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Rent Appropriation in Strategic Alliances: A Study of Technical Alliances in Pharmaceutical Industry

Margaret Hughes-Morgan
Marquette University, margaret.hughes-morgan@marquette.edu

B. Emery Yao
HSBC School of Business

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Abstract

Many existing alliance studies have investigated how embedded relations create superior value for organizations. The role of network structure in rent appropriation or pie splitting, however, has been underexplored. We propose that favorable locations in interorganizational networks provide firms with superior opportunities for appropriating more economic benefits from alliances than their partners do. Specifically, we argue that partners' asymmetric network positions will lead to unequal brokerage positions that promote disparate levels of information gathering, monitoring, and bargaining power, which lead to differing capacities to appropriate value. This in turn results in variations in market performance. We also propose this brokerage position exacerbates existing inequalities such as commercial capital; thus, available firm resources will moderate such network effects. Evidence is presented in the form of market response to technology alliance announcements from a set of pharmaceutical firms. In general, we find that firms within central network positions and those spanning structural holes have higher returns than their partners. In addition, we show that this relationship is contingent upon available firm resources.

Keywords: Social Networks, Value Appropriation, Strategic Alliances, Stock Returns

Introduction

The resource-based view maintains that a firm is composed of a bundle of tangible and intangible resources, and that firms differ in their capabilities to exploit such resources to outpace competitors and generate superior economic returns (Barney, 1991; Wernerfelt, 1984). Strategy scholars have shown that firms attempting to develop the resources needed to outmaneuver the competition in their respective industries will often engage in strategic alliances to acquire essential knowledge and resources, and develop capabilities that are difficult to accumulate internally. These alliances have been reported to earn participants many benefits, such as cost reductions through economies of scale (Anderson and Weitz, 1992; Powell, 1990), access to markets and technology (Bronder and Pritzl, 1992; Bucklin and Sengupta, 1993), acceleration of new product development and reduction of time to market (Bronder and Pritzl, 1992; Deeds and Hill, 1996; Hamel et al., 1989), and provision of learning opportunities and facilitation of interfirm knowledge transfer (Hamel et al., 1989; Hamel, 1991; Powell et al., 1996; Lavie, 2006). Thus, the *value creation* aspects of alliances and positions within a network of alliances have been well documented (e.g., Sleuwaegen et al., 2003). However, prior research exploring *value appropriation* (the division of wealth generated by the alliance between the two partners, or pie splitting) by alliance partners has been limited, but has recently generated scholarly interest (Blyler and Coff, 2003; Gulati and Singh, 1998; Gulati and Wang, 2003; Kalaignanam et al., 2007; Kumar, 2010a, 2010b; Lavie, 2007). As Dyer et al. (2008) suggested, while there is increasing evidence that alliances are an important source of value creation, we know less about the factors affecting how partners split the pie generated from their collaboration. It is this combination of value creation and appropriation that accounts for the contribution of the alliance portfolio to firm performance. In addition, as the few studies on rent appropriation from alliances have mostly focused on how dyadic factors affect asymmetric

market returns, scholarly exploration of how network and alliance portfolio variables affect value appropriation is essential (Lavie, 2007).

We explore value appropriation in the realm of alliances through the lens of brokerage positions in alliance networks. Brokerage is the process of connecting actors (bridges) in systems of relations to facilitate access to valued resources (Granovettor, 1973). Being located between established parties presents entities with opportunities for enhanced access to, and ability to utilize, information, as well as increased bargaining power. This will inevitably lead to gains for the broker that will be context-dependent (Stovel and Shaw, 2012)—in the case of alliances, larger shares of the pie that will be rewarded by financial markets. Granovettor (1973) outlined why these bridging ties are beneficial, bringing to light the network features of brokerage. Since then, various network positions have been shown to increase firm capabilities (Hagedoorn and Schakenraad, 1992; Padula, 2008), which we believe lead to a greater ability to appropriate rents from an alliance.

Stovel and Shaw (2012) elaborate on these brokerage structures, introducing the concepts of "middlemen" and "catalysts" that closely mirror the network concepts of centrality and structural holes respectively. Extending the previous line of research on appropriation in alliances, our study investigates whether firms with these advantageous brokerage positions, such as networks higher in centrality (rich alliance connections with others), or those spanning structural holes (bridging separated sub-groups of firms), will acquire larger shares of the pie compared to their partners. We believe these superior network positions will allow them to better extract and utilize knowledge from the alliance for appropriation and monitoring purposes, and also provide the better connected partner with greater bargaining power (Dyer et al., 2008; Lavie, 2007; Pfeffer and Salanick, 1978; Stovel and Shaw, 2012). Such unequal power distribution has enabled the stronger partner to exploit the weaker in various exchange relations (Dyer et al.,

2008; Emerson, 1962). For instance, Frazier et al. (1989) found that manufacturers with power advantages over their dealers (such as being able to replace them easily with alternative sources) were more prone to use strategies to coerce their dealers into complying with actions favorable to the manufacturers. Particularly, in strategic alliance context, Bae and Gargiulo (2004) raised the concept of substitutability and suggested that if one partner depends more on another for resources, the dependent partner has decreased bargaining power. Accordingly, the dependent firm has decreased ability to reap as large a share of the pie as its stronger partner (Dyer et al., 2008).

Further exacerbating the performance disparity, unequal bargaining power may expose firms to opportunism-related risks: the risks that some firms will try to extract knowledge from the partnership at the other firm's expense (Madhok and Tallman, 1998). Although strategic alliances are supposedly formed for cooperative purposes, scholars have proposed that competition to learn and concerns about value appropriation may lead to self-serving behavior and exploitation. Such exploitation may not be revealed until late in the game because organizations do not have effective means to monitor partners' activities, a weakness that could considerably damage current business operations. A poignant quote from the vice president of a western computer company engaged in an alliance illustrates the hazards of this type of relationship: "A year and a half into the deal I understood what it was all about. Before that I was as naive as the next guy. It took me that long to see that [our partner] was preparing a platform to come into all our markets" (Hamel, 1991, 86).

We argue that advantageous positions in alliance networks can provide firms benefits related to information monitoring, thereby giving them greater ability for early discovery of a partner's opportunistic behaviors such as those mentioned above, thus increasing a firm's potential for reaping larger shares of the pie.

Examining the phenomena of knowledge creation, monitoring and bargaining power associated with alliance announcements between partners in the pharmaceutical industry, we test our propositions using stock market responses to announcements in the form of weighted abnormal returns. Industry characteristics may indeed account for some of the variance in bargaining power and appropriation (King and Slotegraaf, 2011); thus, our choice of a single industry avoids this confounding effect. We chose a set of highly controlled groups of firms within the pharmaceutical industry (SIC 2834), and we restricted our sample observation to those alliances formed for dedicated technology and new product development purposes. In general, we found that partners' asymmetry in alliance network properties significantly affects their difference in market gains, and this relationship was moderated by existing firm resources.

Theory and Hypothesis Development

In their early work on dynamic R&D competition, Grossman and Shapiro (1987) showed both positive and negative dynamics in technology joint ventures: while technology cooperation increases the joint expected profit by saving costs and sharing new knowledge breakthroughs, firms also attempt to reap the greatest share of the outcomes by engaging in intensively competitive races to gain and independently utilize the knowledge created. This partnership hazard results in a trade-off between the common interests in efforts spent on producing a greater joint outcome, and conflicting interests in efforts spent on securing a greater individual part of the pie (Larsson et al., 1998). Zeng and Chen (2003) suggested that alliance partners face social dilemmas in managing the inherent tension between cooperation and competition among themselves. Firms may internalize each other's skills and exploit their partners by applying them to areas outside the alliances (Hamel, 1991; Zeng and Chen, 2003), areas that could possibly be in head-to-head competition with the partner.

As most firms are embedded in broad networks of relationships, it is particularly important to examine how firms' networks of social relations will allow them to reduce the risk of being exploited by their partners and thus realize greater returns from the alliance. In fact, scholars have deemed the segmentation of individual alliances or transactions as an inappropriate unit of analysis. For example, Kogut (1988) noted the limitation of focusing on individual transactions and emphasized that individual alliances may be affected by the historical involvement between the partners. Khanna (1998) also suggested broadening the relevant analytical scope, by highlighting that "individual alliances are influenced by concurrent activities not governed by the alliance." Analysis of the network of alliances is crucial in determining whether a business is in a position to reap superior economic rents, as the overall network in which they are embedded influences firms' activities (Dyer et al., 2008). For example, a specific partner may contribute valuable resources to the focal firm, but this may not necessarily lead to increased dependency as long as the focal firm can seek similar resources from other partners. The notion of resource dependency and partner substitutability emphasized that we need to look at a firm's portfolio of alliances and its overall connections with others to analyze whether the resource a single partner brings is scarce or substitutable, thus increasing bargaining power (Bae and Gargiulo, 2004). More recently, Lavie (2007) proposed an alliance portfolio framework, and also suggested that firms' relative bargaining power depends on relative availability of alternative alliances to partners in its alliance portfolio. In Lavie's (2007) study, he mainly focused on how relational characteristics of ties and partner attributes affect value appropriation between partners in the form of differing market returns. Our current research extends his earlier framework by exploring the structural properties of the alliance network and the positional difference between partners in the network.

Several scholars have addressed the issue of pie sharing from the game theoretic approach, in which the participants typically know ex-ante the nature and size of the pie, and how to assess the processes and resources that create it (Brandenburger and Nalebuff, 1996). Nevertheless, as Jap (2001) suggested, speculation of all the expected outcomes or the magnitude of these outcomes ex-ante may be difficult, and tying each organization's tasks and resources to its outcome is also arduous, as these collaborations often involve significant intangible resources. Especially in the case of lack of formal monitoring mechanisms, firms are at greater disadvantage when they cannot observe partners' behavior, and more importantly cannot predict the impact of partners' actions. Khanna et al. (1998) suggested that firms might pursue private benefits unilaterally by picking up skills from their partners and applying these skills in areas unrelated to specified alliance activities. For example, strategic alliances may suffer from unfavorable knowledge leakage such as uncontrolled information disclosure and asymmetric diffusion of core competencies to partner firms (Inkpen and Beamish, 1997). This concern may be aggravated or somewhat alleviated in the context of alliance networks. Granovetter's (1973) theory introduces the notion that bridges between cohesive clusters are important channels of information flow. As firms exchange information and ideas with a web of partners, they can have additional information sources, such as through third parties, about what activities their partners are undertaking. Network structure also affects the information benefits a firm can obtain, and thus influences the ease of monitoring and deterrence for certain firms.

Network Centrality Effect. As different structural locations in interorganizational networks may affect a firm's ability to benefit from a relationship (Walter et al., 1996), we suggest that firms more centrally located in a network will have a higher likelihood of appropriating larger shares of pie than their partners. This is because this "middleman" brokerage position (an entity in the

middle of otherwise unconnected actors) will lead to performance benefits due to the advantages discussed below (Stovel and Shaw, 2012). Madhavan et al. (1998) suggested that centrally located firms are exposed to richer external resources and have higher control and flexibility of resource allocation to achieve their organizational goals. Because these central firms have a wide range of partners from which to acquire knowledge and access resources (Koka and Prescott, 2002), they depend less on specific partners for strategic assets. Such flexibility and partner substitutability will increase bargaining power (the ability to obtain accommodations from partners), and influence the outcomes of negotiations (Yan and Gray, 1994). This is amplified when its partner does not have symmetric access to resources (Bae and Gargiulo, 2004; Pollock et al., 2004). Lavie (2007) confirmed this notion by demonstrating that when a firm enjoys better access to alternative alliances, it has more options to pursue similar objectives with a multitude of firms, a situation that greatly improves a firm's bargaining power (Lavie, 2007). Similarly, when its partners have limited alternative choices to acquire desired knowledge or resources, the vulnerability of these partners is very high if the focal firm withdraws from the existing alliance relationship. Thus, this centrally connected brokerage position will allow these firms to increase their share of relational rents—thus impacting the difference in market performance.

Central locations can also help firms to better monitor partners' behavior and thus deter them from taking opportunistic action. The level of monitoring in strategic alliances is quite minimal compared with formal level of internal governance. In the absence of these formal hierarchical monitoring systems, social network scholars have long suggested that social ties can provide informal monitoring and coordination mechanisms (Gulati, 1998; Uzzi, 1997). In a network system, members can collect information about potential partners' behavior through embedded ties. For example, Gulati (1999) found that firms actively seek and collect information about others through the existing network of partner connections. Specifically, he reported from

an interview with an alliance manager: “Our network of partners is an active source of information for us about new deals. We are in constant dialogue with many of our partners, and this allows us to find many new opportunities with them and also with other firms out there” (Gulati, 1999, 401).

This evidence suggests that firms will impose sanctions on partners that have behaved negatively in previous alliances, by reporting the behavior to firms the opportunistic partner may want to form relationships with in the future. Compared with firms that are central in networks with rich information channels, peripheral organizations with few connections in the network are more likely to experience delayed or missed information related to their partners’ behaviors. The effect of such network monitoring could be twofold: firms with transparent information exposure are deterred from opportunistic behavior, and organizations with few external monitoring constraints have better opportunities to take unobserved actions for their benefit.

According to Ernst and Halevy (2000), although the stock market responds sharply to announcements of alliances in general, it favors some types of transactions that will increase a firm’s central connectiveness. This study demonstrated that many of the most successful businesses use alliances to position themselves in the center of a network where they can flexibly leverage intangible capital and enrich their information channels. This indicates that even though alliances are dyadic, relative bilateral dependency and bargaining power are also affected by each firm’s connections to others in the overall network. Thus, all else being equal, firms high in centrality engage in alliances with firms lower in centrality be rewarded with higher market returns.

H1: A firm with higher network centrality relative to its partner in an alliance network will have higher weighted returns than its partner does.

Structural Hole Effect. Bridging or boundary-spanning ties can connect a focal firm to resources and opportunities not available to other network contacts (McEvily and Zaheer, 1999). Burt's (1992) definition of a structural hole—when one party is connected to two other parties that are themselves not connected, and thus do not share resources—implies that firms spanning structural holes will enjoy both resource and information advantages over their partners. Knoke (1994) suggested that organizational activities can be viewed as "the process by which social actors create and mobilize their network connections within and between organizations to gain access to other social actors' resources." On some occasions these bridging ties are critical when they can control the resource and information flows. In addition to gaining access to information not available to firms that do not span boundaries, this unique "catalyst" role (the one who controls the flow of information between two entities) will increase its partner's dependency and improve its own bargaining power (Stovel and Shaw, 2012). This will pose a strong deterrence and greatly discourage partners' opportunistic behavior, decreasing the risk that the partner will exploit valuable assets. If a firm that bridges disconnected groups withdraws from an alliance, its partner may be considerably more vulnerable, in that removing such a bridge will render partner firms unable to gain access to information and resources from those connected by this bridge. Thus, powerful partners can extract greater benefits by threatening to withdraw from the collaboration, and instead operate the business alone or with another partner (Pfeffer and Salancik, 1978). Ultimately, spanning structural holes will lead to unique advantages for the firm that make it difficult for its partners to find alternative sources and switch to other alliance targets.

In addition to and separate from bargaining power benefits, Burt (1997) claimed that the structural hole is an opportunity for the connecting party to benefit from non-redundant

information provided by both parties, giving it better opportunities to find complementary assets to amplify the value of the alliance. People whose social ties are limited to one clique, or group, are less likely to receive diverse information, because information that circulates within a clique of highly connected workers is likely to be redundant (Brass, 1984). As a result, firms that bridge groups have better channels by which to gather and monitor partners' behavior. Also, according to Zaheer and Bell (2005), when knowledge is developed through firm interaction, organizations that bridge structural holes will be able to develop new understandings regarding emergent threats and opportunities—advantages denied to those who do not bridge holes. Within the pharmaceutical industry, for example, if Pfizer has alliances to explore genetically engineered DNA with both Alkermes and Amgen (who do not have alliances with each other), and both alliances produce compounds that could potentially be combined into an oncology therapy, Pfizer will garner a substantial amount of the value created by both alliances based on its brokerage position.

As we have argued, the unique combination of alliances provided by a network rich in structural holes affords firms the information control that will garner greater shares of the overall pie. America Online (AOL), which had a market value of over $100 billion after fewer than fifteen years in business, provides additional evidence of this. Earnst and Halevy (2001) attribute this astounding record of success, in large part, to AOL's web of alliances from various separated industry sections, which helped it become the world's largest provider of online services. Such success is more related to the scope of partnerships maintained by AOL across many sectors, rather than the scale of alliance investment or number of partners within a single sector. Through a portfolio of diversified and separated partners, AOL gained access to information regarding potential products, content and technology—information that allowed it to develop unique assets that would not have been available from any single firm. AOL's success in

such alliance management can partially be explained by its unique position to bridge the links across several disconnected groups. Its partners had limited connections within small cliques, and most of the time claimed only a small share of the revenue division because of their weak positions. AOL was rewarded handsomely for this brokerage position, in terms of enhanced market value.

H2: A firm bridging more structural holes relative to its partner in the alliance network will have higher weighted returns than its partner does.

The Moderating Role of Commercial Capital

Khanna et al. (1998) also suggested that firm characteristics can be seen as parameters that affect the particular realization of the partner's perceived benefits. One important factor moderating the potential benefit one organization can receive is its commercial assets, or the resources a firm can utilize to commercialize its technologies and products (Madhavan et al., 1998; Park et al., 2002). Ahuja (2000) suggested that commercial capital is a particularly important resource for transforming knowledge and technical innovations into products and services, which entails the development of manufacturing and marketing capabilities, and assets such as facilities and distribution networks. Thus, firms endowed with higher levels of commercial resources should find it easier to exploit rent-appropriating opportunities as these firms are have less economic constraints, and can quickly use the technology in their product-development processes. As a result, they can expedite the market introduction process and capture additional rents, greatly enhancing future revenue-producing capabilities.

As Zhao (2006) suggested, specialized complimentary assets, such as the right manufacturing and marketing capabilities, are crucial to the successful commercialization of new

technologies. Firms can discourage involuntary leakage and exploitation of its own technology by its partner when commercialization of such technology requires significant capabilities and resources that are not readily available to its partner. Thus, while information and bargaining power asymmetries create unequal potential for partners to acquire different shares of the pie, lack of commercial resources will make it more difficult for firms to realize rent-generating opportunities under such circumstances. We believe that, because commercial capital is an important component of exploiting rent-appropriating opportunities, this will be reflected in their ability to take advantage of their network position to appropriate rents, and resultant market performance. This suggests:

H3a: Organizational commercial capital will positively moderate the relationship between network centrality asymmetry and weighted returns.

H3b: Organizational commercial capital will positively moderate the relationship between structural hole asymmetry and weighted returns.

Methods

Sample. Our focus is on firms listing pharmaceutical preparation as their primary business. According to Okamura and Vonortas (2006), in a study of five industries including pharmaceuticals, plastics, computers, electronics and instruments, pharmaceuticals had greater numbers of alliances than other industries; thus, we believe the pharmaceutical industry to be an appropriate industry in which to study the benefits of networks. We used SIC code 2834 (this designation was taken from COMPUSTAT, as well as the Compact Disclosure and Global Worldscope databases). Four criteria were used to identify a sample of firms from this industry.

First, firms that designated the SIC code 2834 (pharmaceutical preparation industry) as their primary business were selected from the COMPUSTAT database. This set of firms focused on pharmaceutical product development as their major business. We excluded those firms involved only in marketing and distribution activities in the pharmaceutical section. Second, to create a balanced panel of data, we selected only those firms that reported their research and development investments every year from 1994 to 1999, the height of the biotech boom. At this time, pharmaceutical companies were acquiring biotech companies and then forming alliances amongst themselves to share and better exploit the acquired technologies. Thus, this period provided a rich sample of technology alliance announcements. Technology alliance data were gathered from Recombinant Capital, a comprehensive database on pharmaceutical firm alliances widely used by past researchers (Lerner, 1994). To best capture the technology distance between alliance partners, we also limited our sample to those firms that have active patenting activity in each year of our observation window. Third, we focused on the alliances that were publicly announced and carry salient market signals to general investors. Firms may be engaged in various technology collaborations, but cooperative activities that are not publicly announced are not readily known to investors. Fourth, to observe stock price movement by each pair of partners involved in alliance announcements, we selected only those alliances that included public firms with at least two-years' history of stock operation at the beginning of our observation window. This left us with 68 established leading firms with ongoing R&D and patenting activities as our sample coverage.

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Dependent Variables

Difference Between Partners' Performance Outcomes. While the sum of the abnormal returns to the two organizations would reflect the value created, we believe the weighted abnormal returns

accrued to each partner reflects value appropriation. We used the event study method to measure the abnormal returns of both firms involved in the alliance announcement (McWilliams and Siegel, 1997). Empirical studies from various disciplines have shown that event study and abnormal returns are appropriate means to investigate market valuation of alliance announcements. For example, Chan et al. (1997) examined stock market reaction to 345 alliance announcements involving firms traded on the NYSE, Amex, and Nasdaq from 1983 to 1992, and reported that the average abnormal return (the risk adjusted return in excess of the S&P 500) on the date of the announcement was statistically significant. Kale et al. (2002) reported that firms with dedicated alliance functions (functions that strategically coordinate alliance activity with the goal of capturing and disseminating alliance-related knowledge) achieved an average abnormal return of 1.35%, whereas those without this function had a much lower return of 0.18% on average. Das et al. (1998) studied 119 alliance announcements across a dozen industries between 1987 and 1991 and found overall positive abnormal returns when alliances were announced on the same day. Though findings from these studies were largely related to value creation rather than value appropriation or pie-splitting effect, they provided strong evidence that alliance announcements are related to variations in stock gains.

The normal approach in event studies is based on estimating a market model for each firm and then calculating abnormal returns.

$$R_{it} = \alpha_i + \beta_i * R_{mt} + \varepsilon_{it}$$

[R_{it} = the rate of return on the share price of firm i on day t, R_{mt} = the rate of return on a market portfolio of stocks on day t, α i = the intercept term, β_i = the systematic risk of stock i, ε_{it} = the error term for stock i on day t.]

The deviation of the actual return from the expectation (abnormal return, AR) is computed for firm i on the day t as

$$AR_{it} = R_{it} - (a_i + b_i R_{mt})$$

We noted alliance announcement date as t = 0; day -1 as one day prior to the event; and +1 as one day after the event. This three-day window captures the possible "leakage" prior to the publication of the technology announcement or slow reactions by some investors to the announcement; however, this relatively short window excludes confounding events. We then used daily stock return of each firm in the period 260 to 10 days before the event (from day -260 to day -10) to estimate the parameters in the above models (McWilliams and Siegel, 1997). We also ruled out those alliance announcements with confounding events such as M&A and releasing annual financial reports that happened within the event windows.

We then follow Bradley et al.'s (1988) classic finance study in computing the performance benefit to each partner from the acquisition announcement. While they compare the gains from the announcements of tender offers, their approach is general and we believe a rigorous test of our outcome variable.

Using the CARs, we estimated the gain to the focal and partner firm in each alliance as value-weighted portfolio of the ith target and the ith acquiring firm, where the weights used are $W_{T\,i}$ and $W_{A\,i}$ as follows:

$$\Delta W_{F\,i} = W_{F\,i} \cdot CARF_{\,i} \qquad \Delta W_{P\,i} = W_{P\,i} \cdot CARP_{\,i}$$

where

$W_{F\,i}$ = log of the market value of the focal firm on the two days prior to the announcement

CARF $_i$ = cumulative abnormal return to the focal firm over the three-day window

W P_i = log of the market value of the partner firm on the two days prior to the announcement

CARP $_i$ = cumulative abnormal return to the partner firm over the three-day window

Independent Variables

Network Centrality Asymmetry. We used Bonacich's power-based centrality in this study. Bonacich (1987) defined the power centrality measure based on the centralities of units that a unit is connected to. Essentially, the Bonacich power measure suggests that the power of an organization is affected by how powerful its partners are in the same social network. This definition is consistent with our earlier discussion regarding the embedded network resource a firm can access: the focal firm can gather the information not only through direct ties, but the information transmitted by those direct ties is again influenced by their connection to other members in the overall network. In addition, these network ties influence a firm's collection of information about a partner's behavior. For each dyad, we calculate the difference between the partner's Bonacich power centrality based on the standard UCINET formula. The Bonacich power centrality of network note i (denoted ci) is calculated as ci = SAij(a+bcj), where a and b are network parameters. In our study, those parameters are the weight induced by the centrality measures of partners a firm is connected to. According to the formal procedure, we chose the normalization parameter so that the sum of squares of the vertex centralities is the size of the network. We then computed the difference of Bonacich power centrality between each pair of partners.

Network Efficiency Asymmetry. We calculated structural hole measures based on Burt's (1992) formula using UCINET routine (Borgatti et al., 1999). In this formula, P_{iq} is the proportion of i's relations invested in contact q, M_{iq} is the marginal strength of the relationship between contact j and contact q, and C_j is the total number of contacts for firm i (Burt, 1992).

$$\sum_{j=1}^{n} \frac{1 - \sum_{q=1}^{n} p_{iq} m_{iq}}{C_j}$$

After obtaining the structural hole measure for each pair of firms involved, we calculated the difference between the index of the focal firm and its alliance partner.

The Moderating Role of Commercial Capital. Following Ahuja's (2000) approach, we also used a firm's annual assets to represent its commercial resources, and obtained data in each year from COMPUSTAT (Ahuja, 2000). We drew the sample from the leading firms in the pharmaceutical industry, so we were able to gather complete information related to assets. We also developed a similar alternative measure using the sum of the previous five years' sales in the pharmaceutical industry, which generated similar findings. As firm assets and sale measure are highly correlated, we didn't enter both in regression models at the same time, and reported our results based on firm assets.

Control Variables

Network Density. Coleman (1988) argued that a dense network promotes trust and cooperation among its members. We used the standard UCINET routine and calculated the density as the number of existing ties among the firms divided by the number of possible ties among them

(Borgatti et al., 1999). In dense networks, members tend to closely connect and interact with one another, thereby decreasing the uniqueness of any particular firm. In addition, due to the frequent exchange of information, the ease of monitoring other firms' behavior is also affected; thus, we included network density as a control.

We also included other control variables consistent with previous network studies, such as firm age, partner firm age, liquidity, and year dummy. Also, we controlled for alliance experience as the number of alliances entered into in the previous five years (Rothaermael and Leeds, 2004) and firm patent stock and partner patent stock, as the number of patents currently held by each.

Commented [anon3]: Yes, thanks

Commented [MH4]: Should there be an "and" after "firm patent stock"?

Analysis and Results

We present variable descriptive statistics and correlations in Table 1. To observe the stock price movement of both partners at the point of alliance announcement, we had to eliminate those firms that were not listed or did not have enough history in the security exchange market. Our resulting sample firms are among the leading companies in the pharmaceutical industry as represented by their sales volume; during our observation window, all had over ten years of operating history. This sample includes 68 of the largest pharmaceutical firms (SIC 2834) that account for more than 80 percent of the products and sales in this industry.

INSERT TABLE 1 ABOUT HERE

We report regression results on weighted returns in Table 2. Our results showed that most of the year dummy variables were not significant, so we excluded them from our table.

INSERT TABLE 2 ABOUT HERE

Model 1 shows the results from our baseline model. In this model, we found that firms with rich alliance experience are more capable of deriving a large share of rents from the cooperative relationship, resulting in greater market gains from the announcement. This is consistent with previous studies that have shown firms can improve their alliance capacity through their past interactions with various alliance partners, and can better allocate and mobilize their resource to capture rent whenever the opportunity exists. Over time, firms accumulate experience and invest in activities that support dissemination of experience with alliances throughout the company. In most cases, the level of experience is related to the firm's capability of successfully managing a portfolio of alliances (Kale and Singh, 1999).

We test the main effect of centrality asymmetry in Model 2. The results provide weak support, as the coefficient of centrality asymmetry is only significant at α =0.1 level. This suggests that the centrality asymmetry and weighted returns have a loose connection, albeit not highly significant. In Model 3, we found a significant positive relationship between structural hole asymmetry weighted returns, as the coefficient is significant at α =0.05 level. This suggests that a firm that maintains more bridging links to separated groups relative to its partner has a better opportunity to appropriate value, thus generating greater returns. This also supports our earlier argument that a firm's unique bridging role deters partners from engaging in opportunistic behavior, and thus decreases the risk that partners will exploit the firm's valuable assets.

We test the moderating effect of commercial capital, using firm assets as the proxy (Ahuja, 2000) in Model 4. We found that the interaction term between centrality asymmetry and commercial capital is positive and significant at α =0.05 level, providing support for H3a. In addition, the moderating effect of commercial capital on structural hole asymmetry in Model 5 is

weak and positive (α =0.10). These two findings suggest rich commercial capital endowments make it easier for firms to use rent appropriation opportunities, and investors recognize this.

Discussion

In his seminal work, Hamel (1991) pointed out that one negative aspect of collaborative processes is the reapportionment of skills between alliance partners because of the asymmetry of both learning and bargaining power. This creates a situation in which one partner can benefit more than the other in both knowledge creation and rent appropriation. Hamel claimed that asymmetries in learning can change relative bargaining power within the alliance, and successful learning on the part of one participant could lead to a pattern of unilateral rather than bilateral dependence. As a result, a partner that understands the link between interfirm learning, bargaining power, and competitiveness will tend to view the alliance as a race to learn and capture more rents at their partner's expense (Hamel, 1991). While this study does not specifically address the learning process, the general findings extend Hamel's arguments that the partners have asymmetric gains associated with alliance activity.

This study follows the line of recent research on value appropriation in strategic alliances (e.g., Blyler and Coff, 2003; Gulati and Singh, 1998; Gulati and Wang, 2003; Kumar, 2010a, 2010b; Lavie, 2007). Specifically, we complement the alliance portfolio framework suggested by Lavie (2007), by incorporating significantly more social network contexts through our exploration of Stovel and Shaw's (2012) middleman and catalyst brokerage positions. In addition, we not only investigated whether network structure influenced value appropriation between alliance partners, but also studied the contingent effect of firm resources.

Several economic studies have examined value appropriation of alliances based on inter-firm differences of size and technology status, though the findings are inconsistent. For example,

Chan et al. (1997) reported that, without investigating pair-wise partner comparisons, smaller firms experienced an average abnormal stock return of 2.22%, and larger firms achieved a weak and insignificant average return of 0.19% in stock value. However, when they ran pair-wise dyadic analysis on the firms involved in the same alliance announcement, they found no significant association between size asymmetry and abnormal stock returns. Koh and Venkatraman (1991) showed that firms entering marketing-related alliances did not generate significant returns, while firms with technology-related alliances experienced positive and significant market returns. However, Chan et al. (1997) found no significant differences in returns between alliances with technology development functions, and alliances for marketing and distribution purposes. Indeed, these existing studies that focus merely on size asymmetry and technology asymmetry reported mixed results, and suggest that these two factors only serve as incomplete explanations to value appropriation or pie splitting between alliance partners. Our study focused on the network connections of firms in a single industry where technology cooperation is very intensive. With size and technology factors controlled, our results indicate that advantageous network positions can also help firms increase their value appropriation and pie-splitting potential; thus, these should be taken into account.

This paper contributes to existing related research in several ways. Theoretically, our study extends prior literature by examining value appropriation and pie splitting in strategic alliance studies. Building on social network theory, we develop an integrative framework to propose that a firm's social ties and embedded resources can affect information asymmetry and bargaining power asymmetry, and thus impact the ability of a firm to appropriate a larger share of pie. Social ties can also provide additional monitoring and deterrence mechanisms otherwise unavailable in conventional economic agency settings, which help deter partners from opportunistic behaviors. In addition, they greatly affect the resource dependency between the

dyadic alliance relations, as each firm maintains a web of alliances and draws resources from respective alliance pools. Empirically, we show evidence that a firm's stock gains relative to its partner are associated with its structural position in the alliance network, and confirm the contingent nature of network structure in rent appropriation, by demonstrating that commercial resources act as a moderating influence between network structure and the short-term stock performance. We believe that advancing the understanding of the variables and showing how they interact is a valuable addition to the networks literature, because of the profound effect on stock performance. These understandings will provide managers with more prescriptive guidelines for recognizing the actual structure of alliance formation that will appropriate the highest rents, as well as act as positive signals to general public.

Our study has limitations. First, to observe stock price movements for partners involved in alliance announcements, we selected only those public firms with clear news releases on their specific ongoing alliance activities, rather than private or smaller firms. Investors pay close attention to alliance announcements made by leading public firms and are able to capture salient market signals that alliances send, so we expect the stock price adjustment to those leading companies to reasonably represent actual market responses. However, our findings on rent appropriation may not readily apply to alliances involving private companies. Second, we limited our sample to alliances related to R&D collaboration and new product/technology development, excluding alliances formed for marketing or distributing purposes. Alliances formed with intentions to enhance sales of established products may lead to more salient stock market response than do R&D alliances in the earlier stage of new technology development. Third, we relied on patent profiles to investigate dyadic technology distance between alliances partners, so we limited our observations to firms with valid patent records filed with the U.S. Patents and

Trademark Office. Thus, our findings may not generalize to startup firms that do not have public patent records.

A possible extension of this work is to examine the risk-reduction aspects of alliance activity. Chatterjee et al. (1999) suggest, “The next step for developing a strategic model of risk premium is to provide more precise specifications of the included variables and more specific assertions about how those variables interact.” Because firms form alliances predominantly to decrease the risk of developing internally the desired knowledge or product, this next step is logical in the pursuit of this strategic model of risk premium. Ernst and Halevy (2000) suggested that alliances allow companies to develop future revenue-generating capabilities more quickly and with less risk than they would incur with internal development and acquisition. “In some circumstances, the market seems to reward alliances more richly than mergers and acquisitions.” Indeed, building new businesses means assembling a host of new capabilities such as products, technologies and customer relationships. Few organizations can develop these capabilities internally with sufficient speed, and alliances allow companies to leverage their existing skills while they quickly and flexibly access the capabilities of others. Thus, companies develop their networks and undertake additional alliance activity as a risk-reduction strategy. By examining investor-assigned stock risk we can ascertain investors’ evaluations of this strategy in reducing risk.

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Biographies

Dr. Hughes-Morgan received her Ph.D. at the University of Kentucky, her M.S. from the Massachusetts Institute of Technology, and her B.A. from Duke University. Her research and teaching interests lie mainly in the areas of dynamic competitive interaction, investor psychology, and the structure of inter-organizational networks. She has several years of work experience on Wall Street. Her most recent position was a Director for the United Bank of Switzerland, where she specialized in analysis of biotechnology and pharmaceutical stocks. She is on the Board of Directors of MPR Research Corporation, a contract research organization in Detroit, Michigan. E-mail: margaret.hughes-morgan@marquette.edu

Emery Yao is an Associate at HSBC School of Business. He received his Ph.D. in Strategic Management from the University of Pittsburgh. He teaches courses in the area of Strategic Management. His research interests include Strategic Management, Technology and Innovation, International Business, Network Theory and Analysis, and Computational Social and Organizational Theory.

TABLE 1: Means, Standard Deviations and Correlations

		Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1	Weighted Return	0.23	0.12										
2	Centrality asymmetry	1.32	0.67	0.06									
3	Structural hole asymmetry	0.03	0.32	0.08	0.04								
4	Own patent stock	161.80	192.34	0.15	-0.08	-0.12							
5	Liquidity	2.35	1.87	0.20	0.07	0.11	0.09						
6	Network density	0.03	0.01	0.01	-0.04	-0.03	-0.06	-0.05					
7	Alliance experience	2.29	1.75	0.31	-0.15	0.09	0.19	0.14	0.08				
8	Firm age	14.35	5.12	0.15	-0.24	0.15	0.04	0.07	0.10	0.06			
9	Firm Assets	2031.24	1714.55	0.14	0.02	0.05	-0.02	-0.13	-0.08	-0.06	-0.11		
10	Partner patent stock	159.23	188.67	-0.02	-0.04	-0.07	-0.02	0.15	0.07	-0.11	-0.09	-0.06	
11	Partner firm age	13.27	4.96	0.01	0.05	-0.04	0.01	-0.01	-0.02	-0.11	-0.12	0.08	-0.05

(Correlations with absolute values larger than 0.25 are significant at $p<0.001$.)

TABLE 2: Regression Results on Weighted Market Gains

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Centrality asymmetry		0.077*		0.075*	
Structural hole asymmetry			1.378**		1.693**
Centrality asymmetry * Assets				0.0006**	
Struct. hole asymmetry * Assets					0.010*
Own patent stock	-0.005	-0.0001	-0.001	0.0004	0.0005
Liquidity	0.012*	0.002*	0.002*	0.004*	0.002*
Network density	0.002	0.004	0.002	0.006	-0.004
Alliance experience	0.159*	0.116	0.159*	0.189*	0.177*
Firm age	0.026	0.009	0.036*	0.010	0.007
Firm Assets	0.003*	0.006*	0.004	0.003	0.001
Partner patent stock	0.0092	0.001	0.002	0.002	0.003
Partner firm age	-0.009	-0.011	-0.013	-0.001	-0.013
Chi-square	429.01***	455.21***	478.26***	462.54***	452.58***

(* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$)