N = 1,000; Pearson's product moment correlations reported; correlations with absolute value greater than 0.06 are significant at the 5% level.

²N = 887; Pearson's product moment correlations reported; correlations with absolute value greater than 0.06 are significant at the 5% level.

CARs, cumulative abnormal returns; R&D, research and development.

Table 2. OLS regressions of cumulative abnormal returns from inward and outward licensing transactions

	Model 1	Model 2	Model 3	Model 4	Model 5
(a) Inward licensing transactions [†]					
Constant	782.62*** (112.67)	419.56*** (84.92)	327.29*** (84.55)	637.70*** (81.94)	617.72*** (86.08)
Control variables (year dummies not reported)					
Industry	549.59*** (68.95)	975.72*** (56.62)	951.75*** (55.66)	594.07*** (58.61)	614.01*** (64.23)
Foreign partner	-74.94 (68.70)	-28.96 (51.17)	-23.86 (50.19)	-7.14 (46.48)	-6.80 (46.49)
Exclusivity	-134.67 [†] (71.65)	4.16 (53.55)	0.88 (52.52)	8.44 (48.62)	8.35 (48.63)
Licensing portfolio	377.77*** (23.64)	-66.80** (23.72)	-102.16*** (23.93)	-51.79* (22.50)	-50.88* (22.53)
Equity	297.03 [†] (154.77)	181.52 (115.20)	186.70 [†] (112.98)	132.69 (104.67)	136.30 (104.80)
R&D investment	-135.49* (63.75)	-87.14 [†] (47.51)	-79.86 [†] (46.61)	-49.60 (43.21)	-51.50 (43.30)
Joint development	-11.58 (90.29)	6.90 (67.20)	19.13 (65.93)	40.94 (61.05)	41.10 (61.07)
Manufacturing investment	-173.28 [†] (93.54)	-205.92*** (69.73)	-192.47** (68.41)	-198.57** (63.33)	-197.53** (63.36)
Marketing investment	169.07* (65.87)	76.02 (49.58)	76.49 (48.62)	57.36 (45.04)	57.95 (45.05)
Main effects					
Firm size		449.16*** (16.10)	366.07*** (20.56)	234.31*** (21.64)	241.70*** (23.73)
R&D intensity		3.82*** (1.06)	1.45 (1.10)	1.04 (1.02)	0.92 (1.03)
Business relatedness		31.04*** (11.36)	33.16** (11.15)	18.59 [†] (10.38)	18.34 [†] (10.39)
Firm size (squared)			48.33*** (7.66)	76.71*** (7.43)	74.92*** (7.79)
Interaction effects					
Industry × firm size					
Industry × firm size (squared)					
ΔR^2		0.30	0.01	0.05	0.00
ΔF		265.02***	39.82***	163.98***	0.58
R^2	0.33	0.63	0.65	0.70	0.70
Adj. R^2	0.32	0.62	0.64	0.69	0.69
F	25.45***	75.88***	77.19***	93.16***	89.42***

Table 2. (Contd.)

	Model 1	Model 2	Model 3	Model 4	Model 5
(b) Outward licensing transactions ²					
Constant	557.11*** (109.68)	423.02*** (82.58)	179.62* (82.89)	196.83** (75.76)	163.98* (75.89)
Control variables (year dummies not reported)					
Industry	418.72*** (68.48)	828.10*** (57.26)	825.64*** (54.58)	719.46*** (50.54)	736.44*** (50.46)
Foreign partner	-154.56** (57.06)	-33.05 (43.02)	-20.25 (41.02)	4.24 (37.54)	8.33 (37.32)
Exclusivity	-46.15 (70.30)	40.75 (52.79)	46.43 (50.32)	16.46 (46.04)	18.02 (45.76)
Licensing portfolio	298.02*** (23.47)	-97.09*** (23.31)	-141.24*** (22.71)	-70.51** (21.45)	-65.07** (21.37)
Equity	-132.22 (190.40)	49.29 (142.99)	6.25 (136.37)	13.80 (124.63)	32.87 (123.98)
R&D investment	-144.86* (62.69)	-125.47** (47.16)	-107.75* (44.99)	-52.72 (41.33)	-51.30 (41.07)
Joint development	-92.32 (87.04)	-83.13 (65.26)	-70.90 (62.22)	-82.81 (56.87)	-73.91 (56.58)
Manufacturing investment	-63.02 (80.28)	-3.85 (60.26)	-21.36 (57.47)	-41.02 (52.55)	-43.51 (52.22)
Marketing investment	93.79 (62.84)	41.73 (47.53)	62.29 (45.36)	83.66* (41.48)	85.33* (41.23)
Main effects					
Firm size		417.17*** (16.05)	316.38*** (18.70)	247.67*** (17.88)	256.33*** (17.94)
R&D intensity		3.98*** (1.00)	0.76 (1.01)	0.35 (0.93)	0.18 (0.92)
Business relatedness		-17.47 (11.69)	-11.82 (11.15)	-12.29 (10.19)	-10.17 (10.15)
Firm size (squared)			68.93*** (7.35)	85.76*** (6.84)	84.21*** (6.81)
Interaction effects					
Industry × firm size				311.23*** (23.78)	217.19*** (36.10)
Industry × firm size (squared)					48.50*** (14.07)
ΔR^2		0.33	0.04	0.06	0.00
ΔF		226.93***	87.95***	171.26***	11.88***
R^2	0.24	0.58	0.61	0.68	0.68
Adj. R^2	0.22	0.56	0.60	0.67	0.67
F	14.49***	53.24***	59.88***	75.84***	74.20***

¹ $N = 1,000$; [†] $P < 0.10$; $*$ $P < 0.05$; $**P < 0.01$; $***P < 0.001$ (two-tailed); unstandardized coefficients shown, with robust standard errors in parentheses.
² $N = 887$; [†] $P < 0.10$; $*$ $P < 0.05$; $**P < 0.01$; $***P < 0.001$ (two-tailed); unstandardized coefficients shown, with robust standard errors in parentheses.
 OLS, ordinary least squares; R&D, research and development.

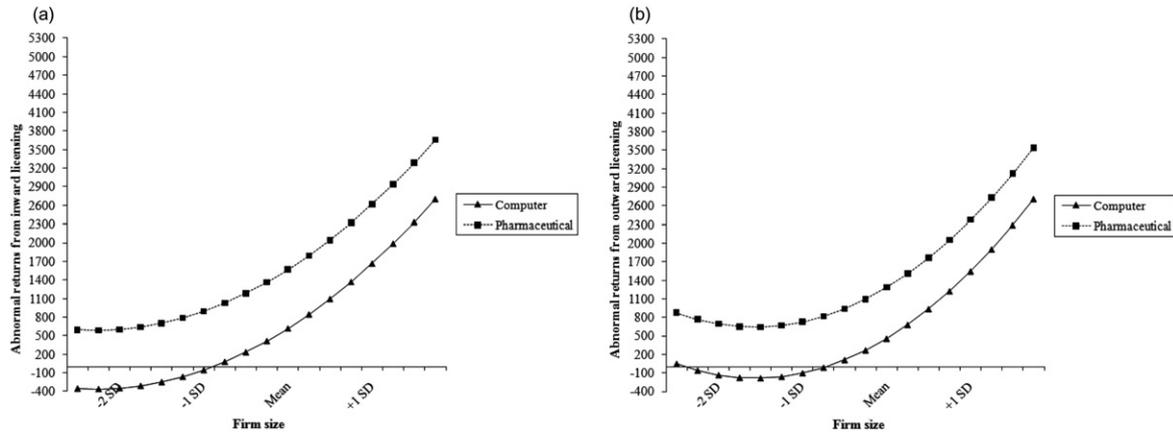


Figure 1. Relationships between firm size and cumulative abnormal returns from licensing. (a) Inward licensing. (b) Outward licensing.

and nonlinear (i.e., increasing) effect, the inflection point falls outside of the range of the predictor (Meyer, 2009). In contrast, Figure 1b clearly shows a quadratic (U-shaped) relationship, with the inflection point falling within two standard deviations from the mean, which rules out a logarithmic effect (Meyer, 2009). These results provide support for Hypothesis 1b, but not for Hypothesis 1a.

The influence of R&D intensity is supported with significant and positive effects on abnormal stock market returns after both inward and outward licensing deals in the main-effects model (Model 2), but becomes nonsignificant when including the squared term for firm size into the regression (Model 3). These results provide only partial support for Hypotheses 2a and 2b. Business relatedness has a significant and positive effect for inward licensing deals, supporting Hypothesis 3a, and has the hypothesized negative sign but is nonsignificant for outward licensing deals, thereby providing no support for Hypothesis 3b (Model 2).

Comparing licensing transactions across industries, I find that firms in both industries, on average, benefit from licensing deals, with CARs of 1.33% (SD = 8.45%) and 1.59% (SD = 7.57%), respectively, for computers and pharmaceuticals, a difference that is not statistically significant at the $P < 0.05$ level. In the computer industry, licensing yields an average CAR of 0.75% (SD = 5.44%) for inward licensing and 1.92% (SD = 10.65%) for outward licensing transactions, a difference that is not statistically significant at the $P < 0.05$ level. In comparison, the average CARs in the pharmaceutical industry are 1.20% (SD = 7.28%) for inward licensing and 2.04% (SD = 7.87%) for outward licensing, a statistically significant difference between these two types of licensing ($P < 0.05$). These findings cor-

roborate the argument that, in contrast to computer firms, pharmaceutical firms benefit more from outward versus inward licensing, and provide support for Hypothesis 4.

Concerning my last hypothesis, the interaction coefficient of industry and squared firm size is not significant for inward licensing deals (Table 2a, Model 5), providing no support for Hypothesis 5a. However, the interaction coefficient is positive and significant for outward licensing (Table 2b, Model 5). Figure 2 provides a graphical illustration of this moderating effect. This figure also shows that the inflection point is well within the range of the explanatory variable, which rules out a logarithmic effect (Meyer, 2009). This result suggests that the squared (U-shaped) effect of firm size on abnormal stock market returns is more pronounced in the pharmaceutical industry, which provides support for Hypothesis 5b.

6.2. Post hoc robustness tests

While not hypothesized, I find that the positive effect of R&D intensity on outward licensing returns is more pronounced in the pharmaceutical than in the computer industry. This is in line with my finding that, due to the systematic technological differences between the two industries discussed earlier, pharmaceutical companies generally benefit more from licensing out than computer firms, and suggests that R&D investments further enhance pharmaceutical firms' abilities to develop technologies with superior licensing potential.

I also performed additional, more nuanced analyses to better understand the effects of different types of complementary resources (i.e., R&D, joint development, manufacturing, and marketing) on abnormal

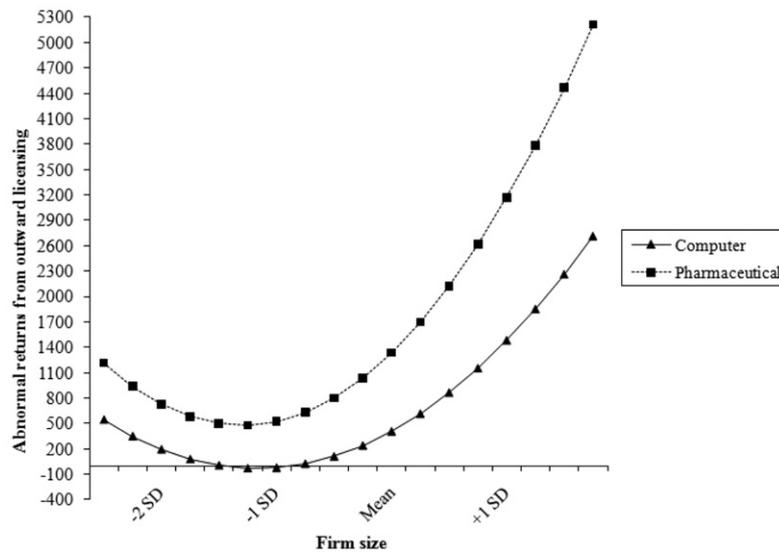


Figure 2. Moderating effect of industry on curvilinear relationship between firm size and cumulative abnormal returns from outward licensing.

stock market returns. While most interactions are not statistically significant, a few results are noteworthy. In particular, with respect to firm size, the curvilinear (U-shaped) relationship between firm size and inward licensing returns (in this case, the inflection point lies within the range of firm size) is stronger (i.e., more pronounced) for transactions that involve marketing ($b = 31.14$; $P < 0.05$). Similarly, the curvilinear (U-shaped) relationship between firm size and outward licensing returns is stronger (more pronounced) for transactions that involve manufacturing ($b = 49.25$; $P < 0.05$) or marketing ($b = 32.01$; $P < 0.05$). With respect to business relatedness, its positive effect on inward licensing returns was enhanced when a licensing transaction involved joint development investments ($b = 70.36$; $P < 0.05$) or marketing investments ($b = 60.23$; $P < 0.05$), and diminished when the transaction involved manufacturing investments ($b = -75.01$; $P < 0.05$). Moreover, its negative effect on outward licensing returns was diminished when marketing investments were part of the licensing transaction ($b = 61.82$; $P < 0.01$).

7. Discussion

7.1. Theoretical and managerial implications

While the global marketplace still rewards firms primarily for developing and commercializing technologies, and not for developing intellectual property per se (Grindley and Teece, 1997), this study is the

first to provide large-sample empirical evidence for firms' abilities to capitalize on both acquiring and selling technologies. However, the large and statistically significant difference between abnormal returns from inward versus outward licensing also illustrates the importance of making this distinction when examining firms' abnormal stock market returns as a result of their licensing activities.

Firm size and R&D intensity, arguably the most crucial determinants of high-technology firms' differential advantages (Atuahene-Gima, 1993; Fu and Perkins, 1995; Kim, 2005; Fosfuri, 2006; Gopalakrishnan and Bierly, 2006), were significant (and in the case of R&D intensity, at least partially significant) predictors of firms' abilities to gain access to complementary resources through inward licensing, as well as to successfully commercialize their technologies through outward licensing. In particular, large firms seem to enjoy disproportional advantages when it comes to acquiring and internalizing external technology, providing support for the benefits of a larger base of complementary resources (Teece, 1977; Ford, 1985; Lowe and Taylor, 1998). In contrast, I find no empirical support for the benefits that prior research has argued small firms may derive from licensing in complementary technologies (Lowe and Taylor, 1998; Bianchi et al., 2010), particularly from more established and reputable licensors (Stuart et al., 1999). While preliminary, this finding suggests important constraints with respect to small firms' external technology sourcing capabilities, which future research might want to examine in more detail.

For outward licensing, in contrast, the current results suggest that both large and small firms seem to enjoy differential advantages in technology licensing deals, whereas medium-sized companies may experience the 'growing pains of a burgeoning organization' (Gee, 1978, p. 40), diminishing their flexibility while they are not (yet) large enough to achieve the advantages from a greater resource endowment. These results provide a reconciliation for the ongoing debate of whether small or large firms are better positioned to successfully commercialize innovations (e.g., Fosfuri, 2006; Gopalakrishnan and Bierly, 2006) by suggesting that it may not be the size of a company that determines its innovative performance, but its ability to successfully engage in licensing agreements that complement its size-related resource disadvantages with the advantages of a partner of a different size.

Moreover, in line with prior empirical work on licensing (e.g., Anand and Khanna, 2000a, b), I find that in some cases, such as licensing by small computer firms, returns to licensing agreements can actually be negative (see Figures 1 and 2 for details). These results lend further credence to the argument in the literature that licensing agreements, while offering an important avenue for the commercialization of technology in general, also have significant downsides, such as morale issues, limited control over the licensed technology, increasing dependence on the licensor, and the erosion of a firm's innovative capabilities (Sen and Rubenstein, 1989; Grindley and Teece, 1997; Lowe and Taylor, 1999; Fosfuri, 2006).

As predicted, licensing in technologies from related companies was a positive predictor of abnormal returns. This finding suggests that the relatedness of the licensed technology to a firm's business and its mitigating effect on transaction costs enhanced a firm's ability to successfully integrate external technologies. The expected threat of licensing out technologies to firms operating in the same market did not affect abnormal stock market returns, however, suggesting that the advantages of licensing royalties may provide a counterbalance to the disadvantages of increased competition and its effects on price-cost margins and market share.

In addition to these hypothesized relationships, the post hoc analysis of investment type as a contingency showed that the more technology-specific investments – such as in R&D and marketing (Somaya et al., 2011) – are required as part of a licensing transaction, the more firms profit from complementary resources (i.e., firm size) and in-depth knowledge of the business environment of the licensed technology (i.e., business relatedness).

I further found support for the argument that the benefits of licensing in general, and the impact of the focal determinants of abnormal stock market returns in particular, differ across industries. Specifically, pharmaceutical firms benefit less from licensing in technologies compared with licensing out, whereas computer firms equally benefit from both types of licensing transactions. Moreover, firm size as a crucial proxy for complementary resources had a more pronounced influence on outward licensing returns in the pharmaceutical industry than in the computer industry, supporting the role of advantage-sourcing and advantage-leveraging motives in inducing licensing collaborations in this industry. In general, the industry differences uncovered in this study corroborate the argument that 'it might be problematic, if not wrong, to analyze a firm's licensing strategy in isolation, abstracting from product and technology market dynamics' (Fosfuri, 2006, p. 1156).

More broadly, the current findings also contribute to and extend the literature on interfirm alliances. Although licensing is generally considered a subset of the broader realm of interfirm collaborations (Anand and Khanna, 2000a), the unique advantage of examining licensing agreements, in contrast to other strategic alliances, lies in the fact that it is possible to distinguish more adequately the source and the recipient of a technology transfer. This role attribution allows me to examine whether the effects of firm and industry characteristics on alliance outcomes are contingent on the role a partner plays in a specific transaction, and thereby to develop a more nuanced understanding of the key determinants of the contribution of interfirm alliances to firm performance. For example, the findings for business relatedness extend prior studies by differentiating the effects of relatedness by the role a partner plays. Whereas prior studies in the alliance literature have found mixed effects of business relatedness (e.g., Koh and Venkatraman, 1991; Mowery et al., 1996; Merchant and Schendel, 2000; Lin et al., 2009), the current results show that benefits from relatedness primarily accrue to licensees, who are arguably the largest benefactors of the decreasing transaction costs due to related technology and market know-how (Ford, 1985).

My results for the influence of firm size on abnormal stock market returns also stand in contrast to the large majority of studies in the alliance literature which has not found a significant effect of firm size on alliance performance (Kale et al., 2002; Luo, 2005, 2008; Robson et al., 2008; Walter et al., 2012). There are two plausible explanations for this deviation. The first is related to the curvilinear (U-shaped) relationship I uncovered between firms size and

licensing returns, which suggests that prior regression models examining only linear effects may have been underspecified, and therefore may have produced biased estimators (Greene, 2003) for the effects of firm size. The second explanation is related to the above-mentioned distinction between licensor (i.e., knowledge source) and licensee (i.e., knowledge recipients), which allows me to examine abnormal stock market returns generated by an interfirm alliance for each partner – and by their respective roles – in the alliance. These differences between licensor and licensee are likely masked in studies focusing on alliance performance alone.

7.2. Policy implications

Although this research has provided ample empirical evidence suggesting that companies indeed profit from technology transfers via licensing agreements, I also found that the magnitude of such profits is contingent on licensing partners' resource endowments. Firms lacking such complementary resources themselves, however, may not necessarily be excluded from capitalizing on their intellectual property via licensing agreements. Instead, they can solicit the help of intermediaries for the selection of appropriate licensing partners, managing a successful technology transfer, locating providers of complementary technologies, and structuring the agreement between licensing partners in mutually beneficial ways (Shohet and Prevezer, 1996; Howells, 2006). In general, such intermediaries can provide access to complementary skills needed for successful licensing agreements and help reduce licensing-related transaction costs, and therefore perform a vital function in industry innovation and knowledge diffusion (Shohet and Prevezer, 1996; Müller-Seitz, 2012). To the extent policy makers are interested in the health of their innovation ecosystems (Nooteboom, 1999), the establishment and support of such intermediaries can therefore help firms compensate for inadequate resource endowments and licensing experience, identified in this research as important hurdles to successful technology licensing agreements.²

8. Limitations and future research

Due to its theoretical and empirical focus, this study is subject to several limitations. First, I followed prior empirical research on technology licensing (e.g., Anand and Khanna, 2000a; Kale et al., 2002) and relied on the SDC database for my sample of licensing agreements. And whereas Schilling's (2009, p. 258) extensive analysis and empirical comparison of the

five most prominent alliance databases (including SDC) concludes with a 'reassurance that even though each database only captures a sample of alliance activity, it may yield reliable results for many – if not all – research purposes', it is up to future research to examine whether or not the current results are generalizable to smaller, privately held companies. Related to that limitation, while I included numerous controls to isolate the effects of large companies' complementary resources on licensing returns, data availability made it infeasible to rule out alternative explanations, such as large firms being more skilled at identifying promising technologies. I derive some comfort, however, from the argument in the literature that such skills may be a product not so much of a firm's size but of its absorptive capacity (Cohen and Levinthal, 1990; Zhang and Baden-Fuller, 2010), which I measure with R&D intensity. Moreover, I find a curvilinear relationship between size and firms' outward licensing returns, which provides some empirical evidence that at least discounts such an effect. Nevertheless, future research might want to address this and related alternative explanations to uncover the exact effects of firm size on licensing returns.

Second, I have focused the analysis on returns from licensing deals (in the form of abnormal stock market returns) that accrue to a focal firm. Licensing transactions may create other types of rents as well, however, such as outbound spillover rents that benefit the licensing partner (Lavie, 2006). Moreover, the research design did not allow me to empirically observe a firm's appropriation of the value generated by a licensing transaction – which would require that I ascertain the difference between the total value generated and the value captured by each licensing partner (cf., Crook et al., 2008) – which in turn may further mask any resource-based advantages that firms may bring to bear on a particular transaction. It would, thus, be interesting for future research to compare different types of licensing deals and their effects on the creation of internal (Peteraf, 1993), relational (Dyer and Singh, 1998), and spillover rents (Lavie, 2006), as well as to examine what proportion of these rents are appropriated by the focal firm versus its licensing partner, and what firm-, dyad-, and industry-level characteristics determine this distribution of rents between partners.

Third, by focusing on advantage-leveraging motives for licensing – and thereby implicitly focusing on resource-based arguments – I neglected other theoretical perspectives that could enrich our understanding of technology licensing transactions. For example, prior studies have referenced both transaction cost theory (Arora and Fosfuri, 2003; Hagedoorn and Heslen, 2007) and social network theory (Powell

et al., 1996; Müller-Seitz, 2012) to explain different aspects of technology licensing. But so far, no study has employed these perspectives to examine the effects of technology licensing deals on companies' abnormal stock market returns in a large-scale, empirical manner. Future research would benefit from considering multiple rationales for firms' engagement in different types of licensing and for their ability to benefit from exchanging their intellectual property via licensing deals.

In conclusion, amidst volatile international credit markets and increasing R&D costs, licensing transactions have become increasingly important means for firms to enhance the contribution of their R&D efforts to their financial bottom line. This study is a first step toward explaining when and why firms should use licensing agreements to exploit their proprietary technologies, and toward making better predictions about the impact of different licensing agreements on firm performance.

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Notes

1. Examples for licensor-imposed restrictions are conditions on purchase of materials, limitations on exports, and grant-back provisions that require the licensee to transfer improvements of the licensed technology back to the licensor without any compensation (McDonald and Leahey, 1985; Leone and Reichstein, 2012).
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