Strategic Broadcasting of Strategic Alliances:
Which firm(s) would broadcast their alliance formation?

ABSTRACT

Interorganizational ties such as strategic alliances function not only as a conduit through which resources flow but also as a prism through which audiences make their inferences about firms' quality. Existing research on network ties as market signals, however, relied on the assumption that formation of network ties ensures visibility to audiences. This paper investigates the assumption by studying the extent to which formed alliances can be strategically broadcasted by firms as a purposeful attempt to affect how their alliances are perceived. Specifically, this paper studies which of the two firms – or none or both - would broadcast its alliance once it is formed. Broadcasting network ties is defined as a purposeful choice of which ties to be publicized to audiences in this paper. Building on the vast literature on how network ties function as status signals, this paper introduces status of a focal firm and its partner firm as two main factors that affect a focal firm's decision of whether to broadcast the alliance. This paper shows that firms are more likely to broadcast their networks as their partners' relative status increases. Furthermore, the paper shows that the result holds mostly for low- and middle-status firms but not for high-status firms. This paper contributes to the literature by providing a novel perspective that benefits of social network ties can come from how network ties are broadcasted by social actors.

Keywords:

Network Agency; Networks and Embeddedness; Status and Reputation; Strategic Alliances

INTRODUCTION

Interorganizational ties such as strategic alliances function not only as a conduit through which resources flow but also as a prism through which audiences make their inferences about firms' quality. Building on Podolny's (2001) metaphor of networks as the prisms of the market, numerous studies have shown the benefits of associating with high-status firms (for example, Baum, Calabrese, & Silverman, 2000; Piazza, Phillips, & Castellucci, 2020; Podolny, 1994; Stuart, Hoang, & Hybels, 1999) and the costs for low-status firms to obtain these associations such as greater level of effort (Castellucci & Ertug, 2010), smaller portion of equity (Ahuja, Polidoro, & Mitchell, 2009), or high-priced investments (Kim & Kim, 2021). Findings of this stream of research, however, relied on the assumption that formation of network ties ensures visibility to audiences. For example, Stuart et al (1999) made the following assumption in their paper studying the positive endorsement effect of prominent venture capital firms: "we must *assume* that gaining a partnership with a prominent organization draws attention to a new venture…" (Stuart 1999, p.391, emphasis added). This paper investigates the assumption by studying the extent to which formed alliances can be strategically broadcasted by firms in order to affect how their alliances are perceived by audiences. Specifically, this paper studies which of the two firms – or none or both - would broadcast its alliance once it is formed. Broadcasting network ties is defined as a purposeful choice of which ties to be publicized to audiences in this paper.

When strategic alliances are formed, firms often do not just wait until the news about their newly formed alliances are picked up by audiences such as public media or analysts. Rather, they are strategic about how their alliances are delivered and portrayed. For instance, firms can be strategic about when their alliances are to be announced (Carlos & Lewis, 2018; McDonnell & King, 2013), through which medium their alliances are announced, how their alliance content is

described, which firm is to announce the alliance, and so on. As a first step to explore firms' strategic broadcasting of alliances, this paper focuses on which firms would strategically broadcast their alliances while others do not, after their alliances are agreed to be formed.

Building on the vast literature on how network ties function as status signals (Halgin, Borgatti, Mehra, & Soltis, 2020; Hsu, 2004; Pollock & Gulati, 2007; Zhang & Wiersema, 2009), this paper introduces status of a focal firm (denoted as ego from now on) and its partner firm (denoted as alter from now on) as two main factors that affect a focal firm's decision of whether to broadcast the alliance. We follow Podolny (1993)'s definition of status as "the perceived quality of the products of a producer relative to either the products of similar others or its competitors" (Podolny, 1993). We explore the tension that naturally emerges from the status difference between two firms in broadcasting their alliance. When a low-status firm and a high-status firm form an alliance, the alliance is typically good news for a low-status firm while the same alliance might not be good news for a high-status firm. Due to these asymmetrical incentives to broadcast alliances between two firms, they might have different broadcasting strategies. Furthermore, we explore the extent to which the impact of an alter's status hinges on an ego's status. Building on the middle-status conformity theory (Phillips & Zuckerman 2001), we theorize and investigate whether middle-status firms show different tendency to broadcast their alliances compared to low- and high-status firms.

I test my claims through press releases of biotechnology firms' strategic alliances. Press releases are widely used by firms to publicly disclose material information, along with other means such as form 8-K or conference announcements. Press releases are useful to answer my research question because every press release clearly indicates which firm made the announcement. For example, a press release announced by 3-Dimensional Pharmaceuticals Inc. on Jan 8, 2002, started

with the sentence "3-Dimensional Pharmaceuticals, Inc. today announced that the company has entered into an exclusive licensing agreement with GlaxoSmithKline (GSK)…" Furthermore, the existence of costs in sending out press releases, due to the amount of time needed to prepare and distribute the news and the risk of disclosing strategic information to competitors, ensures that firms must be strategic in broadcasting their alliances via press releases.

This paper contributes to social network research by connecting two research streams: signaling effects of networks and network agency. So far, research on signaling effects of networks has paid attention to how signals are interpreted by audiences (Hsu, 2004; Podolny, 2001; Stuart, Hoang, & Hybels, 1999). This paper contends that understanding how network signals are *sent* from actors is important because our knowledge of the signaling effect of social networks is more comprehensive once we understand both how signals are *sent* and *received* in the market (Pollock & Gulati, 2007; Spence, 1973). If signals reduce market uncertainty, as suggested by Podolny (1993), actors have incentives to manipulate their signals in a way that can enhance their visibility to audiences. The other stream of research on network agency has paid attention to how actors are strategic in forming and activating networks. However, it has not paid much attention to whether actors are strategic beyond enacting their network structures. Thus, this paper attempts to connect the two streams of social network research by showing the existence of agency in broadcasting network ties.

THEORY AND HYPOTHESES

Firms as strategic actors managing their impression

Social network research suggests that social actors – organizations or individuals - are strategic when they form networks (Hallen & Eisenhardt, 2012; Padgett & Ansell, 2008), when they manage their ties (Burt, 1983; Zaheer & Soda, 2009), and when they activate their network

ties (Granovetter, 1973; Smith, Menon, & Thompson, 2012). Social relations can be attributed, to a certain extent, to actors' agency because some actors deliberately construct their social ties in a way that they can benefit from such relations. Agency is defined as "the temporally constructed engagement by actors… which, through the interplay of habit, imagination, and judgment, both reproduces and transforms structures" (Emirbayer & Mische, 1998, p.970). The definition implies that focus has been centered around how actors enact their network structures, such as forming new networks or reaching out to their existing contacts.

If agency exists in network formation, can agency also exist after network formation? Impression management research is helpful to understand the existence of agency beyond network formation because it suggests that organizations are strategic in managing their impression (Elsbach & Kramer, 1996; Elsbach & Sutton, 1992). Impression management research suggests that firms actively attempt to shape the way in which audiences view them by selectively disclosing information such as their news or internal activities (Bansal & Clelland, 2004; Elsbach & Sutton, 1992). For example, firms attempt to divert external attention by revealing positive news, which help offset negative news (Elsbach & Kramer, 1996; Marquis, Glynn, & Davis, 2007). Chemical firms reveal positive environmental news in their annual reports that can offset negative environmental liability claims (Milne & Patten, 2002). Business schools rapidly react to the first announcement of the Business Week rankings by publicly explaining their lower than expected performance or emphasizing their strengths that are not covered in the rankings (Elsbach & Kramer, 1996). Firms use impression management tactics in order to either amplify positive cues or minimize negative cues (Mishina, Block, & Mannor, 2012).

Although the literature has shown that firms are strategic in managing their impression, it has not yet studied whether inter-organizational network ties are another source of information

that firms strategically manage. Although impression management research would suggest that ties with high-status partners are positive information which firms hope to broadcast to audiences, we need to bring in theories on status and networks in order to better understand conditions under which ties with high-status partners are positive information or ties with low-status partners are negative information. Since inter-organizational ties involve at least two firms, we need to theorize how *both* a focal firm and its partner firm make their own strategic decision about broadcasting of the same alliance. When it comes to inter-organizational ties as a source of managing impression, a unique feature of broadcasting network ties is that the information might be disclosed to audiences even when you attempt to hide from audiences. If your partner chooses to broadcast the alliance formation while you choose not to, audiences will still know about the alliance formation from your partner's broadcasting. Thus, in the following section, I introduce theories on status and networks in order to further understand how firms strategically broadcasting their network ties depending on their own status and their partners' status.

Different levels of endorsement effect of network ties across ego's status

Podolny's (1993) status-based model suggests that the relative status of network partners functions as an important signal in the market. It suggests that when markets are rife with uncertainty, the ties that exist among market participants have signaling effects (Podolny, 2001). "The presence of a tie between two market actors is an informational cue on which others rely to make inferences about the underlying quality of one or both of the market actors (Podolny 2001, pg. 34). In this model, "ties to higher-status actors enhance the prestige with which one is viewed" (Podolny 1993, pg. 833). Many studies have suggested that the increased status from social relations with higher-status actors leads to higher performance or increased benefits (Baum et al., 2000; Benjamin & Podolny, 1999). Past studies also explored how firms deliberately choose their

network partners. For example, Podolny (1994) suggests that high-status firms will exclusively associate with similar high-status firms, especially under a high level of uncertainty because ties to low-status firms provide bad signals about quality (Podolny, 1994). In their study of Formula One racing, Castellucci and Ertug (2010) suggest that higher status firms request greater effort from lower status partners as a compensation for the potential threat of status decline. Similarly, Ahuja et al (2009) suggest that higher status firms acquire more equity stakes in founding joint ventures with lower status firms.

The status-based model suggests that there exists asymmetry of incentives to broadcast their alliances between high- and low-status firms. High-status firms have fewer incentives to broadcast their association with low-status firms because such information can damage their established status. If the low-status partners turn out to be of bad quality, high-status firms can be more damaged because the high-status firm's endorsement will be interpreted as less trustworthy in the future. In contrast, low-status firms have greater incentives to broadcast their alliances with high-status firms because such information enhances their perception through an endorsement effect (Stuart et al., 1999). Low-status actors can be considered as legitimate alliance partners in the future because alliances with high-status actors endorse their quality.

The above theory applied dichotomy to status and considered the benefits of having ties with high-status firms to low-status firms. This perspective can be further developed by splitting ego's status into three positions – high, middle, and low – and applying the middle-status conformity theory suggested by Phillips and Zuckerman (2001). Building on the middle-status conformity theory, middle-status firms tend to conform to audience expectations while high- or low-status firms are less likely to conform but rather differentiate from competitors or deviate from audience expectations.

For high-status firms whose identities are already well-established, it might not be hugely detrimental to broadcast their association with lower status firms to the extent that such relationships do not alter audience expectation. Similarly, it might not add enough value to broadcast their association with similar high-status firms or even higher-status firms because audiences already highly evaluate these high-status firms. It is important to note that broadcasting information about strategic alliances involves costs such as disclosing some strategic information to competitors or internal staffs' time preparing the news material. Hence, the decision of whether to broadcast their alliance formation to audiences might not be much affected by their partners' status for high-status firms.

For middle-status firms, however, it is more important to manage audience expectation by selectively broadcasting their association with firms. Relationships with higher status firms can enhance their impression from audiences while relationships with lower status firms can damage their evaluation. Middle-status firms do not yet establish their status positions from audience perspective, which suggests that they are more susceptible to audiences' evaluation of network ties than high-status firms. Thus, in contrast to high-status firms, middle-status firms should be strategic about broadcasting their networks in a way that they tend to broadcast ties with higher-status firms, and they tend not to broadcast ties with lower-status firms.

For low-status firms, ties with higher status firms are certainly an invaluable source of information that they want to broadcast. However, ties with similar low status firms might provide enough benefits to broadcast such relations because low-status firms are not yet well established in audiences' perception. Every network tie is an important source of information to appeal their legitimacy and quality to audiences. By forming ties and broadcasting these ties, low-status firms seek to be included in the audiences' consideration set. Since any firm would not agree to form

ties with low-status firms if their quality is inferior, network ties are expected to provide positive signals to audiences when broadcasted. It is important to note that this is different from middle-status conformity theory because low-status firms do not deviate from audience expectation. Low-status firms seek to be included in the set by broadcasting any networks, regardless of partners' status positions. The above logics introduce the following hypotheses about low-, middle-, and high-status firms' strategy of broadcasting their alliances:

H1: For middle-status firms, the higher (the lower) an alter's status relative to an ego's, the more (the less) likely an ego firm broadcasts its network ties.

H2: For low-status firms, broadcasting its network ties is not affected by an alter's status relative to an ego's.

H3: For high-status firms, broadcasting its network ties is not affected by an alter's status relative to an ego's.

DATA AND MEASURES

Research context: Alliances in the biotechnology industry

This paper studies the biotechnology industry for two reasons. First, a series of alliances are essential in order to keep up with the rapid pace of patent competition and commercialization for the firms in the biotechnology industry (Powell, Koput, & Smith-Doerr, 1996). This condition indicates that firms will strategically manage their communication of pre-existing network ties because how their network ties are perceived in the market matters for subsequent inter-organizational tie formations. In this setting, researchers can observe a large number of alliances between firms with different levels of status because established biotechnology or pharmaceutical firms frequently agree to form alliances with young biotechnology firms that possess new

technology. Large biotechnology firms with high established status are likely to have resources such as established laboratories or distribution channels that can support the advanced technology of small biotechnology firms with low-status (for example, Baum et al., 2000).

Second, alliances in the biotechnology industry involve a significant level of quality uncertainty because of high technological risks in developing new products (Rothaermel & Deeds, 2004; Santoro & Mcgill, 2005). When biotechnology firms form alliances in order to develop a new medical product, it is difficult for external firms to observe whether a new product development is likely to succeed or what the value of the new product is. Under this situation, existing literature on status suggests that audiences in the market will use the status of affiliated partners as a proxy for quality in order to reduce uncertainty in the market (Podolny, 1993, 2001).

Sample

I collected information about biotechnology firms' alliances from three data sources: Recap (Recombinant Capital Database), Compustat Capital IQ, and Factiva. The Recap database is widely used by researchers who study biotechnology firms' alliances because of its detailed information such as alliance types, alliance stages, involved technologies, and contracts (for example, Ahuja et al., 2009; Asgari, Singh, & Mitchell, 2017; Asgari, Tandon, Singh, & Mitchell, 2018). The Recap data collects alliance information from various sources. They document alliance information both from publicly available sources such as annual reports or 8-K and from private sources by attending conferences or acquiring information from some firms' employees (Schilling, 2009). The Compustat database complements the Recap database by providing detailed information about each firm such as a firm's financial information or business category (i.e., SIC code). I used Factiva for collecting press releases that correspond to the alliances included in the Recap database.

My final sample consists of 2,433 alliances between 664 firms from 1990 to 2017. In restricting the sample, I applied the three criteria. First, I focused my analysis on agreements in which only two firms are involved. Agreements involving more than two firms were excluded in my sample, since my research question asks whether a firm broadcast its alliance in response to its *sole* partner's status. Second, I restricted my samples to strategic alliances by excluding agreements such as joint ventures, spin-outs, letters of intent, and other contractual agreements[1] (Similar to Asgari, Singh, & Mitchell, 2017). In detail, I defined agreements as strategic alliances if an agreement indicates the following agreement types in the Recap database: Co-Development, Co-Market, Co-Promotion, Collaboration, Cross-License, Development, Distribution, License, Manufacturing, Marketing, Research, Sublicense, and Supply. Third, I focus on alliances between two publicly traded biotechnology firms. I attempt to minimize the effect of unobservable factors across publicly traded and private firms by restricting my samples to public firms. Alliances between two private firms or a private firm and a public firm might involve different incentives to broadcast their alliances, compared to alliances between two public firms. Private firms might have greater incentives to disclose information to the public if they expect an IPO in the near future (Beckman, Burton, & O'Reilly, 2007; Certo, 2003; Chen, Hambrick, & Pollock, 2008; Zhang & Wiersema, 2009) or fewer incentives if they intend to stay private. In addition to the above reason, public firms are more observable to researchers because researchers can collect several firm-level characteristics such as firm age, the number of employees, and financial performance. I obtained these firms' information from the Compustat Capital IQ database.

[1] I excluded joint ventures and spinouts because the relationship between parent companies and the new entity (JV or spinout) is unclear. I excluded these agreements types in order to focus on each firm's choice of sending signals. Letters of intent and contractual agreements are deleted because such agreements do not involve resource trade between two firms.

In defining biotechnology firms, I followed existing research (Asgari et al., 2017; Francis, Philbrick, & Schipper, 1994; Spiess & Tkac, 1997) by applying the three NAICS codes: 325412, 325413, and 325414[2]. These NAICS codes are uniquely matched to SIC codes as well. In defining publicly traded firms, I identified public firms that are listed on the following U.S. stock exchange markets: NYSE, American SE, OTC Bulletin Board, NASDAQ, and NYSE Arca[3]. I purposefully restricted my analysis to U.S. public firms because I only considered press releases in English. Including non-U.S. firms may bias my analysis because of omitted press release observations in languages other than English.

In matching firms' names from two different data sources, Recap and Compustat, I first used a fuzzy matching algorithm (Cohen, 2011) and then manually checked the matching results by verifying whether firms changed their names over time. This manual check is necessary because biotech firms frequently change their names and omission of these name changes can lead to a bias in my analysis (Tadelis, 1999; Wu, 2009). I identified fifteen firms that changed their names and were included in the Recap and Compustat database with two different names. For example, Advanced BioHealing changed its name to Shire Regenerative Medicine in 2012.

I excluded alliances prior to 1985 because the Recap database does not include enough alliance observations prior to 1985 (See Figure 1). Although the number of observations between 1985 and 1990 is not large (58 observations), I used the observations from 1985 to 1990 in calculating the main independent variables – ego's and alter's status. In detail, I used a five-year moving window to construct alliance networks. I then used the previous network measure as a

[2] NAICS code 325412 is assigned to firms whose primary business area is in pharmaceutical preparation manufacturing. 325413 is in in-vitro diagnostic substance manufacturing. 325414 is in biological product (except diagnostic) manufacturing. These three NAICS codes can be uniquely matched to SIC codes 2834, 2835, and 2836.

[3] These stock exchange markets can be identified from Compustat by applying Stock Exchange Codes 11,12,13,14, and 17.

lagged independent variable predicting firms' broadcasting of alliance formation in the given year. The final number of observations from 1990 to 2017 is 2,433 alliances between 664 biotechnology firms. This represents about 5% of the total observations recorded in Recap from 1990 to 2017. The major reduction in the number of samples occurred when I only considered alliances between two *public* firms listed in the US stock markets.

Insert Figure 1 here

As a final remark about the sample, given 2,433 alliances between 664 firms, I doubled my 2,433 observations to 4,866 by copying the same alliance information but switching the focal firm and the partner firm in order to explore both firms' behaviors. For example, given an alliance between Merck and Pfizer, my data has two observations where the focal firm is Merck and its partner is Pfizer, and the other way around in the next row. Since I doubled my observations, I clustered my standard errors at each alliance level because error terms for the same alliance are correlated to each other. I supplemented my analysis by clustering at each dyadic level to address autocorrelation issues in the robustness checks.

Dependent variable: broadcasting alliance formation

Based on the 2,433 alliances, I collected information about *(1) whether alliance formation is broadcasted through press releases* and, if broadcasted, *(2) which firm(s) broadcasts its alliance formation* in Factiva. In searching for press releases, I conducted three rounds of search in order to maximize my chances of identifying press releases corresponding to each alliance in the Recap. First, I put the two firms' names as a search keyword, set the time window as two years before and after the alliance date in the Recap database, and searched press releases that have the two firms' names in the articles' headlines. In the second round of searching, I followed the same procedure

but tried shortened firm names (for example, Lexicon instead of Lexicon Pharmaceuticals). In the last round, I followed the same procedure as the second round but searched from the full text instead of from the headlines. This eliminates possible omission of articles in which firms' names are not included in the headline but in the actual text.

Given search results for 2,188 alliances, I read every press release and marked whether it was correctly matched to the corresponding alliance in the Recap database. I compared alliance information in the Recap database and texts in the press releases. For example, the Recap database provides alliance subject information between GlaxoSmithKline and 3-Dimensional Pharmaceuticals in January 2002 as "GW395058 (thrombopoietin mimetic peptide) for thrombocytopenia." Given this information, I looked for press releases about the two firms in January 2002 and verified whether the press releases include GW395058 and thrombocytopenia in the text. If I could identify any press release, I assigned one for a dummy variable indicating that the alliance is broadcasted in press release. Following the above procedure, I identified 1,622 alliances that were announced by firms, which corresponds to 67% of the total alliances.

Conditional on alliance information being broadcasted in press releases, I marked which firm announced the alliance formation. I took advantage of the fact that press releases include information about which firm made the announcements. For example, the sample press release (figure 2) suggests that 3-Dimensional Pharmaceuticals Inc. announced its alliance with GlaxoSmithKline in 2002. Since GlaxoSmithKline was more established and possessed a more central position in the previous five years' alliance networks, this represents an example where lower status firms broadcasted while higher status firm did not. I was also able to observe the opposite case where high-status firms broadcasted while low status firms did not, as can be seen in the figure 3. Figure 3 shows that Merck, one of the largest biotechnology companies, announced

its strategic alliance with a less renowned firm, ARIAD Pharmaceuticals Inc. in 2010. As another example, Figure 4 suggests that Athersys Inc. and 3-Dimensional Pharmaceutical Inc. jointly announced their collaboration.

Insert Figure 2,3,4 here

In operationalizing my dependent variable, I created a binary variable equal to one when firm A broadcasts its alliance formation with firm B in a press release. Out of 2,433 alliances in my final sample, I have 1,006 alliances (corresponding to 41% of the sample) that were only broadcasted by one of the two involved firms. I have 616 alliances that were jointly announced by both firms. Of 1,006 alliances broadcasted by one firm, 291 alliances were disclosed by higher status firms while 715 alliances were broadcasted by lower status firms. Figure 5 shows the distribution of press releases by announcement types.

Insert Figure 5 here

Explanatory variables

I calculated eigenvector centrality as a measure for *status* based on the prior five years' alliance network[4]. Although it is not reported in the paper, I conducted sensitivity analyses by trying different moving windows. Eigenvector centrality is widely used in previous research (for example, Ahuja et al., 2009; Bonacich, 1987; Gu, Lu, & Robinson, 2014; Lin, Yang, & Arya, 2009) in capturing status. Compared to other centrality measures such as betweenness or degree centrality, eigenvector centrality is more suitable in capturing status because it assigns higher weights to alliances with higher status actors than alliances with lower-status actors (Bonacich,

[4] This five-year window is inclusive (i.e., the five year prior window for year 2000 is from 1996 to 2000). I included the focal year in order to avoid zero eigenvector centrality scores.

1987, 2007). By construction, even if two firms have the same number of network partners, one can have higher eigenvector centrality than the other if the firm is connected to more firms that are also highly connected.

Since eigenvector centrality is only defined in a connected network component, I split the alliance network into each component and calculated eigenvector centrality in each connected component. Since eigenvector centrality is normalized in each component, I included the size of a component for each firm as a control variable. In order to capture a partner's relative centrality, I chose the ratio of centrality rather than the difference of centrality between two firms. The ratio is more appropriate in capturing a partner's relative status than the difference because the ratio considers the focal firm's status. For example, if a firm has the centrality measure of 0.2 and its partner's centrality is 0.3, the ratio measure is 1.5 while the difference measure is 0.1. If a firm has the centrality measure of 0.8 and its partner's centrality is 0.9, the ratio measure is 1.13 while the difference measure is still 0.1. In calculating a partner's relative status, I divided the partner's centrality by the focal firm's centrality so that any ratio greater than 1 indicates that a firm forms an alliance with higher status others. A ratio less than 1 indicates that a firm forms an alliance with lower status others.

Control variables

I included alliance-level and firm-level control variables that may affect a firm's choice to issue press releases. For the alliance-level control variables, I control for *different types and stages of alliances*. The Recap database includes information about different types (R&D, manufacturing, marketing, distribution, etc.) and stages (Discovery, Phase I, II, III, FDA approval, etc.). I included dummy variables for each type and stage. I also measured *recurring alliances* with the same partner because experience with the same partner might reduce a firm's willingness to announce

alliance formation. If firms announce their alliances in order to foster better coordination, firms' incentives to announce alliances should decrease as the number of *recurring alliances* increases (Gulati, 1995).

For the firm-level control variables, I included firm-level characteristics for both the focal and the partner firm. I obtained firm *age* (logged), annual *revenue* (logged), and *the proportion of past alliances announced*. I included firm age and revenue in order to control for the effect of unobservable firm-level time-varying factors that might not be perfectly captured by eigenvector centrality. For example, a firm might pay extra attention on issuing press releases to manage their impressions after a sudden increase in revenue. I included the proportion of past alliances announced because it is plausible that issuing press releases is habit-forming. That is, firms might be more likely to issue press releases as they accumulate experiences with press releases. The empirical analysis supports that firms are more likely to announce their alliances if they announced their previous alliances more frequently.

For each alliance, I included a partner firm's announcement, which equals one if the partner makes the announcement, as a control variable because a partner's decision to send out press releases should affect the other firm's decision. If the partner firm decides to issue press releases, a focal firm might be more likely to do so as well because the information will be disclosed to the public even if a focal firm does not make a press release. In addition to the above control variables, I included year fixed effects to control for any time trends that might affect a firm's decision to issue press releases.

METHODS

Since my dependent variable is a dummy indicating whether a firm broadcasts its alliance formation to the public, I used a probit regression model. When I use a logit regression instead of probit, the results are consistent. The unit of analysis is at the mixed-level because the dependent variable is at the firm-alliance-year level but the key explanatory variable, relative centrality, is at the dyadic-alliance-year level. In testing my hypotheses, I used the following regression model:

$$Y_{ijt} = \Phi(\alpha + \beta_1 * \frac{Centrality_{j,t,t-5}}{Centrality_{i,t,t-5}} + \gamma_1 X_{it} + \gamma_2 X_{jt} + \gamma_3 X_{ijt} + v_t + u_{ijt})$$

Biotechnology firms' centrality is calculated based on the prior five-year alliance-network, which is denoted by t-5 in the above model (similar to Stuart et al., 1999). I included own firm control variables (denoted as X_{it}) such as firm own centrality, firm age, firm revenue, and previous alliances announced by own firm. I included partner firm control variables (denoted as X_{jt}) such as partner firm centrality, age, revenue, previous alliance announced, and partner firm's announcement for the given alliance. I also added alliance-level control variables (denoted as X_{ijt}) such as involved firms' network component size, indicator for whether the alliance involved firms from different SIC codes, and the number of past alliances between the two firms. I address possible network autocorrelation issues by clustering standard errors on both firms at a dyad (Cameron, Gelbach, & Miller, 2011; Kleinbaum, Stuart, & Tushman, 2013; Mizruchi, 1989; Reagans & Mcevily, 2003).

RESULTS

Table 1 and **Table 2** present the descriptive statistics and the correlation table with the key variables. Note that the number of observations is 4,866 because I doubled my alliance-level observations to create a firm-alliance level data. I normalized each firm's age and annual revenue

because these variables show right-skewed distributions.[5] The correlation table suggests homophily between firms in choosing their alliance partner with similar status (correlation = 0.62 between own status and partner status). Homophily in partner selection was suggested in the previous studies (Kleinbaum et al., 2013; Kossinets & Watts, 2009; Mcpherson, Smith-lovin, & Cook, 2017).

Table 3 presents regression results predicting the likelihood of broadcasting its alliance formation using a probit regression model. Note that I clustered standard errors on both firms of each dyad. Clustering standard errors at both firms' dyadic level is important because standard errors can be correlated among the same dyads, known as network autocorrelation (Reagans & Mcevily, 2003). I used the "clus_nway" Stata command to cluster standard errors (Cameron et al., 2011; Kleinbaum et al., 2013).

The first column shows the regression results with only control variables. As predicted, the result shows that a firm's decision to issue press releases is positively associated with a partner firm's choice. Negative and statistically significant coefficients for own firm age and revenue suggest that the older and the bigger a firm becomes, the less likely a firm issues press releases. This result, however, should be interpreted with caution because firms are likely to associate with firms that have lower status as they become older and bigger, which is suggested by high negative correlation between relative centrality and age or revenue in the table 2. The first column also confirms that issuing press releases is more likely to occur as firms have more experience with press releases. This is suggested from the positive and statistically significant coefficient for previous alliances announced by own firms.

[5] I took the logarithm of each variable plus one in order to normalize right skewed-distributions that show many zeros. For example, log_age=log(age+1)

In the second column, I added relative status of an alter to an ego. The regression result shows a significant and positive coefficient, which suggests that firms are more likely to announce their alliances when they form alliances with higher status firms than when they do with lower status firms. This positive coefficient indicates an asymmetrical signaling behavior between higher status and lower status firms. When two firms form strategic alliances, higher status firms are less likely to announce the relationships than lower status firms. In the next model, I introduced a firm's own status as a control variable. Including it can address potential endogeneity concerns. Specifically, given the negative correlation between relative status and own status as suggested in the correlation table, the regression might suffer a positive omitted variable bias if higher status firms tend to issue press releases less often than lower status firms. The result shows a consistent positive coefficient for the main effect.

Table 4 presents regression results when I split the samples into three different status categories: low, middle, and high. In the first three columns, I divided samples into each quartile (25%) and consider the top and bottom quartile as high and low and the rest quartiles as middle-status firms. The results suggest that the effect of a partner's relative status is marginally significant at 10% level for low-status firms. It is positive and significant for middle-status firms. However, it is no longer statistically significant for high-status firms. The results support my first hypothesis about middle-status firm's broadcasting behavior. The results also support my third hypothesis about high-status firm's broadcasting behavior. However, my second hypothesis about low-status firms is not supported as low-status firms show their tendency to broadcast their ties with higher status firms more than their ties with lower status firms.

In the next three columns, I divided the samples into 20 percentiles and consider the top and bottom and high and low. The regression results are similar from the previous three columns.

Since there is no clear cut-off to decide which firms are high, middle, or low status using eigenvector centrality, I conducted a quantile regression in the following section. The quantile regression is conducted to investigate how sensitive my results are with respect to the cut-off for low, middle, and high-status firms. **Table 5** suggests that the main effect of a partner's relative status on the announcement is significant for firms whose status in the middle, from 5^{th} to 8^{th} quantiles.

DISCUSSION & CONCLUSION

In this paper, we examined whether firms make strategic choices in broadcasting their alliance formation. We investigated whether the decision depends on firms' own status as well as partners' relative status. I specifically focused on biotechnology firms' choices of issuing press releases as one of the most important signals that firms frequently utilize to send information to the public. The results of my analysis suggest that firms are strategic in broadcasting their network ties. Middle-status firms are especially strategic in broadcasting their network ties with higher-status firms in order to manage how they are perceived by audiences. Aligned with this paper's prediction, high-status firms do not show much discretion in broadcasting their network ties. Low-status firms, in contrast to this paper's prediction, shows high-level of discretion in broadcasting their network ties.

An important contribution to this paper is that it connects two streams of network research on agency and signaling effects of networks. While past research provides numerous findings about how network signals are received in the market (for example, Benjamin & Podolny, 1999; Podolny, 1994; Pollock & Gulati, 2007; Spence, 1973), it does not pay much attention to how signals are actually sent from actors. Similarly, although past research studied agency in network formation (Burt, 2005; Zaheer & Soda, 2009), it does not pay much attention to whether agency

exists even after network formation or whether actors make deliberate attempts to take advantage of the network formation. I suggest that introducing agency in network signaling is important because this perspective can provide unique implications about the effects of network structures. While existing research identifies the source of network benefits from actors' position within a social structure or the whole network structure (Burt, 1992, 2005; Coleman, 1988), my paper suggests the possibility that network benefits can also come from how actors broadcast their position within a social structure or the whole network structure. This unique perspective provides a possible explanation for heterogeneity in the benefits of networks (Burt, Kilduff, & Tasselli, 2012).

The main limitation of this study comes from my focus on press releases as the only channel that firms use to communicate with audiences. There are other communication channels such as conference calls, annual reports, and 8-K, or 10-K reports that firms use to convey important information to the public. The existence of other possible communication channels suggests that my finding can be biased if high-status firms prefer to communicate through channels other than press releases. Although I cannot completely rule out this alternative explanation, as my data does not cover other channels, I made careful attempts to minimize the possible effects of other unobservable factors. First, I restrict my samples to public firms because public firms should follow similar recommendations or requirements regarding whether to disclose alliance information or through which medium to disclose. Second, I provided additional results with firm-level fixed effects and alliance-level fixed effects to control for unobservable firm-level or alliance-level factors that can affect the main relationship. In addition, the independent variable is a lagged variable, which minimizes endogeneity issues such as a simultaneous equation bias. Finally, as an additional test, I divided my samples into two groups, above mean and below mean,

and compared standard deviation of firms' choices of sending signals. I do not find any significant difference in standard deviations, which suggests that it is not likely that high-status firms use other communications other than press releases.

Related to the above limitation, it is also plausible high-status and low-status firms have different preferences with respect to which source of press releases they choose to broadcast. High-status firms might prefer prestigious press releases while low-status firms are indifferent to less prestigious press releases. This provides an alternative explanation why high-status firms are less willing to broadcast because the number of press releases they choose is smaller than the number of press releases that low-status firms choose. As a robustness check, I compared the average centrality across different sources of press releases. In this test, I observed that PR newswire and Business wire are two major sources of press releases because more than half (70%) of the collected press releases were from these two sources. Other sources of press releases include AP newswire, Canada Newswire, Globe Newswire, Reuters, and M2 Pharma newswire. This shows that there is no significant difference of firms' centrality across different sources of press releases.

I can further explore how firms broadcast their network ties audiences by conducting textual analysis on the actual content of press releases. In this paper, I ask whether firms broadcast to audiences. Since I have collected all the corresponding press releases for each alliance, another interesting question that I can pursue is whether there exists systematic differences in the way firms describe their alliances to the public. For example, high-status firms might use careful and modest language when they broadcast their alliances with low-status firms in order to minimize the potential risks of damaging their established status. Low-status firms, at the same time, might emphasize more their partner's reputation when they form alliances with high-status firms. Few studies have investigated how firms manage their impressions using textual analysis (for example,

Lightstone & Driscoll, 2008). I believe that social network research on agency can be further developed if researchers can confirm that firms are strategically managing how they are perceived by audiences.

Social network research has confirmed the existence of agency in network formation, but it has not yet explored whether agency continues after network formation. This paper advances social network research on agency and signaling benefits of networks by proposing that agency exists when actors broadcast their networks. By studying whether biotechnology firms issue press releases about their alliances, this paper shows that firms are more likely to broadcast their networks as their partners' relative status increases. Furthermore, the paper shows that the result holds mostly for middle-status firm but not for high-status firms. This paper sheds light on another source of network benefit by suggesting that indirect benefits of social networks come from how and whether actors present their networks to audiences.

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TABLES AND FIGURES

TABLE 1 – Descriptive Statistics

VARIABLES	(1) N	(2) mean	(3) SD	(4) min	(5) max
Broadcasting	4,866	0.46	0.50	0.00	1.00
Ego Status	4,866	0.12	0.15	0.00	0.71
Relative Status (Alter / Ego)	4,866	2.35	2.84	0.10	10.32
Recurring alliances	4,866	0.20	0.57	0.00	7.00
Previous alliances announced by Ego (%)	4,866	0.22	0.24	0.00	1.00
Cross SIC	4,866	0.52	0.50	0.00	1.00
Age (logged)	4,866	2.95	1.16	0.00	5.12
Annual revenue (logged)	4,866	18.52	4.92	0.00	24.94
Component Size	4,866	222.17	65.12	2.00	274

TABLE 2 – Pairwise Correlation Table

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Announcement (Ego)	1.00										
(2) Announcement (Alter)	0.17	1.00									
(3) Ego Status	-0.11	0.07	1.00								
(4) Alter Status	0.07	-0.11	0.62	1.00							
(5) Relative Status (Alter / Ego)	0.18	-0.17	-0.40	0.14	1.00						
(6) Component Size	0.16	0.16	-0.54	-0.54	0.14	1.00					
(7) Cross SIC	0.00	0.00	0.01	0.01	0.00	0.06	1.00				
(8) Recurring Alliances	0.03	0.03	0.02	0.02	-0.03	0.08	0.05	1.00			
(9) Firm Age	-0.18	0.18	0.23	-0.17	-0.37	0.10	0.03	0.10	1.00		
(10) Firm Revenue	-0.19	0.20	0.19	-0.20	-0.48	0.12	0.02	0.09	0.59	1.00	
(11) Past alliances announced (%)	0.21	0.10	-0.02	-0.08	-0.25	0.30	0.05	0.15	0.04	0.10	1.00

TABLE 3 – Effect of Ego's and Alter's Status on Broadcasting

DV = Broadcasting	(1)	(2)	(3)
Ego Status			-0.354
			(0.307)
Relative Status (Alter / Ego)		0.044**	0.040**
		(0.012)	(0.011)
Partner Firm Announcement	0.533**	0.549**	0.550**
	(0.068)	(0.067)	(0.067)
Component Size	0.000	-0.000	-0.001
	(0.001)	(0.001)	(0.001)
Cross SIC	-0.045	-0.046	-0.044
	(0.052)	(0.052)	(0.052)
Recurring Alliances	-0.021	-0.021	-0.019
	(0.049)	(0.049)	(0.050)
Own Firm Age	-0.108*	-0.093*	-0.086*
	(0.044)	(0.043)	(0.042)
Partner Firm Age	0.105**	0.094*	0.094*
	(0.039)	(0.037)	(0.038)
Own Firm Revenue	-0.051**	-0.042**	-0.041**
	(0.010)	(0.010)	(0.010)
Partner Firm Revenue	0.042**	0.037**	0.038**
	(0.008)	(0.008)	(0.009)
Past alliances announced by ego (%)	1.028**	1.193**	1.192**
	(0.131)	(0.142)	(0.140)
Past alliances announced by alter (%)	0.006	-0.031	-0.026
	(0.123)	(0.123)	(0.123)
Constant	-0.663*	-0.788**	-0.700*
	(0.301)	(0.288)	(0.311)
Year Fixed Effects	YES	YES	YES
Observations	4,866	4,866	4,866
Log-likelihood	-2751	-2739	-2738
Pseudo R2	0.180	0.184	0.184

Note: Robust standard errors in parentheses ** p<0.01, * p<0.05, + p<0.1; Standard errors are clustered at dyadic level using 'clus_nway' STATA command developed by Kleinbaum, Adam M., Toby E. Stuart, and Michael L. Tushman (2013) & Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller. 2011.

TABLE 4- Effect of Ego's and Alter's Status on Broadcasting (Split Sample Analysis)

DV = Broadcasting	(1) L (25%)	(2) M (50%)	(3) H (25%)	(1) L (20%)	(2) M (60%)	(3) H (20%)
Relative Status (Alter / Ego)	0.023+	0.058*	0.029	0.033*	0.044*	0.003
	(0.012)	(0.024)	(0.110)	(0.016)	(0.020)	(0.170)
Partner Firm Announcement	0.582**	0.509**	0.772**	0.580**	0.541**	0.744**
	(0.121)	(0.096)	(0.130)	(0.133)	(0.087)	(0.143)
Component Size	0.002	-0.001	-0.002+	-0.003	0.001	-0.003+
	(0.004)	(0.004)	(0.001)	(0.005)	(0.003)	(0.001)
Cross SIC	0.005	0.059	-0.238**	-0.005	0.046	-0.337**
	(0.096)	(0.075)	(0.091)	(0.113)	(0.070)	(0.096)
Recurring Alliances	0.104	-0.028	0.012	-0.031	-0.030	0.054
	(0.083)	(0.080)	(0.062)	(0.125)	(0.068)	(0.081)
Own Firm Age	0.003	-0.032	-0.141+	0.025	-0.078	-0.114
	(0.059)	(0.053)	(0.076)	(0.069)	(0.052)	(0.080)
Partner Firm Age	-0.028	0.125**	0.148+	0.013	0.113**	0.100
	(0.045)	(0.044)	(0.076)	(0.047)	(0.043)	(0.078)
Own Firm Revenue	-0.011	-0.085**	-0.017	-0.015	-0.071**	-0.011
	(0.009)	(0.019)	(0.020)	(0.010)	(0.017)	(0.022)
Partner Firm Revenue	0.049**	0.025*	0.044*	0.040**	0.035**	0.041*
	(0.011)	(0.012)	(0.017)	(0.012)	(0.010)	(0.017)
Past alliances announced by ego (%)	0.203	1.330**	1.560**	0.358	1.239**	1.676**
	(0.220)	(0.178)	(0.366)	(0.244)	(0.162)	(0.411)
Past alliances announced by alter (%)	-0.041	0.128	-0.196	0.074	-0.005	0.010
	(0.178)	(0.167)	(0.186)	(0.208)	(0.165)	(0.253)
Constant	-2.239**	-0.441	-1.094*	-1.384	-0.752	-0.989+
	(0.674)	(0.598)	(0.490)	(0.869)	(0.526)	(0.516)
Observations	1,202	2,427	1,206	956	2,916	966
Year Fixed Effects	-681	-1311	-607.9	-533.1	-1582	-486
Component Control	0.182	0.220	0.226	0.194	0.216	0.234
Log-likelihood	0.182	0.220	0.226	0.194	0.216	0.234

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1; Standard errors are clustered at dyadic level using 'clus_nway' STATA command developed by Kleinbaum, Adam M., Toby E. Stuart, and Michael L. Tushman (2013) & Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller. 2011.

TABLE 5 - Effect of Ego's and Alter's Status on Broadcasting (Quantile Regression Analysis)

DV = Broadcasting	(1) 1st Quantile	(2) 2nd Quantile	(3) 3rd Quantile	(4) 4th Quantile	(5) 5th Quantile	(6) 6th Quantile	(7) 7th Quantile	(8) 8th Quantile	(9) 9th Quantile	(10) 10th Quantile
Own Status	-33.46	-48.31**	-11.32	21.45	5.995	-18.59*	-2.749	1.132	3.674	-0.855
	(25.25)	(22.09)	(16.28)	(14.43)	(13.87)	(11.18)	(8.99)	(8.44)	(4.14)	(1.02)
Relative Status	0.074	0.12*	0.034	0.019	0.21**	0.27**	0.32***	0.28**	-0.017	-0.25
	(0.062)	(0.066)	(0.077)	(0.090)	(0.096)	(0.11)	(0.12)	(0.140)	(0.15)	(0.21)
Partner Firm Announcement	0.63***	0.73***	0.65***	0.37**	0.61***	0.70***	0.75***	1.03***	0.96***	0.085
	(0.18)	(0.18)	(0.17)	(0.18)	(0.19)	(0.19)	(0.24)	(0.23)	(0.24)	(0.23)
Constant	-8.03**	-7.00	-2.30**	-13.16**	-1.69	5.26***	0.71	-158.1**	-2.37	0.25
	(3.84)	(5.26)	(1.13)	(5.31)	(1.27)	(1.53)	(1.32)	(77.54)	(1.74)	(1.11)
Observations	469	471	484	462	478	476	466	473	468	452
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Log-likelihood	-233	-193.3	-198.2	-152.5	-126.3	-112.8	-74.35	-46.94	-38.74	-114.9
Pseudo R2	0.20	0.26	0.26	0.25	0.35	0.31	0.37	0.49	0.43	0.18

* Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1, control variables are omitted from the table

FIGURE 1: Number of alliances over time

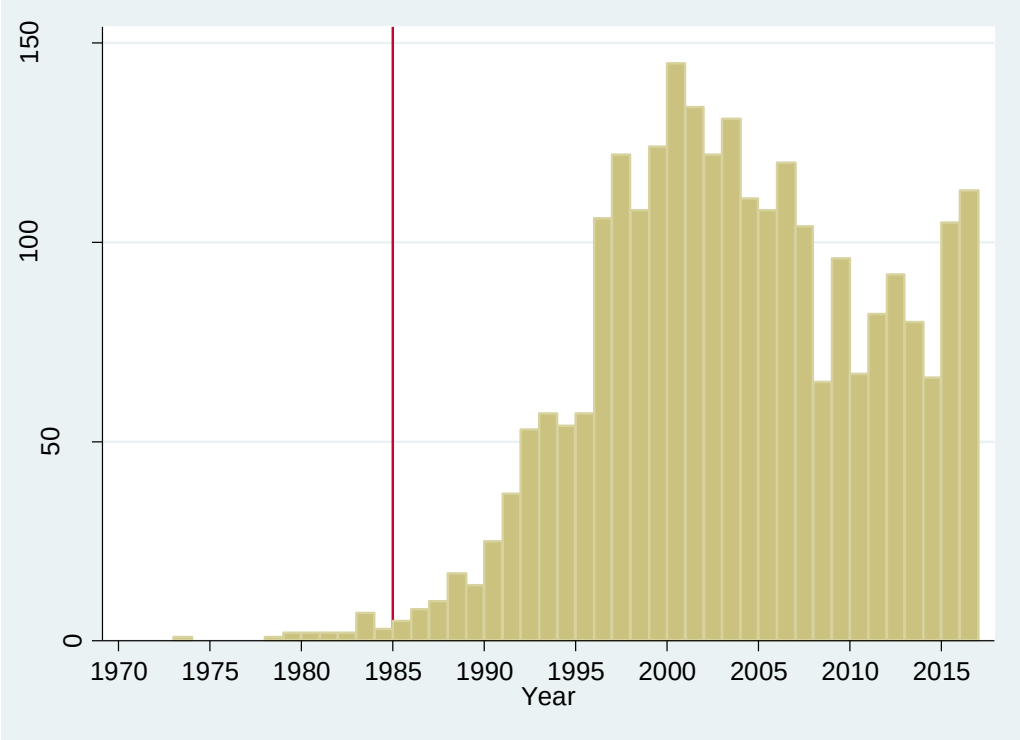


FIGURE 2: Sample Press Release (only lower status firm discloses)

PR Newswire
a CISION company

3-Dimensional Pharmaceuticals Licenses TPO Peptide from GlaxoSmithKline

YARDLEY, Pa., Jan. 8 /PRNewswire/ -- 3-Dimensional Pharmaceuticals, Inc. (Nasdaq: DDDP) (3DP) today announced that the Company has entered into anexclusive licensing agreement with GlaxoSmithKline (GSK), giving it worldwide development, marketing and distribution rights to GSK's pre-IND compound GW 395058 for the prevention and treatment of thrombocytopenia, or low blood platelet count. GW 395058 is a pegylated synthetic thrombopoietin (TPO) mimetic peptide that stimulates the human body to increase its production of blood platelets, which are responsible for regulating the clotting process.

FIGURE 3: Sample Press Release (only higher status firm discloses)

Merck Acquires Development and Commercialization Rights to Investigational mTOR Inhibitor Ridaforolimus from ARIAD Pharmaceuticals, Inc.

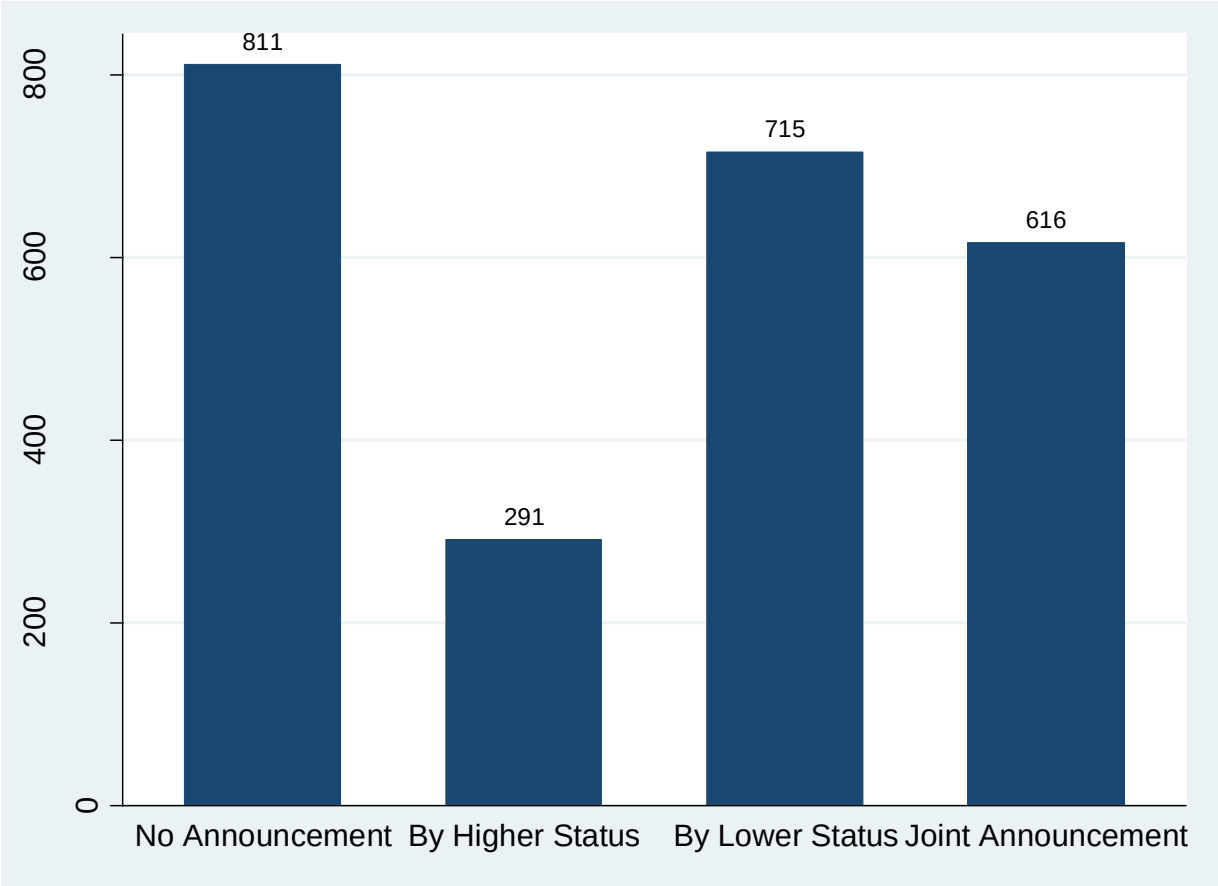
WHITEHOUSE STATION, N.J. - (BUSINESS WIRE) - Merck (NYSE:MRK) today announced that it has restructured its co-development and co-commercialization agreement with ARIAD Pharmaceuticals, Inc. for ridaforolimus, an investigational orally available mTOR inhibitor currently being evaluated for the treatment of multiple cancer types, to an exclusive license agreement.

FIGURE 4: Sample Press Release (both firms disclose)

Athersys and 3-Dimensional Pharmaceuticals Form Drug Discovery and Development Collaboration

CLEVELAND, and YARDLEY, Pa., Oct. 29 /PRNewswire/ -- Athersys, Inc. and 3-Dimensional Pharmaceuticals, Inc. (Nasdaq: DDDP) today announced acollaboration to discover, develop and commercialize novel, small molecule pharmaceuticals by screening against therapeutically relevant drug targets derived from the G-Protein Coupled Receptor (GPCR) family of proteins. This collaboration combines Athersys' functional genomics expertise with 3-Dimensional Pharmaceutical's (3DP) small molecule drug development capabilities for rapid drug identification and optimization of drug candidates.

FIGURE 5: Distribution of Press Releases by Announcement Types



Note: This figure is based on the total 2,433 alliances. Status is measured by eigenvector centrality based on the strategic alliance network.