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FREE-RIDING IN MULTI-PARTY ALLIANCES: THE ROLE OF PERCEIVED ALLIANCE EFFECTIVENESS AND PEERS' COLLABORATION IN A RESEARCH CONSORTIUM

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Research summary: *Multi-party alliances rely on partners' willingness to commit and pool their efforts in joint endeavors. However, partners face the dilemma of how much to commit to the alliance. We shed light on this issue by analyzing the relationship between partners' free-riding—defined as their effort-withholding—and their perceptions of alliance effectiveness and peers' collaboration. Specifically, we posit a U-shaped relationship between partners' subjective evaluations of alliance effectiveness and their free-riding. We also hypothesize a negative relation between partners' perceptions of the collaboration of peer organizations and their free-riding. Results from a mixed-method study—combining regression analysis of primary data on a major inter-organizational research consortium and evidence from two experimental designs—support our hypotheses, bearing implications for the multi-party alliances literature.*

Managerial summary: *Free-riding is a major concern in multi-party alliances such as large research consortia, since the performance of these governance forms hinges on the joint contribution of multiple partners that often operate according to different logics (e.g., universities, firms, and government agencies). We show that, in such alliances, partners' perceptions have relevant implications for their willingness to contribute to the consortium's shared goals. Specifically, we find that partners free-ride more—that is, contribute less—when they perceive the effectiveness of the overall alliance to be either very low or very high. Partners also gauge their commitment to the alliance on the perception of the effort of their peers—that is, other organizations similar to them. These findings provide managers of multi-party alliances with additional levers to motivate partners to contribute fairly to such joint endeavor.*

INTRODUCTION

During recent years, the number of strategic alliances has steadily increased, making them one of the most popular forms of collaboration among firms. Over time, such agreements have also evolved from simple, dyadic arrangements to structures that increasingly involve multiple parties (Zeng and Chen, 2003), often fostering collaboration not only among firms, but also other types of organizations such as universities, research centers, and governmental agencies (Kale and Singh, 2009; Mindruta, 2013). Research consortia are clear examples of such multi-party alliances (Xia, Zhao, and Mahoney, 2012), and their effectiveness

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in facilitating learning, knowledge transfer, and joint problem-solving via the collaborative efforts among firms and research institutions explains their growing diffusion (Gulati, Wohlgezogen, and Zhelyazkov, 2012).

Unfortunately, in many multi-party alliances, these potential benefits remain untapped. This is because multi-party alliances are particular forms of collective action, which "create economic value that has a 'common pool' component, and [their] lack of well-defined property rights invites potential opportunistic behavior and free-riding" (Agarwal, Croson, and Mahoney, 2010: 415). Alliance partners thus often face the classic collective action problem (Olson, 1965) of either having to decide whether to commit their limited resources to the joint endeavor—reducing the net value they appropriate —or "free-ride" on other actors' activity by withholding their efforts toward the joint endeavor. While maximizing their value appropriation, the latter course of action increases the likelihood of alliance failure, both directly, due to the limited investments on part of the focal firm, and indirectly, by discouraging other partners to invest in the alliance (McCarter, Mahoney, and Northcraft, 2011).

Earlier research on alliances has proposed *ex-ante* structural and motivational solutions—based on alliance design, partner selection, and communication of cooperative intent—to align partners' private and public incentives and suppress potential opportunistic behaviors (Gulati *et al.*, 2012).[1] However, no matter how well designed, such solutions can at best only minimize, but not completely eradicate, free-riding (McCarter *et al.*, 2011). So it is surprising to see the limited attention (both theoretical and empirical) that the strategic management literature has paid to the problem of free-riding *post*-alliance formation. As we know little about the behavioral mechanisms underlying alliance partners' actual free-riding behaviors (Zeng and Chen, 2003), empirical investigations of such phenomenon are particularly needed since "many behavioral assumptions [of *ex-ante* approaches] may not hold in reality" (Agarwal *et al.*, 2010) and given that it is "during actual implementation of the alliance that partners may begin engaging in opportunistic behavior that leads to cooperation failures" (Gulati *et al.*, 2012: 551). Adopting a behavioral, *ex-post* theoretical approach may be particularly valuable in multi-party alliances, which differ from their dyadic counterparts due to their higher uncertainty, ambiguousness, and opaqueness (Das and Teng, 2002; Fonti, Maoret, and Whitbred, 2015), characteristics that make specific partners' attributions noisy (Zeng and Chen, 2003) and increase the costs associated with the effective monitoring and sanctioning of free riders (Doz and Hamel, 1998; Luo, 2007).

Our work contributes to the investigation of free-riding in multi-party alliances by offering an empirical investigation of a large, heterogeneous research consortium composed of 40 major universities, firms, and government agencies. We propose that partners' subjective interpretations of inter-organizational relations and outcomes directly relate to the likelihood of them free-riding (Gulati *et al.*, 2012), highlighting how "differential perceptions of other decision makers' actions" (Agarwal *et al.*, 2010: 418) might affect a focal firm's decision to allocate its efforts. Since partners often hold idiosyncratic views about the multi-party alliances in which they are embedded (McCarter *et al.*, 2011)—especially when alliances include both for-profit and not-for-profit organizations (Kale and Singh, 2009)—their perceptions are likely to play prominent roles in affecting any effort-withholding behaviors (Schoorman, Mayer, and Davis, 2007). Thus, we theorize and empirically validate that perceptions of alliance effectiveness—in this case, the extent to which a research consortium performs to its potential in accomplishing its goals—have a U-shaped relationship with actors' free-riding, as partners' perceptions of *both* low and high alliance effectiveness might limit their motivation to contribute to the joint endeavor due to considerations of marginal efficiency (McCarter *et al.*, 2011). Leveraging social comparison theories (Festinger, 1954), we also argue and provide empirical support for the view that multi-party alliance members are attuned to perceptions of their *peers*' behaviors (Kitts, 2006), where peers are defined as other organizations belonging to their same institutional sector (Thornton and Ocasio, 2008). Thus, we show that partners gauge their involvement in the

[1] While management scholars have typically associated free-riding with opportunistic behavior, and thus, we refer to opportunism as we discuss extant research, we are interested in free-riding as effort-withholding behavior in general, and thus, not only limited to opportunistic cases. Partners' involvement in a multi-party alliance may also be limited due to nonopportunistic reasons, such as the lack of norms encouraging strong commitment to the joint endeavor (i.e., normative conformity), or the lack of identification with such endeavor (Knoke, 1990). We thank an anonymous reviewer to bring this issue to our attention.

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consortium on organizations institutionally similar to them—for instance, universities (firms) are particularly attuned to the willingness to collaborate displayed by other universities (firms). In doing so, our approach explores and highlights the overlooked effects of organizational and role heterogeneity within multi-party alliance composition (Phelps, 2010), advancing the integration between institutional theory and strategic management (Oliver, 1997).

THEORY

Strategic management researchers have focused on opportunism and free-riding as primary causes of alliance underperformance and potential failure. Most of these studies have employed *ex-ante* approaches, which focus on the role of structural and motivational solutions in realigning partners' interests so as to provide protection from the risks of free-riding *before* entering an alliance. For instance, industrial organization researchers have studied whether partners should decide to engage (or not) in R&D activities (for a review, cf. Cassiman, 2008). Borrowing from game theory, scholars have theorized which factors affect the payoff structures that drive partners to defect (Khanna, Gulati, and Nohria, 1998; McCarter *et al.*, 2011). *Ex-ante* analyses have also theorized extensively about the optimal governance contracts that ensure alliance cooperation and success (Reuer and Ariño, 2007). Others have highlighted the limits of this approach, defining those situations where relational forms of governance—based on trust, communication, and partners' motivation—are more suited to limit free-riding (Elfenbein and Zenger, 2014; Gottschalg and Zollo, 2007).

Whereas *ex-ante*, rational approaches to the study of effort-withholding in alliances have an extensive tradition, there is a theoretical and empirical paucity when it comes to understanding free-riding from an *ex-post* perspective, i.e. after alliances have been formed (Gulati *et al.*, 2012; Kale and Singh, 2009). In particular, limited attention has been paid to studying which factors relate to actual free-riding and effort-withholding behaviors. Researchers have rarely discussed which mechanisms determine alliance partners' *actual* levels of free-riding, paying much less attention to theorizing and empirically testing the socio-psychological mechanisms influencing partners' decisions about the actual levels of effort they invest in alliances (Gottschalg and Zollo, 2007). We believe this to be an important area to explore. In fact, *ex-ante* structural solutions based on optimizing contracts and governance structures have been proved to be limited in controlling free-riding (McCarter *et al.,* 2011). Such problems are compounded in the case of multi-party alliances, where size and partners' role heterogeneity—as they tend to include parties from different institutional sectors, and thus, with very different agendas and objectives—make free-riding even more likely and its consequences more problematic. Furthermore, the complexities and dynamics of a network of relationships where multiple partners interact with several others are fundamentally different from those in dyadic relationships (Lavie, Lechner, and Singh, 2007), which implies that governance mechanisms also differ between multi-party and bilateral alliances (Li *et al.*, 2012). Things are even more complex when it comes to free-riding as the risk of its emergence is both higher and potentially more damaging in multi-party alliances (García-Canal, Valdés-Llaneza, and Ariño, 2003; Zeng and Chen, 2003). As Das and Teng point out, "given the ambiguity and disjointed nature of exchanges, members of a generalized exchange system have more incentives for free riding" (2002: 448).Our goal is thus to shed additional light on *ex-post* free-riding in multi-party alliances by focusing on how partners' perceptions affect free-riding in a large multi-party research consortium.

Perception of alliance effectiveness and free-riding in multi-party alliances

Effort allocation decisions of alliance partners' are not taken in isolation, but are a function of the expected contributions of other partners. The alliances' success is predicated on contributions from multiple member organizations, and their decisions on how much to commit to their joint endeavors are interdependently made (Gould, 1993). In other words, any organization will decide to commit a certain amount of effort contingently on the expected decision made by the other organizations.

While this view of how alliance partners decide to allocate effort seems reasonable for dyadic alliances, it might not be as straightforward to extend it to predict partners' behavior in large, multi-party alliances. What might complicate its

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translation from dyadic to multi-party alliances is the limited amount of information about other parties' behavior that characterize the latter contexts. In general, large multi-party alliances are akin to complex systems in which the observability of other partners' behavior and investments is uncertain, ambiguous, and opaque (Das and Teng, 2002; Fonti *et al.*, 2015). Partners' behavior is more likely to remain anonymous than in a dyadic alliance as partners "might not easily detect who did what in the multipartner solution" (Zeng and Chen, 2003: 591). Specific attributions become noisy—both in terms of investments made ("who invests how much"), but also in terms of appropriation of value ("who benefits the most"); this is especially true when multi-partners alliances are very large, geographically dispersed, and composed by heterogeneous members (Lavie *et al.*, 2007; Yin, Wu, and Tsai, 2012). As precise verifiability of information decreases, opportunism becomes a more dangerous threat (Luo, 2007), also because it is harder to enforce norms and administer sanctions in large multi-party alliances (Das and Teng, 2002; Doz and Hamel, 1998). In fact, while in a two partners alliance each party can try to influence other's behavior by simply noncooperating—and thus, punishing—in a subsequent interaction, "this degree of 'influence potential' [...] is clearly diluted in the multiparty case, where it is much harder for any single player to shape the group dynamics effectively" (Zeng and Chen, 2003: 591). This high level of complexity in multi-party alliances generates "unique dynamics" (Lavie *et al.*, 2007: 578), and contributes to heightened likelihood of free-riding due to the difficulty of envisioning all possible alliance evolution paths (Zeng and Chen, 2003).

Following these considerations, we join Zeng and Chen in suggesting that the dilemma partners face in a dyadic alliance "cannot be considered representative of the multipartner problem" (2003: 591), and rather frame our contribution around the *social* dilemma partners face as they make contribution decisions based on perceptions of the *overall performance* of the alliance rather than on the contributions of other specific partners, due to the difficulty to track their specific behaviors in the context of a multi-party alliance. Our argument continues an established literature linking managerial perceptions with alliances operations (cf. Luo, 2007; Schoorman *et al.*, 2007), and aligns with a recent call for an "interpretive perspective" that highlights the role played by partners' perceptions and subjective evaluations in post-formation alliance dynamics (Gulati *et al.*, 2012). We thus focus on how *perceptions of alliance effectiveness*—defined as partners' subjective evaluations of the extent to which the overall alliance is achieving its goals and those of its key stakeholders (Sydow and Windeler, 1998)—might be related to effort-withholding behaviors. In large multi-party alliances, focusing on *perceptions* of their effectiveness is critical because alliance partners often differ in terms of how they view alliance activities and frame their role in them (McCarter *et al.*, 2011), and thus, in the extent to which they might want to "bend" the network agenda toward their own particular interests (Sydow and Windeler, 1998). Individual actors tend to have different opinions regarding the need and importance of different network activities, and as a result, of how effective they perceive the network to be (Passy and Giugni, 2001). Furthermore, partners' perceptions as to what the network is doing and how well it is performing also depend on the position they hold within the network structure (Krackhardt, 1990). Even if they have similar goals and power to affect the network's agenda, actors with different structural positions may hold diverging views as to how effective the network is, given the high level of structural complexity and fragmentation of a large multi-party alliance (Yin *et al.*, 2012). These discrepancies make actors' perceptions of the effectiveness of the overall alliance a critical motivator of their decisions and behaviors, including how much effort to allocate to the joint endeavor. Thus, it is likely that partners' subjective evaluations are primary drivers of their commitment to the joint endeavor.

Two distinct mechanisms link the perception of overall alliance effectiveness with partners' free-riding. Based on the expectation that partners' effort-allocating decisions are driven by their eagerness to avoid wasting resources (Gould, 1993), we may expect that, when the overall alliance effectiveness is perceived as *very high*, partners may reroute their limited resources toward other tasks, while still enjoying the benefits of being part of an effective system (Kidwell and Bennett, 1993). This might be due opportunism, which might emerge at this point as partners perceive that there is lots of value to appropriate. They may also rationalize such decision on the grounds that, as they perceive the alliance to be performing well, they might consider the marginal value of

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their contributions to the multi-party alliance as comparatively low (Passy and Giugni, 2001), and that their lower involvement will have little or no substantive impact on the network output (Olson, 1965). Thus, organizations might opt to withhold some of their effort believing that their contribution may be irrelevant—and thus, wasted—due to the alliance's high perceived effectiveness, allowing them to enjoy the shared benefits without incurring much cost—a type of free-riding also known as *offensive defection* (McCarter *et al.*, 2011).

However, similar concerns and outcomes may be associated with situations in which alliance effectiveness is perceived as being *very low*. When perceptions of alliance performance are low, partners are likely to limit their efforts as they do not want to waste limited, valuable resources on a joint endeavor that appears to be yielding limited results (Gould, 1993). Moreover, organizations may withhold efforts from the joint endeavors they perceive to be underperforming to avoid being labeled as "suckers" (Gulati *et al.*, 2012; Schnake, 1991), as such situations might be emerging from other partners' effort-withholding. This type of behavior, which has been labeled *defensive defection* (McCarter *et al.*, 2011), may be even more likely in settings such as research consortia, where "keeping face" may be even more important, due to the simultaneous presence of multiple same-industry players and rivals in them.

For these reasons, we can expect that in settings such as multi-party alliances, the perception of alliance effectiveness has a curvilinear (U-shaped) relationship with free-riding. At low levels of perceived effectiveness, organizations withhold effort *defensively* to preserve resources based on the high likelihood of collaboration failure and the associated fallout. As the perception of overall collaboration effectiveness start to increase, partners will consider more likely that the alliance will generate value, and thus, increase their own efforts in it. However, when levels of perceived alliance effectiveness become very high, organizations may reengage in free-riding. Specifically, they may decide to withhold effort *offensively*, benefiting from the resources invested by others, either due to opportunism or to the feeling that their contribution is no longer very significant.[2] Thus:

Hypothesis 1: The perception of alliance effectiveness has a curvilinear (U-shaped) relationship with free-riding in multi-party alliances.

The relationship between perceptions of peers' collaboration and free-riding in heterogeneous multi-party alliances

As opposed to traditional dyadic forms of collaboration, the presence of generalized reciprocity (Das and Teng, 2002) implies that multi-party alliances rely on more informal mechanisms—such as social sanctions and a cooperative macroculture (Jones, Hesterly, and Borgatti, 1997)—and informal norms of reciprocity (Dyer and Singh, 1998) to ensure partners' compliance and limit free-riding behaviors. While partners are likely to gauge their level of effort according to the norms they perceive emerging from the activities of the alliance network, it is unlikely that all other partners' behaviors carry the same weight in establishing such norms. Characteristics such as being geographically distributed (Whittington, Owen-Smith, and Powell, 2009), having heterogeneous partners (Powell *et al.*, 2005), and channeling difficult to observe resources (e.g., knowledge) increase the opacity of the network (Fonti *et al.*, 2015), thus making it harder for members to fully understand all other partners' activities. Social norms are thus more likely inferred from observing the activities of the subgroup of partners more similar to the observer. Indeed, researchers suggested that, in multiparty alliances, "the focal party forms its perception based on […] a few partners' past behaviors, and then behaves according to its general perceptions of the norm within the alliance" (Zeng and Chen, 2003: 599). Specifically, we suggest that in a large and heterogeneous multi-party alliance, partners are more likely to be aware of and respond to those norms they can infer from the behavior of their *peers*, who are their most visible and relevant referents (Kitts, 2006). At the socio-psychological level, peer influence has been extensively discussed as an effective control mechanism in fostering members' conformity with collaborative norms (Haas and Park, 2010), and operates at many levels (e.g., shame, guilt, reputation) to ensure actors sustain their efforts (Kandel and Lazear,

[2]Such hypothesized relationship is also consistent with experimental lab evidence of individual free-riding (Kerr, 1983; Schnake, 1991), which found that actors tend to free-ride when they perceive joint performance as either extremely high or extremely low.

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1992). We propose to extend this reasoning to the inter-organizational level; partners in multi-party alliances will be more attuned to the social norms inferred from their peer organizations, although due to institutional and organizational—rather than socio-psychological—mechanisms.

Large multi-party alliances such as research consortia are commonly heterogeneous (Kale and Singh, 2009), as they attract the interest not only of firms, but also of other organizations belonging to institutional sectors different than the market, such as universities and government agencies (Mindruta, 2013; Nakamura, Vertinsky, and Zietsma, 1997). These institutional types fundamentally differ in terms of their set of capabilities and organizational cultures, but also in their objective functions and in the logics that guide their strategic actions (Kale and Singh, 2009; Thornton and Ocasio, 2008). For instance, Nakamura and colleagues report that whereas consortia's goals are generally shared among private and not-for-profit organizations, partners prioritize their objectives differently; government agencies seem to be particularly interested in searches for new materials and the development of new manufacturing methods, whereas firms put particular emphasis on product improvement and new product development (Nakamura *et al.*, 1997). In other words, the actions of organizations from different institutional sectors are shaped by different institutional logics, or "sets of organizing principles that contain the cognitive schema, normative expectations, and material practices" (Jones *et al.*, 2012: 1523) to which they abide. More specifically, as actors "are likely to cooperate with the social group [they identify with and] abide by its norms and prescriptions" (Thornton and Ocasio, 2008: 111), we expect that partners organizations will be particularly attuned to the perceived behaviors of the organizations belonging to their same institutional sector, and deduce from them behavioral rules that will guide their action. Thus, we expect partners to use organizations of their institutional type as their referents peers to gauge their effort levels, which is consistent with research showing that actors' behaviors are affected by referents belonging to the same social category (Festinger, 1954) or fulfill similar roles in their networks (Shah, 1998).

Other organizations of the same institutional type are also more likely to be aware of a focal organization's activities and to control the punishments/benefits associated with deviance from compliance with established norms, further increasing the likelihood that partners will adhere to such norms and base their behaviors on that of their peers. Thus, organizations that perceive their peers as highly active in the network may feel obliged to exert more effort, due to the pressure and social control their peers exert (Coleman, 1988). Similarly, high levels of perceived peers' collaboration might boost the focal organization's consciousness of network-specific norms valuing collaboration (Haas and Park, 2010), signal the presence of a cooperative macroculture (Jones *et al.*, 1997), and reinforce the institutional logic they should abide to (Thornton and Ocasio, 2008), thus pushing it to exert its best effort for the overall network good (Coleman, 1988). Finally, normative conformity may lead to peers' actions influencing effort-withholding behaviors not only through norms enforcing compliance, but also via equity considerations based on perceptions of peers' efforts toward shared goals (Kidwell and Bennett, 1993). Thus:

Hypothesis 2: The perception of peers' collaboration is negatively related to free-riding in multi-party alliances.

METHODS

The data for our study came from a 40-member inter-organizational technology consortium, a heterogeneous multi-party alliance comprised of universities, firms, and government agencies, whose purpose was to engage in precompetitive research to advance technologies related to the design, manufacture, and use of machine tools. As is typical of research consortia, participation was voluntary (Makadok and Coff, 2009), and members could leave at any time. Partners were expected to actively contribute to the consortium albeit in different ways, reflective of their specific nature—that is, universities, firms, and government agencies—and associated capabilities. Since consortium results were shared among members, the network's goals closely resembled the production of a public good (Olson, 1965). While each partner had distinctive goals (e.g., universities were interested in publications and advancement in basic research, while government agencies focused on high-level defense or energy-related applications), they all depended on the overall network goal of innovating machine tool

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technology. Although partners' identities cannot be disclosed, they are all world-class players—top U.S. universities, industry leaders, and government agencies.

Data collection

Data collection began with exploratory, open-ended interviews with seven different individuals with intimate knowledge about the consortium to get a good understanding of its activities, ongoing issues, and the roles different types of organizations played in it. Using these interviews and archival data (e.g., consortium newsletters and conference proceedings), we developed a semi-structured questionnaire that we first piloted and then administered in phone interviews (averaging about 60 minutes) with key informants—the individuals responsible for consortium activities in each of its member organizations. Missing data led to two partners being dropped, leaving a final sample of 38 organizations (9 universities, 21 firms, and 8 government agencies)—an almost complete coverage of the network (95% response rate).

Using key informants to obtain organizational-level data is a widely used practice in management research, as these data have shown to be highly accurate (Kumar, Stern, and Anderson, 1993). We followed the standard practice of research on alliances in identifying and targeting informants who were responsible for managing consortium relationships and activities on behalf of their organizations, acting as boundary spanners between them and the rest of the consortium (cf. Luo, 2007; Parkhe, 1993; Xia *et al.*, 2012). As such, they decided the type and level of their organization's involvement in consortium activities, making them the most appropriate individuals to survey to gain data about consortium and individual partners' activities. Since all informants fulfilled the same roles, our choice also allowed us to minimize both selection problems and the risk of bias across network members (Kumar *et al.*, 1993). Where organizations had appointed multiple consortium point-persons, we increased the validity and reliability of our data by surveying and averaging data from multiple informants (Kumar *et al.*, 1993). Such cases represent the 17.5 percent of our sample, a figure close to the 16.8 percent multi-informant organizations reported by Xia and colleagues (Xia *et al.*, 2012).

Dependent variable

To operationalize *free-riding*—the extent to which an organization is withholding effort from the alliance—we first asked each consortium member to rate each of the other members' *potential* performance on a seven-point scale (from 1 = Extremely Poor to 7 = Extremely Good), and then to rate the level of performance those same members actually *realized* on the same scale. We calculated each partner's free-riding by considering the difference between its potential and realized performance, as evaluated by its partners (alters); thus, higher scores identified network members withholding more effort from the joint endeavor. The idea of measuring free-riding as the difference between potential and realized performance is rooted in research arguing that actors create clear expectations about acceptable levels of performance of their partners in a shared endeavor, as they are aware that even one subpar contribution may endanger the performance of the entire network. It is also consistent with recent research examining the factors accounting for deviations between potential and realized value creation in strategic alliances (Agarwal *et al.*, 2010; Gottschalg and Zollo, 2007).

This operationalization also allows us to address two distinct problems. First, there is no reference in the literature to measuring effort-withholding behaviors at the organizational level; extant studies focus on individuals and use scales developed for that specific analysis level. Our measure represents a first attempt to assess effort-withholding from organizations engaged in such joint endeavors as inter-organizational networks. Second, even when available, administering multiple-item scales in network surveys can be problematic, especially when they entail a focal actor's evaluation of each of the other network members as it requires asking a large number of questions just to assess the construct for one network member.[3] Thus, to avoid respondent fatigue, network studies effectively measure most constructs using single items or questions (cf. Casciaro and Lobo, 2015; Kilduff and Krackhardt, 1994).

[3] Since the required number of questions is equal to the number of items in the scale times the number of network members minus one, using a hypothetical five-item scale to assess free-riding in our study would have entailed asking each organization up to 195 questions just to measure this construct, which could have severely affected data quality.

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By measuring each organization's free-riding using an explicit reference to a baseline—its *potential* contribution—we also avoid a limitation of the scales typically used in the literature to assess effort-withholding, which gauge actors' behaviors without reference to differences in their potential contributions to a joint endeavor (George, 1992), thus not discriminating whether an actor's performance is low because it is withholding effort or because it represents as much as the actor can contribute. Finally, the network design of our data collection allowed us to evaluate the extent to which each organization was withholding efforts from the point of view of multiple raters rather than from just one. This should yield a more accurate measurement than previous research, which typically relied on the perspective of a single rater (e.g., a supervisor's evaluation; George, 1992). Consistent with extant free-riding measures, our measure is perceptual; however, by using the perceptions of multiple raters our approach gets closer to an "objective" rather than "perceived" free-riding (for a similar approach, cf. Kilduff and Krackhardt, 1994), thus removing the potential bias a single rater might bring. To avoid introducing measurement noise due to lack of knowledge about an organization's activities and differences in how closely partners worked together, consortium partners were only asked to rank other members they worked or were familiar with. As a result, each partner received ratings from an average of about 8.5 other network members.

Independent variables

Perceived peers' collaboration

We operationalized network peers' efforts using the intensity of *perceived peers' collaboration*. In measuring this variable we faced two separate issues, pertaining to the identification of network peers and the mapping of such ties.

First, we needed to understand whether partners identified peers on the basis of closeness or role similarity (Shah, 1998). In line with recent work examining effort-withholding (Haas and Park, 2010), we used exploratory interviews to understand which was the better criteria to operationalize peers in our context. Informants gave strong evidence of a commonly shared view that the network featured three distinct types of constituents: universities, which led and coordinated the various projects representing the main thrust of the consortium's endeavors; firms that contributed financially and with feasibility studies; and government agencies, which provided expertise and infrastructures.[4] This well-defined role structure and similarities in core competences meant that network members considered as peers those partners in their same role, thus inferring behavioral norms from the behavior of other organizations of their institutional type, rather than from organizations of different types, however closely connected they might otherwise have been. Actors of the same institutional type understood each other's language, motivations, goals, and predicaments more easily, which made them better choices against which to model and gauge their own behavior, including their decisions as to how many resources to contribute to the joint effort. In general, we observed firms' managers adhering to the market logic of profit-maximization; government agencies' public servants guided by a state logic, aimed at ensuring the safety and welfare of citizens; and university professors' following their own professional logic, with the goal of pushing the scientific frontier. Archival information and primary data from the interviews (see Table 1) confirmed the salience of this classification of consortium members, validating our choice of using institutional type (i.e., university, firm, or government agency) as the criterion for identifying peers.

Second, we needed to identify a suitable way to measure partners' perceptions of the intensity of their peers' collaboration. Given the high level of opacity in the network, we asked informants to report their perceptions about the intensity of collaboration ties *between* and *within* universities, firms, and government agencies, thus capturing such perceptions using Cognitive Aggregated Social Structures (Fonti *et al.*, 2015). Informants were provided with a picture of three blocks, one for each institutional type, and asked to draw lines indicating their perceptions of existing collaboration within and between each institutional type, and alongside each line, to rate its intensity on a seven-point scale (from 1 = Very Low Collaboration to 7 = Very High Collaboration). During the phone interviews, we specified to each informant they could indicate collaboration among the same types of organizations with a "loop" line (starting and ending on the same block)—thus, for example,

[4]This role structure is fairly common and institutionalized among U.S. consortia (cf. Nakamura *et al.*, 1997).

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Table 1. Selected open-ended responses to the question "How would you describe the mission(s) of the consortium?"

Answer[a]	Informant type
"Foster collaborative work among *universities* (for the purposes of improving education of our own students, undergraduate and graduate), *industry* and *government*"	University
"Bringing organizations (*government*/*university*/*industry*) together to focus on various machining issues"	Industry
"Combine and integrate expertise and research efforts from *universities*, *government*, *industry* to improve manufacturing productivity"	Industry
"Combine resources and expertise of variety of *universities*, *government agencies*, *industry partners* on research activities; build on strengths"	Industry
"To provide an environment of collaboration between *industry*, *university* and *government partners* for the purpose of advancing research and the application for agile manufacturing techniques and methods"	Industry
"To pioneer effective means of cooperative research between *industry* and *universities*"	Government Agency
"To perform machine tool research in a collaborative *university* and *industry* environment"	Government Agency
"To collaborate with other *universities*, *government*, *private organizations* to address agile manufacturing needs"	Government Agency

[a] Underlined text elements point to the centrality of collaboration in the consortium; *italicized text* provides evidence of the pervasive view of the presence of three different components—that is, the three different institutional types—in the network.

a loop with the value of 6 starting and ending on "Universities" represented a collaboration flow of strength 6 among universities. We calculated perceived peers' collaboration for each actor as the average strength of the collaboration ties it reported for the type of organization to which it belonged—the sum of the strengths of the collaboration ties for its organization institutional type divided by the number of possible ties. For example, if a firm informant perceived a collaboration tie of strength 3 between firms and universities and between firms and government agencies, and of strength 6 among firms, that actor's perceived peer collaboration score would have been $(3 + 3 + 6)/3 = 4$.

Perceived alliance effectiveness

We measured *perceived alliance effectiveness*—the extent to which partners perceive that a network performs up to its potential in accomplishing its goals and those of its stakeholders—by gauging perceptions of realized versus potential overall consortium performance. This aligns with recent studies stressing the relevance of the gap between *potential* and *realized* performance when investigating partners' willingness to commit resources to a joint endeavor (Agarwal *et al.*, 2010; Zeng and Chen, 2003). Partners were asked to rate the whole consortium potential and realized performance on seven-point scales (from 1 = Extremely Poor to 7 = Extremely Good), and each actor's perceptions of consortium effectiveness was calculated as the difference between these two values. To make interpretation of our results more intuitive, we then reverse-coded this measure so that higher values would indicate higher perceived effectiveness. Using the rating of potential network effectiveness as a baseline in our difference score also allowed us to control for variation in organizations' opinions of how well the overall consortium could fare if working at maximum potential.

Control variables

Network structure

We controlled for network structure by considering members' positions in the communication network. The communication network was collected by providing informants with a roster, including all consortium partners and asking them to estimate how much time their organization had spent communicating with each of the others over a typical month during the previous year. Members central to the network tend to have more accurate perceptions of it (Krackhardt, 1990). Therefore, we included *network centrality*—calculated as indegree—as a control variable in our models (alternative centrality specifications—outdegree and betweeness—did not change our results). We also included *network brokerage* to capture the local network structure surrounding each respondent. Brokerage was

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operationalized using the widely used *network constraint* index (Burt, 1992). This variable, which captures the extent to which an actor is connected to other network actors that are also connected among themselves, approaches one for organizations connected to other organizations that are themselves densely connected, and zero otherwise, allowing us to identify actors with lower network constraint scores as network brokers, that is, actors connecting disconnected parts of the network.

Communication activity

Scholars have recently emphasized the importance of motivational solutions to opportunistic behaviors in inter-organizational networks, and in particular, the role of communication (Agarwal *et al.*, 2010; Zeng and Chen, 2003), which can reorient partners toward cooperation by affecting their perceptions and favoring the development of trust and shared identity (Agarwal *et al.*, 2010; McCarter *et al.*, 2011). Thus, our models included *intensity of task-related communication* between the two partners involved in a focal dyad, measured in minutes over a typical month.

Type of involvement

To control for the type of involvement of the different partners, we included dummy variables to indicate whether a specific organization donated and/or received different types of resources, either financial or in-kind (e.g., facilities, research equipment).

Generalized trust

Partners' *concern for sharing research results with others* was measured using one item rated on a seven-point Likert scale.

Organizations' tenure in the consortium

We operationalized this variable using the number of years organizations had been part of the consortium. As partners that joined the consortium earlier were involved in founding it and shaping its direction, they could have had an additional stake in seeing that it performs well (Olk and Young, 1997). Long-term members have also had more opportunities to forge meaningful collaborative ties and develop trust with other members. Finally, since consortium membership is voluntary, a certain degree of self-selection is likely to have occurred over time, which might make long-time members more likely to be satisfied with network dynamics and organizational outcomes as, otherwise, they would already have left.

Point persons' tenure with organization

As previous research found that individual-level attachments to a relationship might affect termination of joint-venture agreements (Seabright, Levinthal, and Fichman, 1992), we decided to include *point persons' tenure with organization* as a control in our models. This variable was operationalized as the numbers of years served by the point person as a member of his or her organization.

Alter's average free-riding rating

To rule out the alternative explanation that high free-riding on part of each alter is a direct consequence of alters' high perception of free-riding in their local neighborhood, we controlled for the average free-riding rating of each alter.

Organization's institutional type

We included an indicator variable for *organization's institutional type* in our analysis. As different types of organizations might have different incentive structures, and thus, different propensities toward investing in the consortium, we included two dummy variables in our statistical models that took, respectively, a value of 1 if the organization was a university or a government agency, and 0 otherwise.

Estimation procedure

Our dependent variable measures free-riding of each organization (ego) dyadically, that is, as rated by each alter using a Likert scale. Each observation is thus an ego-alter dyad, nested within each rated organization. This data structure might carry two types of bias. First, observations are likely to be dependent within rated organizations (egos). We thus modeled error terms using a variance-components model, estimating our coefficients with a random effect maximum likelihood estimation, specifying error clustering on egos (Rabe-Hesketh and Skrondal, 2008). A second source of bias might derive from alters' different interpretations of the anchors of the Likert scale, as

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each rater is likely to impose his or her weighting on the different options. We included dummy variables for each alter to account for this source of dependence, a common practice when performing regression analysis on dyadic data (Reagans, 2005). Finally, we note that—consistently with our theorizing—our explanatory variables vary at the organizational level, and thus, their coefficients compare effects across organizations (Rabe-Hesketh and Skrondal, 2008).[5]

RESULTS

Table 2 provides summary statistics and bivariate correlations and shows consistency with our hypotheses. While the bivariate correlation of *perceived alliance effectiveness* with *free-riding* is not significant ($p > 0.1$), the positive correlation between its squared term and free-riding ($p < 0.08$) is consistent with the presence of a curvilinear relationship we put forth in Hypothesis 1. Similarly, the bivariate correlation between *perceived peers' collaboration* and *free-riding* is negative ($p < 0.05$), which is consistent with the relationship posited in Hypothesis 2.

Table 3 reports the results of our regression analyses estimating free-riding. Model 1 is our baseline model, which includes all the control variables. Our hypotheses concerning the effects of perceived alliance effectiveness (Hypothesis 1) and peers' collaboration (Hypothesis 2) on free-riding are tested in Models 2 and 3, respectively, while Models 4 and 5 consider both effects simultaneously.

Model 1 shows that free-riding is not associated with institutional type or partners' tenure in the consortium, but organizations whose point people have longer tenure seem to be more likely to free ride ($p < 0.05$) while those receiving in-kind resources are less likely to do so ($p < 0.05$), possibly since receiving such resources might pressure these partners to contribute more effort into the joint endeavor. As for the network variables, neither communication activity nor network constraint seem to be associated with actors' tendency to free-ride ($p > 0.05$), even if their negative coefficients seem to point at the expected directions (more communication should align partners' interests, and the same should be expected for organizations located in denser areas of the network); a similar pattern was observed for those organizations more centrally located in the network, which were less likely to free-ride ($p < 0.05$).

Model 2 tests for the presence of a U-shaped relationship between free-riding and the perception of alliance effectiveness by adding the latter and its mean-centered squared term to the model. The positive and statistically significant coefficient of the mean-centered squared term ($p < 0.05$) supports Hypothesis 1.[6] It is important to highlight that, consistently with our theoretical predictions, our results hold while controlling for *alter's average free-riding rating* (as well as its quadratic term). This shows that a global perception of alliance effectiveness—rather than a local rating of specific partners' free-riding—is what is statistically related to one's free-riding. To test the fit of the quadratic functional form, we compared a model with the quadratic term with a nested model including only the linear effect: a significant log-likelihood test between the two models ($p < 0.05$) demonstrated that the curvilinear model provided a better fit with the data. Moreover, a positive simple slope test ($p < 0.01$) proved that the flex point of the parabola falls within the range of our data with statistical certainty (Aiken and West, 1991). Model 3 introduces our second explanatory variable—perceived peers' collaboration—which shows a negative and statistically significant ($p < 0.05$) relationship with free-riding. This suggests that consortium partners tend not to decrease their efforts when they perceive their peers are actively involved in the network's activities, supporting Hypothesis 2. Results of an incremental likelihood-ratio test between Models 3 and 1 confirmed ($p < 0.05$) that the addition of this explanatory variable significantly enhanced the overall fit of the model.

Finally, Models 4 and 5 are full models that, by simultaneously testing both hypotheses together with the control variables, confirm our previous results and show that the two effects jointly account for a three percent increase in explained variance over our baseline model. Since one of the consortium goals is to transfer knowledge between

[5] We ran a robustness test averaging free-riding ratings at the organizational level. These estimations (available from the authors) confirmed our results, despite sensibly reducing our sample size (N = 38).

[6] While a positive value for the linear term might hint at an exponential relation, since the variable is mean-centered, this simply indicates that the vertex of the parabola is located before the mean—see Figure 1 for a graphical explanation.

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Table 2. Descriptive statistics and correlation matrix[a]

	Mean	>S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Free-riding (ego's rating of alter)	1.10	1.01	0.00	4.00																		
2. Organization's tenure in the consortium	2.96	0.90	0.10	3.92	−0.11																	
3. Point person's tenure with organization	9.79	5.64	0.08	32.00	0.00	0.22																
4. Communication activity	36.24	94.77	0.00	960.00	−0.08	0.13	0.02															
5. Network centrality	11.51	7.57	1.00	31.00	−0.12	0.60	0.31	0.19														
6. Network brokerage	0.24	0.13	0.10	1.00	0.05	−0.53	−0.01	−0.13	−0.64													
7. Organization is a university	0.30	0.46	0.00	1.00	−0.11	0.67	−0.01	0.38	0.64	−0.57												
8. Organization is a government agency	0.08	0.27	0.00	1.00	0.10	−0.41	−0.22	−0.06	−0.26	0.17	−0.19											
9. Organization attends workshops regularly	0.74	0.43	0.00	1.00	−0.06	−0.02	0.28	0.03	0.14	−0.04	0.08	−0.12										
10. Organization donates monetary resources	0.21	0.39	0.00	1.00	0.01	−0.30	0.11	−0.12	−0.25	0.09	−0.35	0.30	0.22									
11. Organization donates in-kind resources	0.19	0.38	0.00	1.00	0.02	−0.24	0.09	−0.04	−0.27	0.25	−0.30	−0.21	0.13	0.42								
12. Organization receives monetary resources	0.48	0.46	0.00	1.00	−0.10	0.52	−0.13	0.17	0.36	−0.46	0.92	−0.45	0.15	−0.28	−0.23							
13. Organization receives in-kind resources	0.30	0.40	0.00	1.00	−0.15	0.27	0.05	0.11	0.29	−0.27	0.42	−0.19	0.39	0.19	0.09	0.47						
14. Concern for sharing research results with others	4.44	1.52	1.00	7.00	0.01	0.05	−0.20	0.04	−0.19	−0.01	0.20	−0.35	−0.07	−0.25	0.06	0.36	−0.09					
15. Perceived alliance effectiveness	1.97	0.76	0.00	3.00	0.04	−0.17	−0.19	−0.06	−0.03	0.12	0.02	0.08	−0.24	−0.22	−0.13	0.01	−0.05	−0.01				
16. Perceived alliance effectiveness (squared)	4.44	2.55	0.00	9.00	0.08	−0.18	−0.21	−0.09	−0.14	0.22	−0.02	0.06	−0.26	−0.26	−0.09	0.01	−0.13	0.14	0.94			
17. Perceived peers' collaboration	3.83	1.62	0.67	6.00	−0.15	0.58	0.16	0.16	0.56	−0.36	0.75	−0.45	0.05	−0.35	−0.15	0.66	0.19	0.25	0.06	0.06		
18. Perceived knowledge transfer	2.18	0.78	0.56	4.33	0.01	0.02	0.07	−0.03	−0.03	0.15	0.04	0.18	−0.20	−0.04	−0.03	0.04	0.09	0.15	0.43	0.43	0.27	
19. Alter's average free-riding rating	1.06	0.62	0.00	2.82	−0.04	0.35	−0.02	0.08	0.17	−0.26	0.34	−0.32	0.02	−0.03	−0.02	0.35	0.10	0.10	−0.58	−0.48	0.24	−0.45

[a] N = 322. Correlations bigger than |0.10| are statistically significant at the 0.05 level.

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Table 3. Results of regression analysis of free-riding[a]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Organization's tenure in the consortium	−0.096	−0.123	−0.072	−0.094	−0.097	−0.142	−0.088
	(−1.091)	(−1.280)	(−0.982)	(−1.155)	(−1.144)	(−1.509)	(−0.863)
Point person's tenure with organization	0.017*	0.020**	0.024*	0.025**	0.024**	0.027**	0.025*
	(1.875)	(2.713)	(2.143)	(2.845)	(2.954)	(2.669)	(1.899)
Communication activity[b]	−0.054	−0.038	−0.050	−0.034	−0.035	−0.012	−0.040
	(−1.385)	(−1.008)	(−1.256)	(−0.866)	(−0.867)	(−0.306)	(−0.798)
Network centrality	−0.021	−0.018	−0.013	−0.012	−0.011	−0.009	−0.008
	(−1.479)	(−1.298)	(−1.025)	(−0.903)	(−0.834)	(−0.451)	(−0.306)
Network brokerage	−0.547	−0.827	−0.190	−0.576	−0.602	−1.081	−0.554
	(−1.069)	(−1.375)	(−0.409)	(−1.036)	(−1.038)	(−1.466)	(−0.8)
Organization is a university	0.639	0.602	0.802*	0.841*	0.821*	0.912*	0.851
	(1.182)	(1.226)	(1.729)	(2.147)	(2.142)	(1.821)	(0.904)
Organization is a government agency	0.175	0.124	0.227	0.169	0.139	0.090	0.152
	(0.793)	(0.663)	(1.138)	(0.974)	(0.679)	(0.454)	(0.616)
Organization attends workshops regularly	0.028	0.032	0.029	0.043	0.051	0.033	0.001
	(0.198)	(0.250)	(0.220)	(0.396)	(0.489)	(0.210)	(0.007)
Organization donates monetary resources	−0.067	−0.022	−0.113	−0.052	−0.053	0.011	−0.034
	(−0.468)	(−0.154)	(−0.786)	(−0.379)	(−0.387)	(0.068)	(−0.162)
Organization donates in-kind resources	0.037	−0.032	0.084	0.041	0.038	−0.020	0.069
	(0.190)	(−0.203)	(0.495)	(0.287)	(0.264)	(−0.132)	(0.333)
Organization receives monetary resources	−0.587	−0.608	−0.480	−0.559	−0.532	−0.647	−0.468
	(−1.204)	(−1.224)	(−1.082)	(−1.340)	(−1.256)	(−1.064)	(−0.538)
Organization receives in-kind resources	−0.334*	−0.258	−0.379**	−0.324**	−0.342**	−0.235	−0.359
	(−2.049)	(−1.623)	(−2.768)	(−2.813)	(−2.773)	(−1.184)	(−1.580)
Concern for sharing research results with others	0.005	−0.026	0.025	−0.008	−0.013	−0.057	−0.015
	(0.125)	(−0.831)	(0.753)	(−0.274)	(−0.407)	(−1.246)	(−0.261)
Alter's average free-riding rating	0.087	0.091	0.080	0.082	0.081	0.084	0.080
	(0.861)	(0.902)	(0.797)	(0.809)	(0.794)	(0.922)	(0.881)
Perceived alliance effectiveness		0.183*		0.205**	0.194**	0.454*	0.232*
		(1.909)		(2.620)	(2.404)	(2.202)	(2.095)
Perceived alliance effectiveness, squared		0.178*		0.183***	0.185***	0.460*	0.207*
		(2.263)		(3.127)	(3.1)	(2.213)	(2.245)
Perceived peers' collaboration			−0.116*	−0.125**	−0.132**	−0.151*	−0.165**
			(−2.189)	(−2.903)	(−2.654)	(−1.841)	(−2.442)
Perceived knowledge transfer					0.028		
					(0.401)		
Dummy variables for alters (raters)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.440**	1.527***	1.344***	1.496***	1.502***	–	1.596**
Observations	322	322	322	322	322	322	322
Number of clusters (organizations)	38	38	38	38	38	38	38
R-squared	0.367	0.382	0.379	0.395	0.395	0.361	0.390
Sargan/Hansen test of overidentifying restrictions (p-value)	–	–	–	–	–	0.386	0.481
Estimation procedure	xtreg	xtreg	xtreg	xtreg	xtreg	ivreg2	xtivreg
Random effects	Yes	Yes	Yes	Yes	Yes	No	Yes
Robust standard errors	Yes	Yes	Yes	Yes	Yes	Yes	No
Clustered standard errors	Yes	Yes	Yes	Yes	Yes	Yes	No

[a] z-scores are in parentheses. Reported coefficients are not standardized.
[b] Coefficient multiplied by 100.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; one-tailed tests for hypothesized effects.

partners, Model 5 includes *perceived knowledge transfer* as an additional predictor. Paralleling our process for perceived peers' collaboration, we assessed this factor as the average strength of each partners' perceptions of knowledge transfer ties among and between universities, firms, and government agencies. Results did not affect our main findings, and showed that perceptions of peers' knowledge transfer in the network were not statistically related to free-riding ($p > 0.10$).

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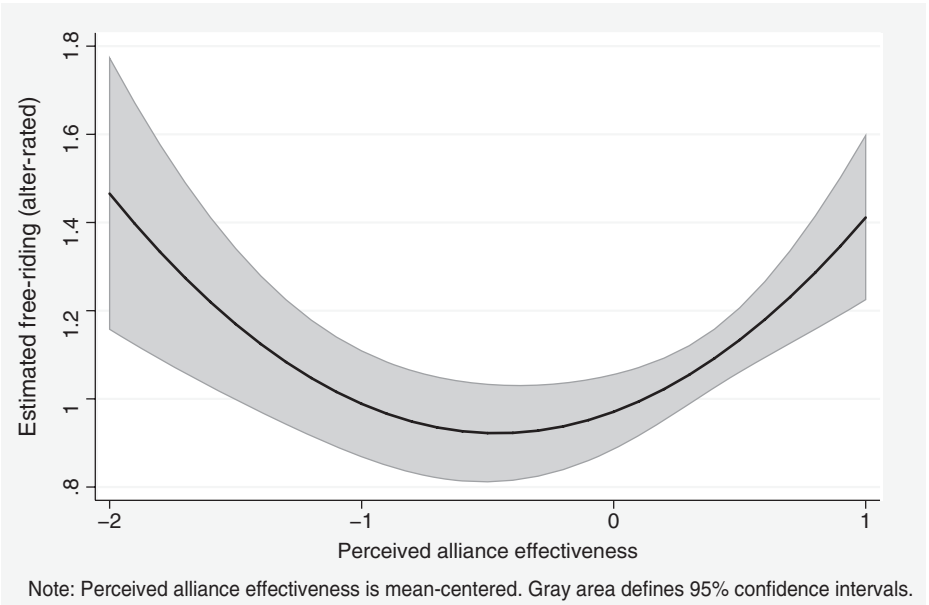

Figure 1. Estimated relationship between free-riding (alter rated) and perceived alliance effectiveness (results from field data regression analysis)

We assessed the statistical validity of our analysis by running regression diagnostics to check if our data met model assumptions. Multicollinearity was not an issue as the average VIFs of our models were low (1.69). We also controlled for the influence of outliers by running alternative models using robust regressions, which substantially confirmed our results. To provide additional detail, we plot our findings about the U-shaped effect hypothesized in Hypothesis 1 in Figure 1, which relates partners' propensity to free-ride (y-axis) to their perception of network effectiveness (x-axis). It is worth noting that, since the latter is mean-centered, zero on the x-axis corresponds to the mean. As the flex point of the parabola is located left of the mean, the "sucker effect" (Schnake, 1991) seems to trigger free-riding only where levels of network effectiveness are relatively low.

It is important to note that, when perceived alliance effectiveness and perceived peers' collaboration are both high, our two hypotheses predict opposite tendencies with respect to effort-withholding behavior. We thus calculated the net effect of these opposite tendencies by estimating the additive effects of our explanatory variables on free-riding at one and two standard deviation increments from their mean. Results show that one standard deviation increase both in perceived alliance effectiveness and perceived peers' collaboration results in a 0.06 standard deviations increase in free-riding, which suggests that in such condition, our two hypotheses effectively offset each other. A more significant increase of two standard deviations in our independent variables positively impacts free-riding by 0.33 standard deviations. In both cases, it appears clear that the peer pressure exercised by organizations of the same type has a strong effect in hindering free-riding at high levels of perceived performance. We further elaborate on this finding in the Discussion section.

Endogeneity and causality: two-stage regression models and experimental vignette studies

Two-stage regressions

Even if causality claims were not part of our theorization, we acknowledge an important limitation of our analysis in the lack of identification of the direction of causality between perceptions and behaviors. We thus ran a two-stage least-square (2SLS) regression to generate initial evidence that perceptions of peers' collaboration and overall alliance performance actually drive free-riding. Since our data lacked an exogenous source of variance, we selected a set of instruments that have "a logical relationship with the endogenous variable, [and are] correlated with the dependent variable only through the endogenous variable"

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(Bettis *et al.*, 2014: 951), an approach adopted by other social network researchers to attenuate endogeneity concerns (cf. Tortoriello, 2015).

Our selection of instruments was guided by well-established social contagion theories, which posit that "attitudes of the others to whom they are directly connected influence network members" (Monge and Contractor, 2003: 174). Thus, in network terms, perceptions are "clustered" around each network node: due to social influence, egos' beliefs are likely to be correlated with their neighbors' ("alters" in network terminology). Leveraging this fact, we base our two-stage modeling on the assumption that alters' perceptions of alliance effectiveness and peers' collaboration are correlated with the corresponding perceptions of ego (first stage), which in turn, should affect ego's behavior (second stage).

We have thus constructed a set of instruments to measure alters' perceptions to employ in our first stage. Two new variables were featured: the first, *alters' weighted average perception of alliance effectiveness*, was calculated—for each ego i—as:

$$\frac{\sum_{j}^{J} comm_{ij} perc - eff_j}{J},$$

where J is the number of ego's alters (the neighboring organizations connected to ego in the communication network) and $perc\_eff_j$ is the perception of alliance effectiveness of each alter j. Each perception is weighted by the relative amount of communication between each ego i and each alter j ($comm_{ij}$), following the idea that greater communication between two actors would make their perceptions more similar (Monge and Contractor, 2003). The second variable, *alters' weighted average perception of collaboration of egos' peers*, was calculated following the same logic, featuring alters' perceptions of collaboration of egos' peers instead of their perception of alliance effectiveness. Finally, we also included the *number of alters* and the *percentage of alters in egos' roles* (i.e., university, government agency, and firm) in our set of instruments as we believe these variables could also influence egos' perceptions and so, indirectly, their behaviors.

Model 6 presents our two-stage instrumental variable estimations, where *perceived peers' collaboration*, *perceived consortium effectiveness,* and *perceived consortium effectiveness (squared)* were treated as endogenous. The validity of our instrument set was confirmed by various tests. A significant test ($p < 0.001$) using the Wald F statistic rejects the null hypothesis that our instruments are weak—in fact, our instrument set consistently explained more than 60 percent of the variance in our first-stage models. A nonsignificant ($p > 0.05$) Sargan-Hansen test increases our confidence that the instruments were not correlated with the error terms, and are thus valid. The coefficients reported in Model 6 confirmed our results; furthermore, Model 7 replicates the two-stage model with the inclusion of random-effects. While we do not claim that these additional tests provide strong evidence for causality, they show consistent results under stricter model specifications and aligned with the predictions of established theories, and thus, help ruling out alternative explanations (Bettis *et al.*, 2014; Tortoriello, 2015).

Experimental vignette studies

To provide additional support for the directionality of our findings, mitigate concerns of omitted-variable and common method bias, and rule out alternative explanations, we used experimental vignette methodology (EVM; Aguinis and Bradley, 2014) to conduct two experiments where we asked participants to allocate resources as part of a multi-party alliance (for a similar approach, cf. Casciaro, Gino, and Kouchaki, 2014). In each experiment, we randomly assigned participants to different conditions to test the influence on free-riding of their perception of alliance performance (Hypothesis 1; Study 1) and of peers' collaboration effort (Hypothesis 2; Study 2). We recruited 879 participants on Amazon's Mechanical Turk (61.4% male; 41.9% with budgeting experience; mean age = 34.1, s.d. = 11.07; mean years of work experience = 11.07, s.d. = 9.16), a common procedure for multi-method studies that include an experimental vignette component (cf. Casciaro *et al.*, 2014). To further test the robustness of our findings, we used a different outcome measure that directly assesses the level of alliance involvement in terms of resources invested using a four-item scale (Cronbach's alpha: 92%). OLS estimations performed in Study 1 confirmed the support for Hypothesis 1 (n = 677; $p < 0.001$). The estimated curvilinear relationship is displayed in Figure 2.

In comparison to Figure 1, which estimated the same relationship using field data, the experimental

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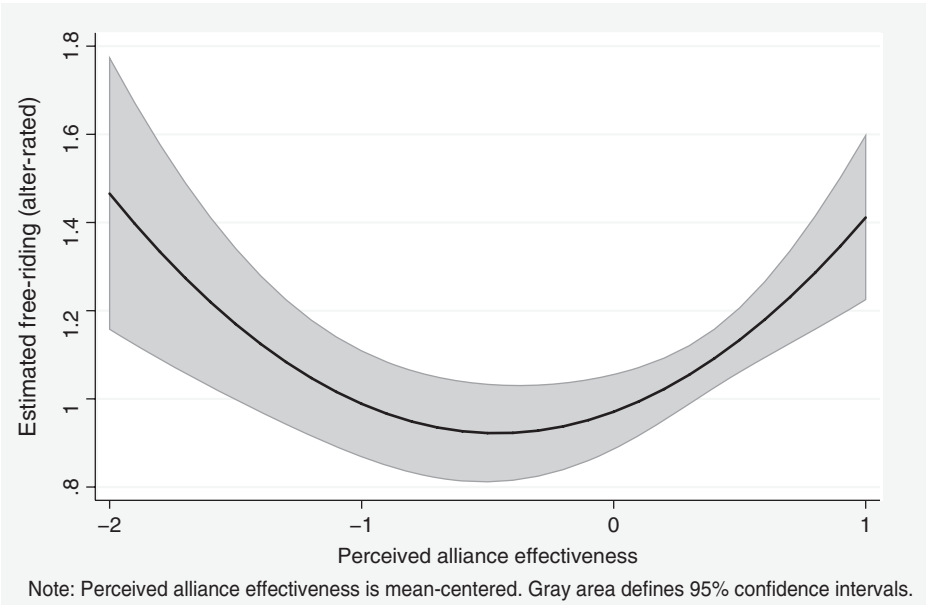

Figure 2. Estimated relationship between free-riding (ego investment) and perceived alliance effectiveness (results from experimental vignette study)

evidence seems to suggest a weaker increase in free-riding at high levels of perceived alliance performance. We discuss the theoretical implications of this difference in our Discussion section. Our second hypothesis (Hypothesis 2) was also supported by the experimental evidence provided by Study 2, confirming that partners are less likely to free ride as their perception of peers' collaboration increases ($n = 202$; $p < 0.001$). In this case, the resulting standardized coefficients are very similar across the experimental versus the nonexperimental setting (-0.18 versus -0.21). A full description of Study 1 and 2 is provided in the Appendix S1.

DISCUSSION

Since the success of alliances as governance forms is predicated on the strength of their members' voluntary and fair contributions, by detailing the relationships between free-riding and partners' perceptions of both overall alliance effectiveness and peers' collaboration, we take an important step toward a better understanding of the behavioral factors that may affect the performance of multi-party alliances. Our study starts to "unpack" the black box that has, until now, generally assumed rather than directly analyzed opportunistic tendencies and behaviors in multi-party alliances. While the literature on alliances theorizes about mechanisms leading to alliance withdrawal or "shirking," it rarely (if ever) empirically investigated the amount of effort withheld by the various parties, instead focusing on whether the collaboration is initially enacted and/or maintained from a rational actor perspective. While our findings are consistent with a view that organizations' investment decisions are deeply rooted in their desire to maximize the utility of their resources, we also highlight how socio-psychological mechanisms such as perceptions, subjective interpretations (Gulati *et al.*, 2012), and social comparisons (Festinger, 1954) affect their effort-allocating decisions. By doing so, we complement current theories positing the role of *ex-ante* structural and motivational governance solutions by highlighting how *ex-post* socio-psychological mechanisms also play important roles in the allocation of effort in inter-organizational networks. In providing insights into the behavioral and cognitive underpinnings of strategic decision making, we answer recent calls to move toward a behavioral approach to strategic management (Gavetti, 2012; Levinthal, 2011). In particular, by showing that both rational (Olson, 1965), relational (Gould, 1993), and behavioral (Festinger, 1954) mechanisms influence free-riding, we overcome the false dichotomy between rational and behavioral mechanisms underpinning strategic

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actors' choices (Levinthal, 2011), thus offering additional evidence for the importance of the cognitive micro-foundations driving strategic decisions. Finally, our work represents a rare empirical analysis of the factors associated with free-riding at the inter-organizational level in a natural setting, as work on effort-withholding in alliances is either theoretical (cf. Zeng and Chen, 2003), based on simulations (cf. Gould, 1993), or on lab experiments (cf. Agarwal *et al.*, 2010).

Contributions to the literature on multi-party alliances

We believe our results carry at least two important implications for the literature on multi-party alliances. First, by combining primary field data with an experimental setup to provide evidence of a U-shaped relationship between perceived alliance effectiveness and free-riding, we offer a robust empirical evidence of the nonlinearity of the link between perceptions and behaviors in multi-party alliances, which includes preliminary support for the presence of a causal relationship between the two. In doing so, we provide empirical evidence and new theoretical directions for the "social dilemma" approach (Zeng and Chen, 2003), which postulated the primacy of perceptions in determining the level of cooperation in multi-party alliances. The comparison of the two U-shaped functions resulting from our field data (Figure 1) and experimental evidence (Figure 2) is also interesting, as the latter shows much less "bending" than the former. Such difference can be interpreted both empirically and theoretically. From the empirical standpoint, one could argue that Figure 2 depicts a much purer relationship between the two variables than Figure 1 as the experiment purges the results from endogeneity and omitted variable bias. However, such comparison also provides grounds for theoretical speculations, based on the fact that free-riding in Figure 1 is rated by alters, while in Figure 2 it is measured directly as a given partner's investment decision. We thus might infer that even small reductions in one's investments (right end of Figure 2) get severely amplified in observers' perceptions (right end of Figure 1). Thus, when the alliance performs well, even a small level of effort withholding by a given partner might have severe repercussions in terms of others' judgment of its behavior. The opposite is true when the performance of the alliance is very low as a comparison of the left side of the two curves seems to indicate that partners' are not as harshly judged when they withhold efforts in low performing alliances. While these speculations are intriguing, more research is needed to shed light on the relationship between internal decisions and their repercussions in terms of external perceptions of a given partner's behavior.

By exploring the overlooked issue of partners' heterogeneity (Phelps, 2010), our study provides a second important contribution to the multi-party alliances literature. Partners' heterogeneity is a central aspect that distinguish dyadic from multi-party alliances as the latter feature a wider array of partner organizations that vary not only in their size and resource availability, but also in their objectives, and most importantly, in the logics that determine their interests and systems of incentives. We found this to be particularly relevant when organizations from different institutional sectors—the state, the market, and the professions—join the same alliance. Our results show that the norms embedded in the logics unique to each sector curb organizations free-riding through what we labeled as peer effects. Our findings indeed emphasize the importance to partners of the perceived behaviors of their peers, which might affect the focal partner even if they are not directly working together. For instance, let us assume that university U1 is collaborating with companies C1 and C2, university U2, and government agency G1 on a specific project within the consortium. Our results show that U1 gauges its involvement on the perceived effort exerted in the joint endeavor by its peers (other universities of the consortium, such as U2, U3, etc.), whether or not they work on the same projects.

The magnitude of such effect is also relevant. At one standard deviation increases in both our independent variables, the effect of perception of peers' collaboration offsets that of overall alliance effectiveness. While at two standard deviations increases in both variables, perceived alliance effectiveness has a stronger effect than perceived peer collaboration (as we observe a net increase of 0.33 standard deviations in free-riding), this might be linked to the multiple contingencies that characterize the latter effect, such as the level of identification with and visibility of one's peers and the type of control they exert. Further studies looking into how such contingencies affect the relative magnitude of alternative drivers of network evolution (Ferriani, Fonti, and Corrado, 2013) might help to better understand outcome heterogeneity in multi-party

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alliances. This finding also highlights the powerful impact that institutional processes—in particular, taken-for-granted institutional logics (Jones *et al.*, 2012)—have on organizations' strategic decisions. In this sense, our findings contribute to further integrate neo-institutional theory into mainstream strategic management theories (Oliver, 1997).

Managerial implications

Our results carry practical relevance for managers of organizations involved in multi-party alliances and for those responsible for their governance. Perceptions of poor alliance effectiveness might signal that the network is entering a vicious cycle, where low alliance effectiveness and free-riding may reinforce each other. In such a case, managers may need to reassess the relevance of that alliance for their organization. If critical, they should act purposefully to reduce free-riding, especially among their peers (whom they may influence directly); otherwise, they might consider leaving it, rather than wasting further resources on an endeavor whose problems might soon worsen. When perceived alliance effectiveness is low, managers responsible for network governance should spur collaboration and act to reduce free-riding. However, driving up members' perceptions of overall alliance effectiveness too far might also lead to the reemergence of free-riding. This double-edged effect might be avoided by using impression management techniques to lower members' perceptions of alliance effectiveness (e.g., using signals or spreading rumors minimizing alliance success): By keeping partners from perceiving the alliance as "too effective," this should reduce free-riding tendencies. Such advice may be even more critical for consortia: As these governance forms are characterized by very weak productivity incentives (Makadok and Coff, 2009), leveraging perceptions might be one of the few tools their managers have to influence the level of members' participation. In our case, given how people react differently to incentives framed positively (as bonuses) rather than negatively (as penalties), such possibilities might include adding a "thematic workshop" to those periodically scheduled to disseminate results among a specific set of partners, or allowing more people from the same partners' institutional type to attend scheduled workshops.

Limitations and future research directions

This study has a number of limitations that should be discussed. As the complexity of securing repeated access to large corporations and government agencies made collecting longitudinal data unrealistic, our data were only cross-sectional. This severely limits our ability to theorize about the *recursivity* among partners' effort allocation decisions and their perceptions of alliance effectiveness. Partners' allocation decisions hinge on their perception of alliance effectiveness, but are also influenced by the perceptions of the effort put forth by their partners. In turn, such decisions influence their partners' perceptions of alliance effectiveness as well as by changing their commitment to the alliance. While the recursivity concern is alleviated in our context due to the opacity of the multi-party alliance we investigated—which reduces partners' ability to gauge their investment in the consortium on the investment of other partners—longitudinal data are needed to truly unpack such relationships. Due to the complexity of considering recursivity of perceptions and behaviors among several partners, scholars might consider using computer simulations to assist in investigating such issues in multi-party alliances.

While recent studies suggest that common method variance (CMV) only rarely biases analyses to the extent of invalidating theoretical findings (Doty and Glick, 1998), CMV might still be seen as a problem in our study since our all data were collected using the same survey. However, we believe our data are relatively robust to CMV because of the diversity of sources from which they originated (independent and control variables came from the focal firm's assessments, while the dependent variable was operationalized using other partners' responses), the lack of social desirability or negative affectivity connotations for most of them (Brannick *et al.*, 2010), and the use (when available) of multiple referents from each organization (Xia *et al.*, 2012). Finally, low correlations among most of our variables were further evidence of the absence of significant CMV in our study (Brannick *et al.*, 2010).

Partners' heterogeneity might also affect organizations' effort allocation. While we accounted for time heterogeneity (controlling for partners' time of entry in the consortium in our models), other differences between partners might contribute to their decision to free-ride, such as the presence of

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direct competitors in the alliance or their degree of dependence on the technology that is being developed (such as in the case of startup partners, which are likely to be more committed even in the case of low performance due to their dependence on the technology being developed). While most partners in our consortium were major players in their field, and rivalry was not an issue as the consortium's goal was to develop basic technology, future studies might investigate other multi-party alliances to ascertain the role that different types of partner heterogeneity play in their effort allocation decisions.[7] Also, while technology-developing consortia typically require the active involvement of all partners, "scaling down" efforts is acceptable in other types of consortia, such as those developing new standards. This highlights that several alliance characteristics, such as freedom to enter or exit, the existence of different types of roles (for instance, the presence of noninvesting observer organizations), or the technological versus standard setting nature might very well impact the expected outcomes of our theoretical claims. Future studies should investigate these different types of alliances—as well as inter-organizational networks that are temporally bounded such as those that are project or event-based (Maoret, Massa, and Jones, 2011)—to assess our findings' generalizability.

While we used a two-item scale to assess free-riding, a scale with more items might have yielded a more accurate measurement. However, this would have come at the expense of overall data quality due to respondent fatigue. The research design of network data collections makes the use of multi-item scales problematic, as they quickly lead to respondent fatigue and poorer data quality. Thus, while it remains a limitation of our measure, our choice reflects a common trade-off in social network studies (Labianca and Brass, 2006), which tend to use either one-item (cf. Labianca, Brass, and Gray, 1998) or at best two-item scales to measure a construct (cf. Hansen, 1999).

We also assessed free-riding by gauging the difference between potential and actual performance rather than resource contribution. While we acknowledge that these two constructs are not perfectly correlated, using the gap between potential and actual performance as a proxy for effort withholding is in line with recent work that has associated low performance to perceived opportunism (Agarwal *et al.*, 2010; Gottschalg and Zollo, 2007). To strengthen the construct validity of our study, in the experiments we assessed free-riding more directly—that is, in terms of resource contribution. The fact that our results were confirmed using different operationalizations of free-riding increases the construct validity of our measures.

[7]We are indebted to an anonymous reviewer for bringing this potential issue to our attention.

Conclusion

Free-riding is a common behavior in multi-party alliances and other types of inter-organizational networks. By theorizing and offering evidence for the relationship between partners' perceptions and their effort-withholding behaviors in multi-party alliances, we have identified another mechanism that may affect free-riding, thus advancing our understanding of organizations' decisions to commit or withhold their efforts.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix S1. Experimental procedure.