Network centrality and organizational aspirations: a behavioral interaction in the context of international strategic alliances

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INTRODUCTION

Organizational behavior is often conditioned by strategic changes that involve interorganizational collaborations that increase the firm's adaptability to various opportunities and threats (Cyert & March, 1963; Greve, 1998; Lungeanu, Stern, & Zajac, 2016; O'Brien & David, 2014; Shipilov, Li, & Greve, 2011; Tyler & Caner, 2016). In this regard, extant research has combined both behavioral and social network theoretical perspectives to explain organizational strategic choices. The behavioral perspective draws from the Behavioral Theory of the Firm (henceforth BTF) to argue that performance above and below aspirations influences firm's motivation to change and risk preferences (Baum, Rowley, Shipilov, & Chuang, 2005; Cyert & March, 1963; Greve, 1998). In particular, while performance below aspirations (i.e. negative aspirations) may trigger a 'problemistic search' for potential solutions (Cyert & March, 1963; Greve, 1998, 2011), performance above aspirations (i.e. positive aspirations) is seen as a good enough reason to avoid the risks inherent to organizational change therefore reducing interorganizational strategic alliances (henceforth, ISA) (Baum et al., 2005; O'Brien & David, 2014). However, empirical evidence is not fully consistent with this view, and proposals exist on the possibility of a 'slack' motivated search of new alternatives for firms with positive aspirations, as well as rigidity behavior motivated by threats to firm survival for firms exhibiting negative aspirations (Di Lorenzo, 2011; Greve, 1998; Staw, Sandelands, & Dutton, 1981). The social network perspective is based on the Social Network Theory (henceforth SNT), and considers the formation of external relationships that create strategic ties such as alliances, a byproduct of complex dynamic firm behavior, ultimately embodied in organizational actions and choices (Gulati, Nohria, & Zaheer, 2000; Uzzi, 1997; Zaheer & Bell, 2005). Their important impact in taping knowledge and cooperation opportunities enhances the role of both network members' identity and the structural pattern of the network itself (Gulati, 1999). SNT specifically acknowledges that the formation of strategic collaborations requires an

'inducement-opportunity' perspective referring to the focal firm's desire and its potential partners' interest in forming collaborations (Ahuja, 2000a).

Researchers combining both behavioral and social network perspectives have observed how aspiration performance relates to firm's embeddedness, with betweenness centrality being one of the most studied network indicators in this context (Baum et al., 2005; Shipilov et al., 2011). However, extant definitions of centrality measures do not consider the variability of the firm's position throughout the network evolution. To counter this issue, we introduce the concept of 'dynamicity' defined as the variability of each actor's position in the short-term network compared to its position in the long-term network (Shijaku, Larraza-Kintana, & Urtasun-Alonso, 2016; Uddin, Piraveenan, Khan, & Amiri, 2013). While aspiration performance may trigger the firm's intention to establish new collaborations, firm's dynamic structural position within its interorganizational network molds the context in which such intention becomes an actual strategic change decision. Given that firm proximity to others in a network (i.e. closeness centrality) improves information flow and learning capabilities (Landherr, Friedl, & Heidemann, 2010; Sullivan, Tang, & Marquis, 2014) which in turn has a direct effect on organizational aspirations (Baum & Dahlin, 2007), it is surprising that proximity has been neglected in the organizational aspirations' research. More importantly, extant studies bridging aspiration models with social networks often disregard the dynamic nature of firm's embeddedness (i.e. betweenness, closeness dynamicity) in a network, and that 'it takes two to tango' when it comes to explain ISA formation.

Under what behavioral conditions do firms initiate interorganizational ties that span dynamic networks? This study aims to address this question by integrating behavioral and social network perspectives in order to analyze firm's dynamic networks, and their association with organizational aspiration models, explored in a unique dataset that takes into account strategic

alliances from the top 84 global pharmaceutical firms for the period 1991-2012. In this regard, we consider the moderating role of firm's brokerage and proximity dynamicity in the aspiration – alliance formation relationship. In particular, we argue that firm's dynamic brokerage and proximity to others influence its aspirations to form new ISA over time.

The paper aims at two primary research contributions. First, it links behavioral and social network theories through the perspective of organizational aspirations. By positing a direct relationship between ISA formation and organizational aspirations, we find that new strategic alliances decrease the further firm's performance departs its aspirations, as a result of both actors' desires and opportunities. Second, by incorporating the concept of dynamicity, we dwell into the dynamic behavior of organizations that occupy brokerage and proximity positions in ISA networks. In this vein, our observed effects are especially visible if the firm is dynamically embedded in alliance networks. Finally, from a practical viewpoint, our study provides a framework for managers to consider ISA initiation as an important factor for successful strategic practice formulation.

THEORY AND HYPOTHESES

The structural nature of ISA

Interorganizational strategic alliances have long been viewed as a relatively inimitable and non-substitutable resource in itself that firms draw on to acquire competitive capabilities (Andersson, Forsgren, & Holm, 2002; Hitt, Dacin, Levitas, Arregle, & Borza, 2000; Huggins, 2010; McEvily & Marcus, 2005). ISA have observable benefits in reducing organizational risk by enabling firms to form interorganizational relationships in order to spread the financial risk, and share costs of research and development associated with new products or production methods (Elmuti & Kathawala, 2001). Companies are likely to employ ISA because of the difficulty of operating alone while concurrently excelling at performing the plethora of

interorganizational business functions (Mehta, Polsa, Mazur, Xiucheng, & Dubinsky, 2006). A critical advantage of such collaborations over single-firm strategies is their ability to draw upon resources and opportunities of more than one firm which in turn ensures better success odds for the collaboration and its participating members (Das & Teng, 2000). Despite such advantages, it has been argued that ISA often carry some elements of organizational risk and uncertainty as a result of firms facing both relational risk (i.e. probability and consequences of not having satisfactory cooperation) and performance risk (i.e. probability that an alliance fails due to intensified rivalry, new entrants, demand fluctuations, etc.) (Das & Teng, 1996, 2002; Mani & Luo, 2015). Therefore, ISA have both inhibiting and stimulating effects on organizational risk.

Performance feedback and strategic relationship choice

Several studies have attempted to link strategic relationship choice to organizational aspirations using performance feedback theory (Baum et al., 2005; Greve, 2011; Kim & Rhee, 2014; Shipilov et al., 2011). This theory draws on the concept of organizational aspirations originally coined in the Behavioral Theory of the Firm formulated by Cyert and March (1963) who consider performance feedback as a combination of firm's own performance history (i.e. historical aspiration) with the performance of other firms in the same industry (i.e. social aspiration). Negative aspiration performance indicates potential problems in attaining long-term goals hence it triggers a 'problemistic search' for solutions to close the gap, and stimulates the exploration of new practices, strategies and courses of action. Thus, the low performing firm will engage in new practices (e.g. ISA) in an attempt to turn things around. On the other hand, for performance exceeding aspirations, performance feedback model predicts that the high performing firm will be more reluctant to change its already familiar and successful strategy and refrain from taking unnecessary risks associated with new strategic

choices (Baum et al., 2005; March & Shapira, 1987). Thus, the high performer will exhibit a rigid behavior that stems from its reluctance to abandon successful routines.

Empirical evidence has proved to be fairly consistent with the patterns proposed by performance feedback theory. In this vein, current research on the subject also seems to be consistent with the idea that performance-based aspirations specifically affect interorganizational collaborations. For example, Di Lorenzo et al. (2011) show that firm's financial performance either above or below aspirations has a significant influence on changes in partnering behavior. On the other hand, Tyler and Caner (2015) show that in the firm's new product introduction context, negative aspirations increase the number of R&D alliances entered by the firm.

Nonetheless, it has also been proposed that this general pattern (i.e. search of new strategic options for firms performing below aspirations) can change under certain circumstances. For example, negative aspirations may trigger a conservative behavior if threats to firm survival are perceived (Greve, 2011; Staw et al., 1981). In an underperforming event defined by performance below aspirations, the probability of the firm behaving rigidly and resisting organizational change is increased since low performing firms have an increased chance to reach a critical survival point where any further failure could threaten organization's existence (Di Lorenzo, 2011; March & Shapira, 1987). Furthermore, a firm performing below aspirations is seen as incapable of achieving acceptable performance through local search and incremental adjustments to its status quo (Baum et al., 2005). Therefore, maintaining existing routines could be a cost effective option instead of establishing new ones (Di Lorenzo, 2011).

On the other hand, in a positive aspirations' scenario, the existence of slack resources may motivate an exploration behavior that leads firms to work on new ideas, predicting a 'slack search' effect (Baum et al., 2005; Cyert & March, 1963; Greve, 1998, 2011; O'Brien & David,

2014). There seems to be a lack of consistent empirical evidence on the generalized occurrence of threat rigidity or slack search (Iyer & Miller, 2008). For example, threat rigidity seems to be more likely for small firms than for big ones (Greve, 2011). O'Brien & David (2014) observe that slack search is contingent upon the national culture of the country, observing that such behavior occurs to a great extent in communitarian contexts, like Japan. Thus, it seems both threat rigidity and slack search are contingent on firm-specific factors such as size and organizational culture that may differ within a given industry.

It takes two to tango

A model that explains strategic transaction formation is incomplete if one only considers, as performance feedback models do, the disposition of the focal firm to develop such transaction. Problemistic (or slack) search may result in intentions to form interorganizational collaborations but do not directly cause strategic alliances to actually take place (Baum et al., 2005). Hence, the performance feedback model provides a 'unilateral' view of the alliance formation process in that it helps us understand why a company may be willing (or not) to enter ISA with other firms. However, it says nothing about the other side of the agreement. As noted by Ahuja (2000), firm's linkages with other partners reflect the firm's incentives to collaborate and increase its attractiveness to potential partners. That is, a model of ISA formation should consider the firm's desire to seek interorganizational partners (i.e. actors that may be willing to form an alliance with the focal firm) but also acknowledge the inclination of other firms to transact with the focal firm itself (i.e. the existence of an opportunity to form an alliance). We note here that this willingness is also, in part, a function of the focal firm's performance relative to its aspirations.

Seeking strategic partners becomes a staggering job as firm performance decreases, and moves away from organizational aspirations. Firms with negative aspirations may be seen as a burden

and an additional risk by potential partners. Even if the low performing firm is, due to its relative performance, eager to form strategic alliances, it will be the 'obscure' figure nobody wants to get involved with.

On the contrary, positive aspiration performers will have more opportunities to form linkages with other firms, and will be more likely to receive propositions to enter new ISA. However, firms performing well above their aspirations (i.e. very high performers) may not be willing to form alliances with other firms, and will behave 'selectively' potentially refusing collaborative propositions. In fact, from a performance feedback perspective, performing above aspirations' level tends to reduce firm's incentives to find new alternatives, and courses of action which may include new partners (Baum et al., 2005). As firm performance improves so does firm's image and confidence of its managers, making alliances with other (less attractive) firms less interesting since the focal firm may sense it may learn much less from their partners than vice-versa (Ahuja, 2000a).

Inducement-opportunity is not the only reason why firms fail to initiate strategic collaborations. Specifically, a negative aspirations' scenario could lead the firm to experience organizational rigidity by restricting information processing and centralizing decision making (Greve, 2011; Staw et al., 1981). Additionally, performing below aspirations could signal the inability of the firm to initiate ISA due to lack of resources. On the other end of the spectrum, positive aspirations induce an exploitative behavior of the firm's current strategies potentially leading to a success trap (Rhee & Kim, 2015) which in turn enhances the chances for a rigid, not survivalist, albeit reductionist behavior.

Therefore, we suggest that firms' preferences to develop ISA converge when the focal firm's performance matches its aspirations' level. Conversely, those preferences will not match for firms in the upper and lower ends of the aspiration performance spectrum. High performers,

while attractive to others, will not be particularly interested in forming new strategic alliances due to their successful strategy. Low performers on the contrary, while interested in establishing strategic alliances, will be less likely to find new partners and fall victim to organizational rigidity behavior to survive. In view of these arguments, we posit the following hypotheses:

Hypothesis 1a: For firms performing below their aspiration levels, decreases in performance are negatively related to ISA formation.

Hypothesis 1b: For firms performing above their aspiration levels, increases in performance are negatively related to ISA formation.

Network embeddedness and alliance formation

The rationale behind tie and subsequent network formation that generate firm's embeddedness can be traced from organizational objectives, management vision for organizational development, and specific strategies necessary to improve firm competitiveness in rapidly changing environments (Cravens, Piercy, & Shipp, 1996). In the alliance context, network embeddedness gives the firm the opportunity to multiply collaboration benefits through both alliance-to-network and network-to-alliance transfers (Swaminathan & Moorman, 2009). Traditional embeddedness models are mostly related to the structural dimension of embeddedness, and make use of network indicators that measure firm centrality such as betweenness and closeness centrality. One issue with the current representation of such measures is the static nature of structural embeddedness that does not capture the interchangeability of the actors throughout the network evolution over time. This myopia is addressed by the use of the dynamicity concept (Shijaku et al., 2016; Uddin et al., 2013) that includes the combined effect short and long-term networks formed as a result of tie aggregation over time. In comparison terms, both static and dynamic centrality measures are believed to behave similarly, with highly embedded firms tending to engage more in strategic alliances

(Ahuja, 2000a, 2000b) which is why we believe that dynamicity positively affects ISA formation.

Organizations use position in the network as a competitive tool, and something that can be manipulated to increase performance, profits, or control (Cowan, Jonard, & Zimmermann, 2007). Even though resource sharing is an important factor in ISA formation, highly embedded firms are provided with preferential treatments due to their central status, and have higher propensity to form new collaborations. In this sense, highly embedded firms use their prior connections to build new ties, and remain deeply embedded in the network (Ahuja, Polidoro, & Mitchell, 2009). In fact, network embeddedness is relevant to alliance success because it promotes cohesion between partners during the collaboration process, and provides clues as to which partner selection will be more successful (Polidoro, Ahuja, & Mitchell, 2011).

As firms tend to find partners close to them in the network space, this affects the probability that they will form partnerships in the future (Cowan et al., 2007). For example, Gulati (1995, 1999) finds a positive effect of firm's embeddedness in prior ties affecting subsequent interorganizational alliance collaborations. However, a positive relationship between network embeddedness and alliance formation is not always warranted. In fact, Chung, Singh, & Lee (2000) show that direct and indirect ties have an inverted U-shaped relationship with the probability of alliance formation. This said, the curvilinear effect is sometimes not assumed directly but arises from the way the processes of alliance formation are modeled.

A key concept of network embeddedness is the brokerage construct embodied by the measure of betweenness centrality. In general, brokerage or intermediary relations are connections between two actors that are mediated by a third party (Stuart, Ozdemir, & Ding, 2007). Such actors are likely to have sparsely connected networks, and benefit from brokering the connection between groups that otherwise are unconnected (Burt, 2000). This conception of

brokerage is closest to our use of the term in the context of the global pharmaceutical industry to the extent that firms enter alliance collaborations with cluster of firms that otherwise remain unconnected. This brokerage position is especially advantageous as it translates into higher knowledge flow as well as diverse information because broker firms bridge different groups with different information content (Koka & Prescott, 2008). This increases the centrality of the firm and its possibilities to initiate the formation of new alliances (Gilsing, Nooteboom, Vanhaverbeke, Duysters, & van den Oord, 2008; Gnyawali & Madhavan, 2001).

Another network embeddedness concept, closeness centrality (i.e. proximity) captures the extent to which an actor is closely linked to others by capturing the focal actor's capability to reach any direct or indirect network tie faster and more efficiently. A high degree of closeness centrality places the firm in close proximity to others suggesting cluster formations and speedy transfer of information highlighted by research showing both positive and negative effects of closeness centrality on firm performance (Larcker, So, & Wang, 2013; Lee, Choi, & Kim, 2012; Sullivan et al., 2014).

Given that brokerage and proximity are fundamentally static measures that capture snapshots of networks, they lack the ability to gauge on the evolution of these measures through time which is why we believe the inclusion of a long-term aggregated network is warranted to properly analyze firm's centrality from a dynamic perspective. Furthermore, based on previous research, there is reason to believe that dynamic measures will behave similarly to the static ones with respect to ISA initiation. More formally, we posit the following hypothesis.

Hypothesis 2a. Firms exhibiting high brokerage dynamicity are more likely to initiate interorganizational strategic alliances.

Hypothesis 2b. Firms exhibiting high proximity dynamicity are more likely to initiate interorganizational strategic alliances.

Dynamicity and strategic behavior

Ample research has provided a socialized account of firm behavior by establishing a direct connection between networks of external relationships and firm's strategic actions, observing the advantages that network structures have on firm's strategic management especially with regards to firm performance (Granovetter, 1985; Gulati et al., 2000; Uzzi, 1997; Zaheer & Bell, 2005). This impact is a direct result of the network's ability to offer access to knowledge, and cooperation opportunities that an isolated firm may not possess (Burt, 1992; Uzzi, 1997). In fact, networks of contacts between actors can be vital sources of information for the participants, a process that enhances both the identity of network members and the structural pattern of the network itself (Gulati, 1999). In this sense, a network of interorganizational ties has been viewed as a strategic resource, and its important impact on both firm's economic and innovative performance has been extensively researched (Andersson et al., 2002; Borgatti & Foster, 2003; Burt, 1992; Giuliani, 2010; Granovetter, 1992; Uzzi, 1997).

Given that the theoretical arguments concerning performance feedback show some level of overlap, both in theoretical reasoning, and in empirical findings regarding the effects of relative performance on the actors' risk preferences and motivations to change, recent studies have begun to focus their attention on identifying and examining moderating variables that take into account firm's embeddedness in network structures (Kim & Rhee, 2014; Shipilov et al., 2011). For example, Baum et al., (2005) show that partner selection tendencies in alliance networks are influenced by performance feedback on firm's market share and network status. On the same lines, Shipilov et al., (2011) successfully combine Structural Hole Theory with performance feedback by identifying determinants of alliance partner selection, and showing that organizations in brokerage positions set aspiration levels differently from the rest; that in turn affects decisions about partner selection and subsequent tie formation. Additionally, Kim

& Rhee (2014) argue that the actor's structural position in a network moderates divergent behavioral mechanisms in terms of risk preference and motivation to change by inducing decisions that change courses of action based on performance relative to aspirations.

We acknowledge that firms form networks, and that network position is important in this interaction. Specifically, we posit that network brokerage and proximity influences firm's desire to form linkages, and modifies its attractiveness to other potential partners by moderating the relationship between performance relative to aspirations, and alliance activity of the firm posited in Hypotheses 1a and 1b. As argued in Hypothesis 1a, a firm is less likely to engage in alliance formation, the further its performance falls below aspirations. We argue that this behavior will be reversed when the firm is dynamically embedded in a network of collaborations since a highly dynamically embedded firm will have a stronger network position which will translate itself into higher attractiveness (Li et al. 2008).

Despite few exceptions (Lin, Yang, & Demirkan, 2007), the majority of the studies involving network centrality measures do so from a static perspective that neglects the evolution (i.e. dynamicity) of the firm's centrality through time. Even simulation models (Lin et al., 2007) that are able to dwell on the contents of dynamic networks do so holistically without being able to gauge on the effect of each network member's position through time. Instead, using the concept of dynamicity, we are able to capture the evolution of firm's centrality through time in each of its ego-networks.

Being already central (i.e. broker and proximal to others) gives the firm access to more potential partners (Hypotheses 2a, 2b). Hence, it is easier to find a potential partner that is central, rather than the contrary. A highly dynamically embedded low performer will herein give a better image to its potential collaborators who will in turn increase repeated ties, and engage in ISA despite the former's obscure image as an underperformer. In other words, low performers will

establish new collaborations simply because they are attractive due to their central status. Even though new alliances can signify higher uncertainty and risk (Das & Teng, 2002; Mani & Luo, 2015), the underperforming firm is willing to consider them in its problemisitc search, while other firms will be eager to tap-in to the level of expertise and knowledge that the highly embedded firm possesses and potentially dwell on post-alliance agreements (e.g. acquisitions). Therefore, an increased dynamic embeddedness of the firm weakens the negative effect that the increased performance-aspiration distance has on ISA formation.

On the other hand, a firm performing increasingly above its aspirations will have a lower propensity to engage in strategic transactions. This effect will be augmented, the more centrally dynamic, highly statutory a firm is considered in its network. As noted by Ahuja (2000a), incentives to form linkages for those firms that have the opportunity to do so (i.e. high performing firms) vary with firm's structural position in the network, such that they vanish beyond a point of embeddedness. For highly embedded firms, "the marginal benefits of forming new linkages will be low and the marginal costs of additional links will be high" (Ahuja, 2000a: 322). In this case, embeddedness (e.g. brokerage and proximity) would be used by overperforming firms to explicitly manifest their unwillingness to enter into new relationships with their more 'mediocre' peers. More formally, we posit the following hypotheses.

Hypothesis 3a. The negative relationship between performance below aspirations and ISA formation will be weaker for firms that experience high brokerage and proximity dynamicity.

Hypothesis 3b. The negative relationship between performance above aspirations and ISA formation will be stronger for firms that experience high brokerage and proximity dynamicity.

METHODS

Data and sample

We test our hypotheses by examining the global pharmaceutical industry chosen due to its traditionally high economic impact, the extensive collaborations between pharmaceutical firms, and the fact that ISA are considered a norm for this type of medium. To study how firm´s brokerage and proximity dynamicity, and aspirations affect ISA formation, we select a sample of 84 organizations by identifying those that have appeared at least once in the top 50 of the Pharmaceutical Executive Magazine yearly editions from the period 2002-2013, and whose ranking selection criteria is based on the firm's total sales. Subsequently, we use the Pharma and Medtech Business Intelligence database to collect all alliances that involve the top 84 firms in question between January 1, 1991 and December 31, 2012. These transactions used to proxy our network variables amount to over 9,041 collaborations of which about 7,595 involve alliances between the top 84 pharmaceutical firms, and the rest involving alliances between these leading firms and the remaining population totaling 4,645 firms. In order to measure organizational aspiration and control variables, we use COMPUSTAT and DATASTREAM databases supplied by annual report information whenever data is deemed incomplete. Since financial data concern the top 84 firms from Western Europe, United States, Asia, Africa and Australia, we convert all local currencies to USD with an exchange rate based on the particular year the data is retrieved.

Measures

Dependent variable. Our dependent variable, *alliances* is calculated as the number of total strategic alliances that each of the top 84 firms initiates with any other firm of the total sample population in a given year from 1991 to 2012. Our choice on this matter is motivated by the fact that strategic alliances (joint venture, marketing and licensing, intra-biotech deals, reverse

licensing and similar) are the most common type of strategic relationships analyzed by empirical studies involving social network concepts as seen in Table 1.

Insert Table 1 about here

While several studies using this type of variable choose a dummy unit of analysis (Ahuja et al., 2009; Garcia-Pont & Nohria, 2002; Hagedoorn, Roijakkers, & Van Kranenburg, 2006) due to the nature of our weighted socio-matrix networks, we opt for a counted representation previously used in social network analysis of strategic transactions (Demirkan & Demirkan, 2012). Specifically, the dependent variable takes a nonnegative integer value of 1 or higher for occurrence and repetition of strategic alliances, and 0 for a nonoccurrence of such collaboration for any given firm in any given year.

Independent variables. The primary independent variables of interest relate to performance relative to aspirations, brokerage and proximity dynamicity. To measure performance relative to aspirations, we first construct measures of both firm performance and aspiration levels as seen in the current BTF literature (Greve, 2003; Iyer & Miller, 2008; O'Brien & David, 2014). Aspirations are usually defined with respect to a particular dimension of firm performance which in the current research has generally been associated with return on assets (henceforth, ROA) (Greve, 2011). However, as Bromiley & Harris (2014) duly note, these studies have not addressed whether other performance measures might be superior, nor have they considered the inherent issues associated with single accounting measures such as recognition of discretionary items and depreciation. Therefore, we follow Bromiley & Harris (2014) guidelines, and construct a composite measure that includes ROA, return on stockholder equity (ROE) and return on sales (ROS). This measure is constructed using Stata alpha procedure that computes the inter-item correlations or co-variances for all pairs of variables and Cronbach's α statistic

for the scale formed from them while factor analysis is used as a confirmatory method to validate its outcome.

Researchers often combine self- and social-referent aspirations into a single measure of aspirations which aligns well with corporate practice of the firm usually retaining only one set of stated goals for a given activity at a given time (Bromiley & Harris, 2014). Similar to Greve (2003) and based on Bromiley & Harris (2014), we use a weighted proxy for organizational aspirations that combines both historical and social aspirations. Specifically, we measure historical aspiration as a weighted average of firm's past composite performance calculated as: $HA_t = 0.7(P_{t-1}) + 0.2(P_{t-2}) + 0.1(P_{t-3})$ where P is the composite performance measure that includes ROA, ROE and ROS. Social aspiration is operationalized as $SA_t = \frac{\sum P_t}{N-1}$ where P_t is the composite performance measure for any given year (t), N is the number of all firms (i.e. 84), and the final aspirations' level measure constructed following Greve (2003a) as $AL = 0.7 \times SA + 0.3 \times HA$. The proposed weights for the aspiration level are obtained after principal component analysis using Stata software. Similar to Kim and Rhee (2014), in order to analyse the relationship between strategic transaction formation and performance relative to aspirations, we subtract aspirations from performance, and split the results into positive and negative values meaning *Performance below aspirations* (henceforth, PbAL) when performance < aspirations and *Performance above Aspirations* (henceforth, PaAL) when performance > aspirations. Both are continuous variables, but while PbAL takes negative values, PaAL takes positive ones.

Bearing in mind various methods of longitudinal social network analysis that take into account missing actors such as stochastic actor-oriented or 'multi-agent' simulation methods (Uddin et al., 2013), traditional centrality measures could be updated to include a specific constant that

takes into account their dynamic evolution. This is the rationale behind 'dynamicity', a concept that has been applied to track evolutionary social network analysis in the global pharmaceutical industry (Shijaku et al., 2016). This approach to actor-level dynamics captures actor's positional evolution in the longitudinal network by centering itself around two key topologies: (i) the static topology which applies traditional SNT analysis methods over an aggregated *long-term* network encompassing all observational time periods, and (ii) the dynamic topology which applies longitudinal analysis techniques over each observational time period referred to as *short-interval* network (Braha & Bar-Yam, 2006; Shijaku et al., 2016; Uddin et al., 2013). Although there are several indicators used to measure actor's centrality in a network, in this study, we focus exclusively on betweenness and closeness centrality whose analysis has been crucial in modeling actors' social influence and interaction (Freeman, 1978; Friedkin, 1991; Newman, 2005).

In order to operationalize dynamic brokerage and proximity (*i.e. betweenness and closeness dynamicity*), we model each year over the sample period as a separate network, formally characterized as a symmetric (i.e. square matrix that is equal to its transpose so that the main diagonal of the sociomatrix always contains zeroes in order to avoid firm self-reference ties) N x N 'weight' matrix, whose generic entry $wij = wji > 0$ measures the interaction intensity between any two actors (zero if no link exists between actor i and j). This means that ties between actors are valued according to the actual number of strategic transaction formations, a procedure seen in the network literature (De Montis, Barthélemy, Chessa, & Vespignani, 2007). Following this framework, and using software R that enables us to handle large vectors, we build 22 symmetric 4,735 x 4,735 matrices to capture dynamic embeddedness of the firms for the given period. To minimize bias, we decide to include all alliances that firms make with each-other throughout the study period. The obtained longitudinal sample has a dynamic nature since some firms are active (i.e. forming strategic transactions) in a given network at a given

time and others are not. Once our sample is defined, we build the social networks for all participating firms. Dynamicity represents the variability of the structural positions of an actor in all short-interval networks compared to its structural position in the aggregated network. The mathematical expression for this measure originally proposed by Uddin et al., (2013), and later modified and adapted by Shijaku et al., (2016) is given by the following equation 1:

$$DDA^{i} = \frac{\sum_{t}^{m} \alpha_{t,t-1} \times \left(OV_{AN} - OV_{t}\right)}{m} \qquad (1)$$

where DDA^{i} is the degree of dynamicity shown by i^{th} actor, OV_{AN} is the observed variable (i.e. betweenness and closeness centrality) for the aggregated network, OV_{t} is the observed variable (i.e. betweenness and closeness centrality) for t^{th} yearly network for the i^{th} actor, m is the number of yearly networks considered in the analysis, and $\alpha_{t,t-1}$ is a constant valued according to whether the actor is present or missing in the current and previous short-interval network. The presence of this constant is of crucial importance to properly count for actors that disappear from the network due to simple inactivity or possible lack of presence due to acquisition effects. The possible combination values that $\alpha_{t,t-1}$ can take are given in Table 2.

Insert Table 2 about here

For the first short-interval (yearly) network (i.e. $\alpha_{i,0}$ for $t = 0$), the value of the constant will depend on the presence or absence of each actor (i.e. either 0 or 1) at the particular period.

Separately, we operationalize the observed variables that will be included in equation (1) namely the traditional measures of betweenness and closeness centrality. *Betweenness centrality* formally represents the number of shortest paths between any two actors which pass

through a specific actor (Freeman, 1980) modified to take into account the fact that in weighted networks, the actors with the highest actor strength are more likely to be connected in networks from a range of different domains (Opsahl, Colizza, Panzarasa, & Ramasco, 2008; Shijaku et al., 2016). *Closeness centrality* formally represents the inverse total length of the paths from an actor to all other actors in the network, and is based on the idea that actors with a short distance (i.e. path) to other actors can spread information very productively through the network (Landherr et al., 2010). This measure is also modified to suit weighted network structure. We note that, all weighted centrality measures in our analysis have been normalized and are calculated using *tnet* package available in R software.

Control variables - In addition to our independent variables, we control for several factors that could potentially impact ISA formation. Specifically, in order to gauge on the mechanism of attractiveness through which the effect of relative performance, and network embeddedness influences ISA formation, we control for *Tobin's Q* measured according to Chung & Pruitt (1994) with the following formula:

$Q = (MVE + PS + DEBT) / TA$ where MVE is the product of firm's share price and the number of common stock shares outstanding, PS is the firm's outstanding preferred stock, DEBT is the value of both short and long-term debt, and TA is the book value of total assets. Specifically, by analyzing Tobin's Q index, we can determine if the company is undervalued or overvalued at a specific point in time, which affects the perception of firm's attractiveness by other industry players. An undervalued firm would signal potential problems that could affect negatively firm's ability to initiate ISA with its network partners. Instead, an overvalued firm would signal high profitability, and promote interorganizational cooperation via alliance formations.

Moreover, we control for several forms of *slack* since according to BTF, slack (i.e. resources) is highly dependent on whether firm's performance is above or below its aspirations' level. If the firm is performing above aspirations, it will have more slack at disposal while if

performance is below aspirations, slack may be lacking as a result of the firm using resources to improve its performance (O'Brien & David, 2014). Specifically, we control for *unabsorbed slack* measured as cash and marketable securities divided by current liabilities, *absorbed slack* measured as the ratio of selling and administrative expenses to sales, and *potential slack* measured as the ratio of total long-term debt to total assets (Bromiley, 1991; Greve, 2003; O'Brien & David, 2014). We also control for the *age* of the firms operationalized as the foundation year minus the year considered in the 1991-2012 panel analysis, since as firm performance declines with age (Loderer & Waelchli, 2010) chances are this will affect the performance-based organizational aspirations. Finally, we control for *size*, operationalized as the natural logarithm of firm's employees as a common proxy used in empirical regression models. This variable has been observed of having an important impact in aspiration models with respect to positional rigidity (Greve, 2011).

Model

As our dependent variable is a nonnegative integer, we apply a negative binomial regression for our analysis. This choice is motivated by the fact that our data presents overdispersion; therefore an ordinary least regression (OLS) would not be appropriate in this case. However, this form of analysis presents several methodological considerations of a critical nature. First, as the data presents overdispersion either Poission or negative binomial models can be applied. Since variance and mean of all the dependent variables substantially differ, we opt instead for the negative binomial model. This choice is further validated by comparing Poisson and negative binomial implemented via the user written *countfit* function in Stata which plots the residuals from regression models against count outcomes where negative binomial is the model with the smallest residuals. Second, in order to avoid the multicollinearity issue in these regression models, and specifically between the two-way interaction items, we mean center all the interaction variables of our models. Third, we test for multicollinearity by

implementing *coldiag* Stata test on our dependent variables based on the regression collinearity diagnostic procedures found in Belsley, Kuh, & Welsch (1980) that gives a value of 9.7 for alliances, well below the 30.00 limit. Fourth, similar to O'Brien and David (2014), we lag all independent variables by one year to correct for serial correlation, and infer causality according Tyler et al., (2015). Fifth, approximately 20 percent of the dependent variable presents zeros; therefore we also examine zero-inflated negative binomial models that count for this problem as well as for overdispersion with similar results to those reported. Sixth, the slack variables contain some outliers, so we follow O'Brien and David (2014) method, and Winsorize their distributions at the top and bottom of 0.5^{th} percentiles. Additionally, since centrality measures are heavily correlated with each-other we apply specific regression models to brokerage and proximity dynamicity.

Results

Descriptive statistics and Pearson correlations among the variables used in the negative binomial regression models are provided in Table 3 while regression results are given in Table 4. The number of observations varies across variables due to missing items in longitudinal data. The correlation table shows that centrality measures are significantly correlated between themselves and the dependent variables which might be a sign of multicollinearity already taken into account in the model part of our study. The significant correlation that PbAL and PaAL have with alliances is an indicator that firms reduce their strategic alliances when performance falls short or exceeds organizational aspirations. Additionally, the high mean of *age* variable is an indicator that the top 84 pharmaceutical firms are quite old. Elsewhere, *size*, *Tobin's Q*, and various control slacks introduced into our model are meaningful as significant correlations are observed.

Insert Table 3 and 4 about here

Looking at the main effects in models 2 and 4, it is observed that ISA formation significantly increases as does PbAL, that is when aspiration levels are approached ($b = 0.57$, $p < 0.001$ in model 2; $b = 0.53$, $p < 0.001$ in model 4) while decreases for PaAL ($b = -0.35$, $p < 0.05$ in model 2; $b = -0.34$, $p < 0.05$ in model 4) confirming both H1a and H1b. Throughout the analysis, we observe a direct and positive effect of closeness dynamicity on ISA formation akin to proposed H2 ($b = 0.88$, $p < 0.05$ in model 4). This is not the case for betweenness dynamicity for which H2 is not supported.

Models 3 and 5 incorporate the two-way interactions between the dynamicity indicators and aspiration performance. This moderation posited by H3a is supported in the case of betweenness dynamicity and PbAL ($b = -0.85$, $p < 0.05$ in model 3), and closeness dynamicity and PbAL ($b = -4.03$, $p < 0.05$ in model 5). The moderation posited by H3b is supported only for betweenness dynamicity ($b = 1.1$, $p < 0.05$ in model 3). Finally, we introduce Tobin's Q as a control variable that measures firm's attractiveness as perceived by the network partners of the industry. By explicitly including the effect of attractiveness (through Tobin's Q), the estimated coefficient of aspiration performance will be focused on firm´s willingness to form ISA. Specifically, we model Tobin's Q as an endogenous variable affecting ISA initiation. The coefficient of this variable is the residual of a two stage least square regression analysis, and as observed, its inclusion has a positive and significant effect on ISA formation throughout all models.

Insert Figure 1 about here

Figure 1, shows the two-way interactions, for the negative binomial regression for both betweenness and closeness dynamicity which is a log link function plotted from the mean minus one standard deviations to the mean plus one standard deviations. Specifically, Figure 1 plots are based on the regression models 3 and 5 of Table 4 and illustrate the estimated change

distances when dynamic network indicators, PbAL and PaAL are one standard deviation above or below their means. In particular, it can be observed that both betweenness and closeness dynamicity moderate the aspirations-alliance formation relationship (i.e. high and low performers in broker and proximtiy positions are more likely to form ISA).

Robustness tests

In order to validate our results, we conducted several robustness tests. Above all, we added a quadratic term to both brokerage and proximity dynamicity in the main effect regression models. Prior studies have suggested a curvilinear relationship between centrality measures and new strategic alliances, pointing out that too many connections information will not necessarily be helpful and might be dysfunctional, given that any organization's information and knowledge processing capacity is limited (Ahuja, 2000a, 2000b; Paruchuri, 2010; Simsek, 2009). The new regression results remain supportive of our hypotheses but do show a weak inversed U-shaped relationship between brokerage and proximity measures with ISA formation. Finally, as we are dealing with non-linear regression models, we tested the marginal effects of our regression models confirming our given results.

DISCUSSION AND CONCLUSION

This study is motivated by a limited research in understanding performance-based aspiration mechanisms of firm strategic behavior in dynamic network contexts. Specifically, we propose an integrated framework bridging behavioral and social network perspectives to test our hypotheses in a database containing information about the biggest firms in the global pharmaceutical industry. Our results show that organizational behavior in the form of ISA initiation is more visible the closer the distance between firm performance and its aspiration level, but less visible the further firm performance departs from its aspirations both above and below; these results being in line with current literature on the topic (Baum et al., 2005; Di

Lorenzo, 2011; Greve, 1998, 2011; Kim & Rhee, 2014). In this sense, both high and low performers seem to encounter a similar pattern of rigidity behavior and reduced network dynamism. However, this similar behavior of firms with radically different performance may be due to different reasons; while the high performer may have access to partners to establish strategic alliances, its preferences avoid new potential linkages which is consistent with previous research that has found firms being unable to benefit from lower-quality competitors (e.g., Kalnins & Chung (2004). On the other hand, the low performer will seek potential partners but alliance formation will be difficult due to its aspiration performance.

Additionally, we confirm that dynamically embedded firms moderate the relationship between ISA formation and organizational aspirations. Specifically, we find that both brokerage and proximity have a significant role in the increase of ISA when performance falls below aspirations' level. This result makes sense, if we consider that a greatly underperforming firm would go at great lengths to increase its strategic ties seeking solutions to its performance-related problems and alter its network structure towards a more central positioning. This seems a logical behavior of sorts in the global pharmaceutical industry where firms are engaged in an ever competitive environment. More importantly, our results confirm similar research into the important effect of structural embeddedness in performance-based aspirations (Baum et al., 2005; Kim & Rhee, 2014; Shipilov et al., 2011).

Results also show that brokerage in dynamic networks cancel out the effect of positive aspiration performance on ISA formation; this being in line with the inconsistence of slack search observed by extant empirical evidence. The same cannot be said about proximity which seems to not affect the relationship between ISA and positive aspirations. A possible explanation could be that proximity acts differently from brokerage since the former allows the firm to know from the start the aspiration performance of its potential partner which will subsequently affect its decision to engage or not in ISA formation. From the brokerage

perspective, the partnering firm has no knowledge of the focal firm's (i.e. broker) strategic partnerships, thus it will rely on the assumption that firms with negative aspirations will have more alliances with underperforming firms; hence it will stir away from engaging in ISA with such brokers.

Having said this, it is important to note that our analyses are not free of limitations. To begin with, the lack of support for a direct relationship between brokerage and ISA formation warrants further research as to why highly correlated centrality measures behave differently. Additionally, the use of large samples from archival data leaves unexplored the processes that go on within organizations and that are at the core of the BTF especially with regard to how managers think about and pursue changes in strategy. Caution is also warranted when assigning the weights to the aspiration measure as these might not reflect actual managers' view. Finally, the extrapolation of this study's results to other industries should be carefully motivated as the pharmaceutical industry evolution has historically depended on alliances which might be sparse and of different strategic nature in other industries.

Nevertheless, this study hopes to contribute to the literature in several ways. First, from both performance feedback and threat rigidity perspective, we contribute to the strategic decision making behavioral theory (Cyert & March, 1963; Greve, 1998, 2003; O'Brien & David, 2014) by analyzing the factors that influence ISA formation under the lens of performance-based aspiration models. Our results show that performance-based aspirations affect ISA formation. Second, this study contributes to the social network literature by positing that under the moderation of dynamic brokerage and proximity (i.e. betweenness and closeness dynamicity), the relationship between aspiration performance and strategic alliance formation is significantly altered. In particular, we show that dynamically central firms increase alliance formation for negative aspiration performance and decrease them for positive aspiration levels.

Our study is thus an attempt to integrate elements from both behavioral and social network perspective by providing a 'dynamic' nexus that we hope further bridges these concepts and lays foundations for future research. Specifically, new dynamic measures could be proposed that help the academia understand the nature of organizational behavior in the network level, providing new insights on network consequences and aspiration antecedents as well as the exploitation of other behavioral concepts (e.g. organizational attention), and their potential role in the aspirations of a dynamically embedded firm. Additionally, the deconstruction of the aspiration measure into its original social and historical constituents, and their consideration in the model analysis could be beneficial in understanding the relationship of each factor with dynamic embeddedness and strategic transaction formation.

In addition to our theoretical contributions, our results could provide practical implications as well as answering to the framing of successful strategic processes. Specifically, recognizing the crucial effect of brokerage and proximity dynamicity could have important consequences to the aspiration performance of the firm. In this vein, firms could focus their attention on tracking the interorganizational network in which they are dynamically embedded by analyzing the aspiration performance consequences of organizational processes, and business practices that involve ISA formation. Such analysis could yield insights on the crafting of strategic activities that focus on collaborative networks, and avoid threat rigidity behavior that despite its survivalist intentions could harm the firm in the long run.

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TABLE 1
Strategic alliances by type

- Co-marketing
- Co-promotion
- Disease Management
- Includes Contract
- Includes Equity
- Includes Royalty or Profit Split Information
- Intra-Biotech Deal
- Joint Venture
- Manufacturing or Supply
- Marketing-Licensing
- Product or Technology Swap
- Product Purchase
- R&D and Marketing-Licensing
- Reverse Licensing

Source. PharmaandMedTech Business Intelligence

TABLE 2

Possible combination of presence and absence of a firm in two consecutive short-interval networks

Current t	Previous t	Constant α
Present	Present	$\alpha_{p,p}= 1.0$
Present	Absent	$\alpha_{p,a}= 0.5$
Absent	Present	$\alpha_{a,p}= 0.0$
Absent	Absent	$\alpha_{a,a}= 0.0$

TABLE 3

Means, standard deviations and Pearson correlations

Variable	Obs.	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. Alliances	1604	7.889	10.3	1										
2. PbAL	1512	-0.0717	0.18	0.0752*	1									
3. PaAL	1738	0.0665	0.351	-0.0640*	0.0826*	1								
4. Betweenness dynamicity	1764	0.111	0.29	0.7258*	0.0416	-0.0235	1							
5. Closeness dynamicity	1848	0.12	0.0946	0.4399*	-0.0256	-0.0783*	0.3590*	1						
6. Age	1364	77.53	66.52	0.1122*	0.1612*	-0.0061	0.1307*	-0.1172*	1					
7. Size	1356	8.231	1.979	0.4371*	0.1636*	-0.3655*	0.3700*	0.2725*	0.2918*	1				
8. Tobin's Q	902	0.472	0.605	0.1289*	-0.0393	-0.0032	0.1126*	0.1201*	-0.3001*	-0.2055*	1			
9. Absorbed slack	1133	0.461	0.869	-0.023	-0.1597*	-0.0457	-0.0003	-0.0711*	0.0938*	-0.0720*	-0.0367	1		
10. Unabsorbed slack	1103	1.393	2.594	-0.1101*	-0.1710*	0.0678*	-0.0852*	0.0111	-0.2271*	-0.3842*	0.2276*	0.1686*	1	
11. Potential slack	1132	0.209	0.538	-0.1088*	-0.0045	0.1103*	-0.0655*	-0.0953*	-0.0375	-0.2544*	-0.0356	0.1684*	-0.0787*	1

Note. Coefficients are reported at * $p < 0.05$

TABLE 4
Determinants of ISA formation

	Alliances					
Model	1	2	3	4	5	6
Controls						
Age	-0.000	0.004+	0.005+	0.005+	0.003	0.004
Size	0.006	0.124+	0.148*	0.134*	0.116+	0.136+
Absorbed slack	-0.142*	-0.140*	-0.143**	-0.140*	-0.110*	-0.118*
Unabsorbed slack	-0.006	-0.027+	-0.0287+	-0.028+	-0.029+	-0.032*
Potential slack	-0.510***	-0.476***	-0.478***	-0.468***	-0.486***	-0.503***
Tobin's Q	0.118	0.361***	0.416***	0.355***	0.334***	0.389***
Main effects and interactions						
PbAL		0.572***	0.585***	0.535***	0.552***	0.578***
PaAL		-0.357*	-0.343*	-0.348*	-0.310*	-0.310*
Betweenness dynamicity		0.284	0.186			0.239
Betweenness dynamicity x PbAL			-0.855*			0.561
Betweenness dynamicity x PaAL			1.104*			0.543
Closeness dynamicity				0.885*	0.833*	0.719*
Closeness dynamicity x PbAL					-4.039**	-4.588**
Closeness dynamicity x PaAL					0.779	0.221
Model statistics						
Wald Chi2	30.08	52.78	67.85	57.20	72.38	79.07
N	757	757	745	757	745	745

Note. Coefficients are reported at + $p < .1$ * $p < .05$ ** $p < .01$ *** $p < .001$

FIGURE 1

Non-linear effects of betweenness and closeness dynamicity on the relationship between aspirations and ISA formation