

**Bringing Tasks Back In: An Organizational Theory Of Resource Complementarity
and Partner Selection**

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ABSTRACT

To progress beyond the idea that the value of inter-firm collaboration is largely determined by the complementarity of the resources held by partners, we build a theoretical framework that explains under which conditions a set of resources or capabilities can be considered as complementary and resulting in superior value creation. Specifically, we argue that the tasks that an inter-firm collaboration has to perform determine complementarities, and that complementarities arise from similar and dissimilar resources alike. We capture this relationship in the concept of task resource complementarity. Further, we examine factors that impact on the relevance of this construct as a predictor of partner selection. Finally, we discuss which implications arise for a theory of the firm when tasks are explicitly incorporated into the conceptualization of resource complementarity.

Keywords: complementarities; organizational design; interorganizational relationships

BRINGING TASKS BACK IN: AN ORGANIZATIONAL THEORY OF RESOURCE COMPLEMENTARITY AND PARTNER SELECTION

Since approximately the early 1990s, management research has emphasized the key role of resources in enhancing the likelihood of firm survival and supernormal returns. Scholars initially directed their attention to those characteristics by which resources bring about significant performance consequences (Barney, 1991; Barney, 1986), but soon afterwards noticed the importance for that purpose of the patterns of connection across resources (Dierickx & Cool, 1989; Reed & DeFillippi, 1990). Whether focused on particular resources or on their linkages, one line of investigations concentrated on firms' internal resources. In parallel, another stream of research brought about the awareness that a firm's critical resources may also span firm boundaries (Dyer & Singh, 1998). As a result, the idea that inter-firm *resource linkages* are one important source of idiosyncrasy has become common wisdom, and countless studies attest to the idea that inter-organizational relationships are *loci* of creation of competitive advantage.

The concept of *complementarity* is frequently invoked to describe the advantages of combining resources in particular ways, and a number of organizational consequences have been ascribed to it (Adegbesan, 2009; Richardson, 1972; Stieglitz & Heine, 2007). We argue that despite its intuitive appeal and the attention it has attracted, the concept of resource complementarity is still insufficiently analyzed, and that this partial understanding limits the possibility of exploiting resource linkages more effectively.

In what is probably the most common conceptualization, complementary resources are defined as those that together generate superadditive value – rents that exceed the sum of the rents obtainable from standalone resources applications. Uncontroversial as it may seem, this definition poses considerable challenges. An obvious one is that of escaping the

tautology that arises whenever a relationship is argued to exist between resource complementarity, defined in outcome terms, and its performance consequences (Tanriverdi & Venkatraman, 2005). Another is how to select among alternative complementary combinations. If the value that each of them brings about can be calculated, then knowing that they are complementary represents redundant information. If, instead, it is not known, then the questions arise of how complementary resources can be identified as such, and of how to select among alternative superadditive combinations. Indeed, it has been claimed that recognizing the potential value of resource combinations with complementary partners is one of the principal challenges that firms face when they attempt to better exploit their resource bases through inter-organizational relationships (Dyer & Singh, 1998).

While we broadly agree with this assessment, we argue that the challenge is more fundamental than developing the capability to search and evaluate potential partners. As indicated above, the problem we face is to define resource complementarity independently of its effects (Davis & Thomas, 1993). For this purpose we develop a concept of resource complementarity that is more heuristic than extant ones, and that seems to match some of the methods by which firms engaging in collaborative partnerships screen each other. The concept we propose is based on the idea that resources are complementary – and therefore capable of generating greater value – only in view of the specific task for which they would be jointly deployed, and only in comparison with other combinations of resources and tasks. Put differently, no two resources are complementary *per se*, or by nature, but only in their association for the execution of a specific task. Thus, the resulting concept of resource complementarity is a ternary relationship between sets of resources and the task for which they are used.

The three-way relationship we propose is in line with recent thinking on complementarity in general (Ennen & Richter, 2010), which advocates a more contextual

view of this construct. Our concept moreover attaches a greater importance to an element that is, to all evidence, the very reason why resources are usually combined (Inkpen, 2001), yet which is at best implicit in, if not wholly absent from, extant conceptualizations of complementarities – namely, the task. Even those studies that are more clearly rooted in the organizational theoretical tradition and that analyze resource complementarity as “strategic interdependence” (e.g., Gulati & Gargiulo, 1999), in the ultimate analysis have not significantly leveraged the concept of task. The theory developed in some recent work indicates a growing awareness of the role that tasks have in shaping the relationship itself (see, for example, Garrette, Castañer & Dussauge, 2009; Mitsuhashi & Greve, 2009). Yet in empirical applications, complementarity is still typically operationalized as a dyadic relationship among resource sets.

The concept of complementarity has found applications in a variety of situations, and it has been used to describe the relationships between a host of organizational factors. Therefore, when proposing substantial amendments to it, it is tempting to aim at overly general conceptualizations that apply to combinations of *any* elements of strategy. Instead, we propose the concept of *resource* complementarity, which obviously has less broad applicability – though still a very wide one. We do so because we think that the limited usefulness that the concept of complementarity has had so far is largely due to its being too generic, and to making insufficient distinction between the level of resources and the level of activities. Moreover, one of the terms of the ternary relationship under discussion – the task – only makes sense if the other terms of that relationship can be meaningfully related to it. This is the case for resources, but it is not for other elements of strategy, unless the concept of task is stretched beyond recognition.

To gauge the usefulness of the construct we propose, we shall discuss its relationship with the nomological network of one perspective that assigns an important role to resource

complementarity, namely the relational view of competitive advantage (Dyer & Singh, 1998). Therefore, in keeping with the key concern of that perspective, we develop resource complementarity as an inter-organizational construct, and we investigate its importance for the selection of the partner of a (task-based) relationship. In fact, if relationships are one of the *loci* in which rents are generated, it is arguably of paramount importance to understand *which* relationships to establish. By relationship we mean a pooling of the services of poorly tradable resources by two organizations, and the accompanying exchange of obligations and coordination mechanisms. Two restrictions are implicit in this approach. First, we focus on resources that are to some extent *specific*, at least in terms of the timing, the place and/or the amount of their application. Resources that are completely non-specific can be the object of discrete transactions that scarcely require the underpinning of a business relationship (Williamson, 1979). Second, in line with Dyer and Singh (1998), we focus – at least as a first take – on resources that are *accessed* through relationships, but that do not change ownership. These restrictions still identify a huge domain of application, encompassing most forms of inter-firm cooperation.

Whether in the sense of superadditivity or in the one that we are going to develop, the concept of resource complementarity can be understood, at least metaphorically, as a “force of attraction” between different resources, or sets thereof. One may wonder, therefore, if and under what conditions this force provides enough incentive not just for the formation of a specific inter-organizational relationship, but for the consolidation of resources under unified ownership. We will discuss when this is the case, and therefore under what conditions resource complementarity helps explain the resource boundaries of the firm.

We build our theory in five steps. First, we take a closer look at the concepts of resource complementarity that are in currency in strategy and organization research, and how they are applied in the prediction of inter-organizational processes and outcomes. We then

discuss why harnessing tasks and the resources required for their execution helps overcome limitations in those conceptualizations; and how partners in real-world business relationships actually leverage tasks to identify complementary resources. Third, by examining the relationship between tasks and resource endowments we articulate a set of conditions for superior resource combinations. This enables us to define the task resource complementarity construct and to articulate its constituting dimensions. Furthermore, we discuss task and resource-related reasons that moderate the importance of this concept as a predictor of the identity of the partners of a business relationship. Finally, we discuss some resources complementarity implications for the theory of the firm.

THEORETICAL PERSPECTIVES ON INTER-ORGANIZATIONAL RESOURCE COMPLEMENTARITY

In very general terms, complementarity can be defined as a “beneficial interplay of the elements of a system, where the presence of one element increases the value of others” (Ennen & Richter, 2010). In principle, such a concept can be applied not only to resources and not only to inter-organizational relationships, but to anything that is usefully analyzable as a system of interrelated elements. Indeed, in the managerial literature alone, complementarity among resources or among elements of organizational architecture has been argued to predict a variety of organizational outcomes, such as the sustainability of competitive advantage (Reed & DeFillippi, 1990; Rivkin, 2000; Siggelkow, 2002), rent appropriation (Adegbesan, 2009; Teece, 1986), superior innovation outcomes (Tzabbar, Aharonson, Amburgey & Al-Laham, 2008), the interdependence of organization design choices (Milgrom & Roberts, 1995), reduced organizational change (Roberts, 2004), resource lock-in (Stieglitz & Heine, 2007), and alliance formation (Richardson, 1972). The range of business phenomena to which the complementarity viewpoint has been applied includes

multi-business firms, mergers and acquisitions, human resource systems and, of course, strategic alliances and inter-organizational relationships.

This breadth of applicability attests to the importance of the concept. At the same time it bears out how the complementarity perspective has not been developed beyond the stage of a meta-theoretical approach (Ennen & Richter, 2010). An essential requirement for establishing the concept of resource complementarity on firmer ground – thereby facilitating the possibility to exploit the concept as a reliable source of relational rent – is to inquire into the sources of complementarity (Davis & Thomas, 1993) and thereby to define the concept, independently of its effects. In the remainder we plan to undertake such an investigation and to perform it in reasonably general terms. Yet we think that any attempt to attribute all types of “beneficial interplay” to a single source, independent of the nature of the interacting elements, is likely to prove a futile exercise. We therefore focus specifically on *resource* complementarity, and from the managerial literature we review selected conceptual and empirical work that discusses this concept.

The idea that resource complementarity is a driver of certain actions by organizational actors can be traced back to the resource dependence theory (RDT), which developed the organizational consequences of Emerson’s (1962) theory of social exchange. The key theoretical claim of the RDT is that the need to pursue certain objectives makes an organization dependent on others that have the necessary resources and capabilities, and creates incentives for the organization to eliminate, by means of unilateral or bilateral tactics, the uncertainty that dependence implies (Pfeffer & Salancik, 1978). A number of empirical investigations have demonstrated that resource dependence does trigger important organizational actions, thus indicating that focusing on inter-organizational relationships defined in terms of resource exchange constitutes a fruitful line of enquiry. However, it is also apparent that the concept of complementarity that is implicit in these RDT studies is not

the one that the relational view assumes. For one thing, in the RDT resource interdependence exists and is defined primarily in terms of inter-sectoral rather than inter-firm transactions (Pfeffer, 1987). In addition, at least in early applications of this perspective, the types of dependence addressed were typically those associated with financial constraints and with fungible resources.

These issues have been addressed to some extent by a more recent wave of empirical investigations that are indebted to the RDT (Chung, Singh & Lee, 2000; Gulati, 1995b; Gulati & Gargiulo, 1999). First of all, in these studies resource complementarity is specified as an inter-organizational dyadic construct. Second, in Gulati and Gargiulo (1999), complementarity is explicitly ascribed to the “filling of a gap”: a conceptualization that provides a basis for observing it independently of its outcomes.

Given the difficulty of measuring resources and capabilities directly, in this literature resource complementarity and the strategic interdependence that it engenders have been operationalized as niche (non) overlap, on the assumption that firms operating in different niches possess different sets of resources and capabilities; and on the assumption that this differentiation enhances their complementarity and increases their mutual dependence.¹ This operationalization has not entirely escaped criticism. For example, it has been noted that firms can occupy non-overlapping niches without being complementary to one another (Rothaermel & Boeker, 2008), and that the stronger attraction that is observed between non-overlapping firms may depend on their conflict of interests being low, rather than on a positive interplay of their resource bases (Gimeno, 2004). Another undesirable, though certainly unintended consequence of this operationalization is that it may have helped reinforce a trend in the literature to focus overwhelmingly on interactions of dissimilar resources (Das & Teng, 2000), based on a common understanding that the “elements involved in the emergence of complementary relationships are of a heterogeneous nature”

(Ennen & Richter, 2010: 225). Although some notable exceptions in the literature suggest that a similarity of resource profiles facilitate inter-firm collaboration (e.g., Pfeffer & Nowak, 1976; Mowery, Oxley & Silverman, 1996; more recently Lane, Salk & Lyles 2001 and Ahuja, Polidoro & Mitchell, 2009), the field seems to have become rather skeptical about the possibility to create value through combinations of similar resources.

Nevertheless, there are multiple reasons why synergistic effects may be expected to follow from the pooling of similar resources. One of these reasons is that the minimum efficient scale required by a certain production process exceeds the level that is feasible with the resource endowments of one focal firm (Hennart, 1988). A second one relates to the opportunity for a firm to learn from a partner endowed with similar resources (Cohen & Levinthal, 1990; Lane, Koka & Pathak, 2006; Luo & Deng, 2009). A further case is when the combination of compatible resources facilitates the provision of products of consistent quality, and simplifies the governance of the relationship by equalizing inducements and contributions (Mitsubishi & Greve, 2009). Drawing on the implications of these studies, we argue that both similar and dissimilar resources can interplay beneficially.

A parallel line of inquiry on resource complementarity, quite independent of the RDT paradigm, has been pursued within the international business literature. Noting that merely advising a firm's management to seek "a partner with complementary capabilities" offers little guidance on which specific capabilities a potential partner should provide, some studies in this field have undertaken to determine what actually makes up complementarity. This literature has identified task characteristics as one critical determinant of the success factors for a venture, and therefore of the criteria that should guide the search for an alliance partner and for its resources and capabilities (Geringer, 1991). In our view, this suggestion is an important contribution as it clarifies the sources of the motivational investments toward complementary resources; something that had not been adequately explicated by the RDT.

This intuition, however, has not been elaborated further. Complementary partners are defined simply as those that are able to provide those task-related skills and resources that are necessary to fill the capability gaps of the focal firm.

Partly for these reasons, and despite Geringer's contribution and those of a handful of studies that tested his propositions (Glaister & Buckley, 1997; Luo, 1997; Roy, 2012), the view that resource complementarity is critically shaped by task requirements does not appear to have become common wisdom. Nonetheless, there appears to be a growing awareness in the field that comparing resource pairs, not otherwise dimensionalized but simply on the basis of their degree of similarity, does not warrant valid conclusions about the value that can be obtained from each combination, not even in simple comparative terms. Some authors of the literature on complementarities suggest that the terms of the comparison should be expanded to include a third factor (Matsuyama, 1995), and that the analysis of complementarity should "take the critical role of contextuality into account" (Ennen & Richter, 2010: 224). In our view, the task captures much of the contextual aspects that are relevant for the assessment of resource complementarity, as the next section seeks to demonstrate.

THE TASK-RESOURCE DEPENDENCE AND VALUE CREATION

Tasks are pervasive in the conceptualization and the methodologies of nearly all major areas of managerial research. On a rare but influential occasion where the meaning of the concept was made explicit, Dill (1958: 411) defined the task as "a cognitive formulation consisting of a goal and usually also of constraints on behaviors appropriate for reaching the goal". Although organization studies have also seen somewhat different uses of the term, there now appears to be a consensus on the fact that the core components of an adequate task definition consist of a certain predefined objective, along with certain requirements

concerning the resources and the actions required for accomplishing the goal (Hackman, 1969; MacGrath, 1984; Zigurs & Buckland, 1998).

There are a number of aspects in this conceptualization that need to be emphasized. The first is the cognitive nature of tasks. In this sense, a task is akin to a “theory”. The content of this theory is a rational connection between means and ends. In various domains of practice this connection is often explicitly stated when communicating tasks to other organizational actors.² The second aspect to emphasize is that this conceptualization entails no assumption as to how the theory inherent in a task is arrived at. While it can come about as a response to a well-defined problem, in which the goal is specified in terms of a particular product, or of a certain performance (e.g., Cyert & March, 1963), it can also stem from a search for new uses for existing resources (Grandori, 2010). When tasks involve novel combinations of resources, experience and perception, as well as reason and justification, are certainly important determinants of the formulation of tasks. However, imagination also plays a role (Felin & Zenger, 2009). As imagination is at least in part separated from what is, or has been seen, observed, perceived, experienced, or known, the formulation of tasks involving novel combinations of resources is not fully determined by extant resources or by extant activities. Therefore, it is reasonable to treat tasks as an exogenous factor in a number of organizational decisions.

Tasks can be performed through different processes, which vary in terms of efficiency. Coordination theory suggests that it is critical for process efficiency that dependencies are managed (Malone & Crowston, 2002). Dependencies varies in intensity, and they require different coordination mechanisms, depending among else on whether they arise between activities, between resources, or between activities and resources. Overall, the coordination mechanisms called for by dependencies involving resources – that include identifying required and available resources, choosing a particular resource, and assigning it

to the process (Crowston, 1997) – are considerably simpler and less intrusive than those commonly prescribed for between-activity dependencies.

Obviously the question arises whether firms actually understand and actively manage the interdependence between the resource requirements of tasks and the resources actually available, particularly in the context of inter-organizational relationships; or whether they combine their resources based on different heuristics, such as the diversity of their resource profiles. These managerial decisions are difficult to observe from close by, but strategic alliance agreements offer insight into their content. What these agreements reveal is, first of all, that stipulations concerning resources can be very specific. For example, Lerner and Merges (1998) found that a number of issues that are closely associated with the alliance resources are “painstakingly negotiated and carefully delineated in alliance agreements” (Lerner & Merges, 1998: 127). Robinson and Stuart (2007), for their part, found that about 50 percent of the biotech strategic alliance contracts in their sample contained provisions requiring the partners to allocate a specific number of full-time equivalents to the research project. Sometimes the specification also included quality restrictions, such as the requirement that the persons were appropriately qualified in biochemistry or biology or that they held Ph.D. degrees. In some cases contracts even specified that named individuals should be deployed strictly on a particular project.

A second observation derived from such agreements is that capabilities can be matched not just to the partner’s different resource profile, but more specifically to the particular requirements of the alliance task. This was the case, for example, in the 1994 alliance between Affymetrix and Hewlett-Packard. Here, Affymetrix’s GeneChip™ technology for the development of DNA chips and Hewlett-Packard's measurement and instrument capabilities appeared to be matched to the requirements of the alliance task of jointly developing and marketing a DNA analysis system comprising DNA probes on

microchips, and the electronic instruments to read these chips. The same is apparent in the 2004 alliance between Sunesis Pharmaceuticals, Inc. and Biogen Idec, established for the purpose of generating small molecule leads that inhibit kinases, a family of enzymes that play a major role in the progression of cancer. Indeed, the contract for that alliance specifies first of all that Sunesis should bring to the alliance its Tethering® proprietary drug discovery technology, which the company had begun to apply to the discovery of kinase inhibitors. The contract moreover offers a glimpse of the micro management of the task-resource interdependence: it reveals that already in the negotiation stage, the partners had specified their high-level discovery goal as a specific task comprising 59 distinct activities to be performed during the first four years of the collaboration, and had determined the allocation of scientific personnel to several different sub-projects on a quarter-by-quarter basis.

Overall, this anecdotal evidence from these inter-organizational collaborations indicates: 1) that the identification of complementary resources involves more than a simple similarity comparison of the partners' resource profiles; 2) that the parties expect it to have important economic consequences; 3) that the task of the alliance is critical for identifying what is and what is not complementary; 4) that the parties are careful to assign their resources to task activities in proper doses.

This evidence pertains to alliances that involve non-routine, innovative tasks, in which the resources required, their mutual interdependence, and their interdependencies with the task are supposedly understood only partially. For even stronger reasons we can expect these processes to be at work when the task is better known, and when the performance of the alliance critically depends on operational-level efficiency.

BEYOND THE ESTABLISHED NOTIONS OF RESOURCE COMPLEMENTARITY

Task Resource Complementarity

Following Penrose's original intuition, we posit that organizations are collections of resources, which consist of bundles of potential services that allow organizations to perform tasks (Penrose, 1959; Teece, 1982; Teece, 1986). Given the plasticity of resources, the potential applications of resources are largely indeterminate, and so is the value that can be obtained from them (Alchian & Woodward, 1988). Therefore, the use-value of resources and the degree of "beneficial interplay" among them – their complementarity – are not knowable with precision, unless reference is made to a specific task. Of course, a task may initially be understood only in broad terms, and may therefore undergo a process of further specification. However, without guidance from the theory that a task embodies the search for valuable resource combinations would be an almost hopeless process of blind search through a highly complex fitness landscape (Gavetti & Levinthal, 2000; Rivkin, 2000).

Conceptualizing resource complementarity as the interplay between firms' resources *and* task characteristics is a relevant change in the perspective on value creation in inter-organizational relationships. Due to the level of generality at which it is situated, this new conceptualization can be described as a logic that incorporates, within an overarching framework, both the traditional actors-dyadic perspective – focused on the resources individually held by actors – and the content that actors should perform jointly, that is, the collaboration task.

In what follows we apply this logic to articulate *questions* that help us capture more accurately the characteristics of an effective and efficient means to fill resource gaps, in the context of interorganizational collaborations. Our inquiry is tailored to this context because, as a matter of facts, critical resources often can be accessed only through collaborative partnerships, and because this entails that resources typically become available as parts of

wider resource bundles.¹ To illustrate the value of this approach we will draw comparisons with the aforementioned conceptualization, which have predominantly focused on the mere relationship between the actors' resources, notably that of strategic interdependence. For simplicity the argument is developed assuming a dyadic relationship.

Task Resource Set, Resource Scope and Resource Depth

The first question that needs to be addressed is *which* resources and which characteristics should provide the basis for assessing resource complementarity. In keeping with Penrose's (1959) view and with the international business literature that emphasized the importance of task-related variables for the viability of a venture's operations (Geringer, 1991; Harrigan, 1987), we focus on the resources and capabilities required for the execution of a given task. Henceforth we shall refer to this collection of resources as the *task resource set*.³ Further, we distinguish between resource breadth and width, variety and specialization (Katila & Ahuja, 2002) and we propose two dimensions of the task resource set: the variety of the resources called for by a given task (for simplicity, the resource *scope*) and the intensity (quantity, volume) of the requirement for each task resource (for simplicity, the resource *depth*).

The logic of task resource complementarity, coupled with the idea of complementarity as the filling of a gap, also inspires a second question, namely whether the resource endowment of the firm enables it to be self-sufficient in the accomplishment of a focal task. An organization owning the resources that are necessary to perform a given task has no dependence-restructuring incentives (Pfeffer & Salancik, 1978), and only weak efficiency incentives, to seek a partnership with other organizations for those resources, as it can hardly

¹ In turn, this follows from the fact that establishing a partnership entails some expectation of exclusivity (Pfeffer et al., 1978), so that two focal firms partnering with each other are somewhat restricted in their possibility to source task resources from alternative exchange counterparties; and from the fact that the costs of collaboration increase with the number of the partnering organizations (García-Canal, Valdés-Llaneza & Ariño, 2003), which likewise limits the possibility to unbundle resources and recombine them on an individual basis.

expect value creation from redundant resources. While considerations of legitimacy and risk management may still be reasons to engage partners, the joint performance of a given task increases coordination costs and poses governance hazards (Williamson, 1975). The well-established logic of strategic interdependence (Gulati & Gargiulo, 1999), operationally implemented as niche non-overlap, largely overlooks all these arguments.

Another issue concerns *relevance*, that is, establishing which among the resources owned by the parties belong to the task resource set. Assuming that neither of two firms is self-sufficient and that both need to tap into someone else's expertise, it is apparent that while some of the resources and capabilities can help discharge the task, others are totally irrelevant (Das & Teng, 2000) and do not increase the likelihood that these two firms will establish a collaboration. Occasionally, resources that are irrelevant to the task are partially entwined with relevant ones. Whenever this occurs, applying the latter to the task forces the former into idleness, causing opportunity costs. Thus it should be correct to say that these resources do not contribute to inter-organizational resource complementarity, if they do not subtract from it. In our view these arguments are not adequately captured by the logic of strategic interdependence, which assigns equal complementarity value to all types of resources.

The fourth question examines how much of a resource gap remains unfilled once resources are pooled. As stated earlier, the idea that complementary resources are such because they compensate for gaps is common in managerial studies. However, the consideration of the task helps determine the extent of the gap. Certain resource bundles pooled by two firms only enable the partial filling of a gap, while others saturate the task requirements. Sometimes a partial filling is the best that can be done, and the remainder needs to be procured either through an arm's length exchange or through the creation of a multi-firm relationship. Yet due to asset specificity, to the scarcity of suppliers or to other sources of market failure, arm's length transactions may be problematic. Second, as multi-

party combinations are likely to involve greater coordination and governance costs (Garcia-Canal et al., 2003; Gulati, 1995a; Oxley, 1997), resource combinations that leave fewer task resource requirements unfulfilled should be considered as more complementary. Likewise, the consideration of the task also helps appreciate that a given gap may be more than filled by a resource combination. Replicating our reasoning on irrelevant resources, it can be claimed that the value of anything contributed in excess of the task requirements has limited value, if any. These mechanisms are not captured by niche (non) overlap, for which the complementarity value of two firms is given, irrespective of the demands posed on their resources by different tasks.

Another issue concerns *duplications*, that is, the possibility that the task resources of the parties overlap and the extent thereof. Here the distinction between resource scope and resource depth proves important. For the purpose of filling a variety gap between the task resource set and the resource line-up of each party, contributions of same-kind resources are redundant. However, each firm's endowments of particular resources may fall short of the depth required by the task. In this case, even the pooling of identical resources can have a complementarity value up to a point, as it may enable, for example, a level of activity closer to the minimum efficient scale (Hennart, 1988). However, in a logic of strategic interdependence, the pooling of same-type resources would be classified as non-complementary even if it fills a resource depth gap.

Clearly these questions identify a fairly complex set of requirements, the fulfillment of which is likely to enhance the efficacy and the efficiency of a combination of different resource sets, thus creating inducements for the choice of specific partners. Therefore, we define *task resource complementarity* (henceforth TRC) as the extent to which these requirements are satisfied by two firms in relationship to a specific task. As we saw, some of these conditions are not necessarily fulfilled by strategically interdependent firms.

Prospective partners may value strategic interdependence, due to the increase in the capability that it brings about to deal with unforeseen circumstances, and due to the protection from competition that associates with difficult-to-imitate combinations of dissimilar resources (Harrison, Hitt, Hoskisson & Ireland, 2001). However in collaborations that are primarily motivated by the need to perform a particular task effectively and efficiently, those benefits are likely to represent only second-order considerations, unlikely to compensate for the costs and the dysfunctional consequences of neglecting task requirements when assessing resource complementarity. Therefore we posit:

PROPOSITION 1: Relative to Strategic Interdependence, the Task Resource Complementarity between two firms is a stronger antecedent of their inter-organizational collaboration, and its value, in those collaborations that are undertaken with the primary objective of performing a particular task effectively and efficiently.

These requirements are such that they cannot be captured by simple combinations of extant constructs, such as resource endowments and task requirements. For these reasons, TRC needs to be articulated as a complex relationship, and its effect on interorganizational outcomes cannot be proxied by its constituting elements, taken in isolation or in simple interaction with each other. Therefore the next section further articulates the nature of this relationship.

COMPONENTS OF TASK RESOURCE COMPLEMENTARITY

The distinction between the depth and the scope of task resources has not featured prominently in our theory development, as most of the questions articulated in the previous section apply to gap filling along both dimensions. In what follows, the aforementioned conditions for an effective filling of a resource gap are restated, separately for same-type and

different-type resource combinations. This will enable us to define two sub-constructs within TRC: *depth complementarity* and *scope complementarity*.

Depth complementarity

In our theory, depth complementarity captures the potential for effectiveness and efficiency advantages deriving from pooling same-types resources. More precisely, we state that given a task, two firms exhibit depth complementarity at the level of a resource i required to perform the task, if they fulfill both of the following conditions: if neither firm possesses the focal resource in an amount that is sufficient to perform the task; and if by pooling the focal resource they draw nearer to, match or exceed the depth of resource i required to perform the task.⁴ Depth complementarities are experienced quite often in so-called scale alliances, especially in those of the shared-supply type (Garrette & Dussauge, 1995). In these alliances, the partners contribute same-type resources, avoid duplicating tasks, and produce a common product – identical or scarcely differentiated – that is used as a component in their respective end products, or sold as such to end-consumers. An example is the Française de Mécanique, an alliance for the production of automobile engines between Renault and Peugeot, which existed for more than 40 years. It is evident how in this alliance synergies largely depend on reaching an adequate “depth” of distribution, which enables the plant to operate on a very efficient scale (1.6 million engines in 2006). In fact at the time of the founding, and for several decades afterwards, the sales and distribution positions of the partners largely overlapped, and they could not be coordinated, due to European law regulations. Figure 1 graphically illustrates our concept of depth complementarity.

Insert Figure 1 about here

Scope complementarity

Scope complementarity assesses the potential for effectiveness and efficiency advantages achieved through the pooling of different types of resources required by the task. Roughly, this concept captures the overlap between the variety or scope of the resources possessed by two firms and the resource scope required by a task.

Assume that the focal task requires certain amounts of the resources 2, 3, ..., 11 (in our notation, $TRQ_2, TRQ_3, \dots, TRQ_{11}$). Assume further that firm A possesses resources 1 to 6 and firm B resources 6, 7, 8 and 12. In our framework, resources 1 and 12 are irrelevant for the assessment of complementarity (they fall outside the task resource set), and do not contribute to scope complementarity. Assume further that either partner possesses the task resources in sufficient amounts (that is, $R_{A2} \geq TRQ_2, R_{A3} \geq TRQ_3$, etc.). Therefore, by definition we are dealing with resources for which the parties have null depth complementarity. This ensures that depth complementarity and scope complementarity do not overlap, while being closely interrelated. We then argue that due to the possession of resources 2 to 5, 7 and 8, the two firms exhibit a certain degree of scope complementarity with respect to the focal task. Resource 6 is also helpful for performing the task. However, as argued above, its simultaneous possession by both organizations is unlikely to enhance effectiveness or efficiency, and may possibly engender governance problems. Therefore we do not regard it as contributing to complementarity. Intuitively, A or B's possession of also resources 9, or 10, or 11 would further increase the resource scope complementarity of the dyad, given the focal task, while A or B's possession of all the resources 2 to 11 would negate the existence of resource scope complementarity among them. Figure 2 reports a graphical illustration of scope complementarity.

Insert Figure 2 about here

Given the way we have defined them, both depth complementarity and scope complementarity may vary in degree. Moreover, the filling of task resource gaps and the effectiveness and efficiency of a collaborative endeavor in performing its task can be argued to increase with the extent of both complementarity constructs. Therefore, we advance the following two propositions:

PROPOSITION 2a: When depth task complementarity between two firms increases, the probability that they will establish a collaboration, and the value they can expect from it, increase as well.

PROPOSITION 2b: When scope task complementarity between two firms increases, the probability that they will establish a collaboration, and the value they can expect from it, increase as well.

FACTORS MODERATING THE RELATIONSHIP BETWEEN TASK RESOURCE COMPLEMENTARITY AND PARTNER SELECTION

Theories of why depth and scope complementarity are valuable as predictors of collaborative resource pooling among firms, should also explain *when* they are valuable. Broadly, for firms facing well-defined tasks, analyzable into their resource requirements, the case for leveraging that information to assess the performance consequences of alternative collaboration partners is quite compelling. However, there are several factors that may influence the relevance of task resource complementarity for such an assessment.

What we will focus on here are task-related and resource-related reasons that impinge on the possibility of task resource complementarity to effectively discriminate among alternative partners. These factors can be traced back to at least four fundamental reasons: task uncertainty, risk of losses, learning, and spillovers across tasks.

Task uncertainty

The power of TRC depends primarily on the possibility to understand *ex-ante* the nature and the characteristics of the tasks that partners should perform jointly. Sometimes such understanding is incomplete. Task uncertainty is the degree to which tasks are open to chance-based, task-relevant influences (Hirst, 1987), and it relates to a lack of specificity of task methods and to poor predictability of task results (e.g., MacCrimmon & Taylor, 1976). With lower levels of task uncertainty, firms know which resources to use and which results may be expected from the pooling of their resources. On the other hand, with higher levels of task uncertainty firms do not exactly know which results may be expected. In the limit, uncertainty may also concern the set of resources that should be used and pooled by the partners. However, such a case takes us beyond the boundaries of our framework, which assumes that tasks are analyzable in terms of their resource requirements. Within such boundaries, uncertainty may still blur the connection between resources and expected results. For example, a firm may know that for the clinical trials of pharmaceutical agents that treat a particular disease it needs technical personnel with certain specializations, but it may be uncertain about the proper number of such personnel. Uncertainty may be addressed directly, for example by increasing the information-processing capability of the organization (Galbraith, 1974). Where this is possible, uncertainty need not interfere with the assessment of resource complementarity. An alternative strategy, which is called for particularly in case of higher levels of uncertainty, is to let the future run its course and to be prepared to introduce adjustments *ex-post* (Perrow, 1967; Van de Ven, Delbecq & Koenig, 1976). A typical way to prepare for the future is to assign capabilities and resources to the areas where problems could arise (Knight, 1921), in excess of what a perfectly fine-tuned assignment of resources would require (Starbuck & Milliken, 1988). This may lead a firm to select partners that have wider and deeper resource endowments than strictly required by the task under conditions of low uncertainty. Thus, firms may perceive that partners that are task-

complementary are less than ideally matched to them, though under a number of scenarios their combined resources would still enable them to discharge the task successfully.

Consequently task uncertainty moderates the relationship between task resource complementarity and the formation of relationships. Therefore we suggest that:

PROPOSITION 3: The influence of task resource complementarity on the probability that two firms will establish a collaboration and the value they can expect from it is contingent on task uncertainty. Specifically, uncertainty of the task they plan to undertake negatively moderates the relationship between task resource complementarity and these outcomes.

Risk of losses

Uncertainty may or may be not associated with risks (operational, financial). Risk sharing, and the dilution of a firm's involvement in a project, are particularly critical when the risks of losses from the project are high. In fact, undertaking to perform a task often requires making commitments of resources that will only be partially recoverable if the task is abandoned or substantially redesigned. If those losses are not affordable, how to reduce them becomes a salient concern of the decision makers (Dew, Sarasathy, Read, & Wiltbank, 2009; Kahneman & Tversky, 1984). For the purpose of reducing risk, tasks can be structured in a way that enables staging the required investments (Gunther Mcgrath, 1999) or taking advantage of other forms of real options (Tiwana & Wang, 2007). Whenever these options are not available or do not reduce risk sufficiently, potential losses can be contained by spreading contributions of task resources over multiple actors (Das & Teng, 1996; Alter & Hage, 1993). This negates or attenuates the link between TRC and partner selection. In fact, if risk sharing is important a dyadic relationship will be attractive even if one or both of the parties are self-sufficient, and a dyad that makes a modest contribution to resource gap filling may be preferable to one that fills the gap completely. Therefore,

PROPOSITION 4: The influence of task resource complementarity on the probability that two firms will establish a collaboration, and the value they can expect, is contingent on the risks of losses associated with the task. Specifically, risk in the tasks they plan to undertake negatively moderates the relationship between task resource complementarity and these outcomes.

Learning

Task resource complementarity is conceptually associated with the ability of firms to “get things done” by pooling non-redundant resources which match with a given task. As a result, the enhancement of effectiveness is the main reason why it may drive the formation of collaborative IOR’s. However, the pooling and the integration of resources often enable collaborating firms also to learn from each other. Associations in which the primary objective of the partners is to learn from each other constitute an important class of inter-firm relationships, which have been investigated particularly in the context of strategic alliances (Hamel, 1991; Hamel, Doz & Prahalad, 1989; Khanna, Gulati & Nohria, 1998). What firms seek in such alliances is the possibility to absorb some of the partner’s skills and routines. Skills and routines are complex action patterns, and are not reducible to specific task resources. However, they are also maintained by physical artifacts and organizational practices (Cohen et al., 1996) which can be part of, or can be enmeshed with, the resources of a particular organization. To the extent that the resources of a potential partner signal the existence of valuable organizational knowledge, they provide incentives for the selection of the partner, partly irrespective of the inducements offered by task resource complementarity. The two interests will not necessarily be opposed to one another. Indeed, to the extent that seeing the partner’s skills actively deployed in a particular task facilitates the absorption of skills in general (Huber, 1991; Nadler, Thompson & Boven, 2003) and of their tacit components in particular, task resources will be a more salient concern than partner resources

that are unrelated to the collaborative task. However, whereas task complementarity negates self-sufficiency and probably avoids duplications, waste and redundancies as well, a certain degree of overlap in capabilities and resources is positive for learning purposes (Lane & Lubatkin, 1998; Luo & Deng, 2009; Mowery & Oxley, 1998; Mowery, Oxley & Silverman, 1996). Moreover, as the ‘student’ firm is likely to orient itself on partners that possess the sought-for capabilities in high degree, it is likely that the ‘teacher’ firm will be self-sufficient in the underlying task resources. For all these reasons we posit:⁵

PROPOSITION 5: The influence of task resource complementarity on the probability that two firms will establish a collaboration and the value they can expect is contingent on learning objectives. Specifically, a significant interest to use a collaboration as a means for learning from partners negatively moderates the relationship between task resource complementarity and these outcomes.

Spillovers on future tasks

The process of collaboration produces a wide range of spillovers. One of them is the development of inter-organizational routines, which are largely partner-specific and have a comparatively strong effect on alliance performance (Zollo, Reuer, & Singh, 2002). Besides, economic exchange favors the emergence of trust and social ties (Uzzi, 1997). Dyad-specific advantages are also created through investment in co-specialized assets (Teece, 1986; Teece, 2007). Therefore, other conditions being equal, collaborations between firms that had prior partnership experience with each other may expect to outperform collaborations of first-time partners.

The anticipation of such future benefits may influence the selection of the partner for a focal relationship, because firms can choose the current partner with an eye to future collaborations, partly irrespective of their complementarity in the current one. This has been frequently observed in new subcontracting relationships, in which the need to figure out each

other's trustworthiness, motivation and capabilities, often drives the parties to engage in probationary collaborative work (and Larson, 1992; also see Lorenz, 1993; "to waltz a little," as nicely stated by Whitford, 2012), that will be eventually expanded in size and complexity depending on the outcome of the probation. This obviously reduces the link between TRC and partner selection, as the partners may be oversized for the probation task, or have partly overlapping task resources.⁶ Such distortions may be unimportant in stable environments, but they may be significant whenever environmental changes create the need to collaborate with new partners. For all these reasons we claim:⁷

Proposition 6: When the process of collaboration produces important partner-specific experience and social bonding, and the tasks that the partners may perform with each other in the future alliances entail resource requirements significantly different from those of the current task, task resource complementarity will have a weaker effect on the probability that two firms will establish a collaboration than when these contingencies are small.

Figure 3 synthesizes the theory of task resource complementarity as developed here.

Insert Figure 3 about here

RESOURCE COMPLEMENTARITY AND THE THEORY OF THE FIRM

At the core of the concept of task resource complementarity as we defined it lies the interdependence among resources that arises from their association with a common production process. Under conditions of rationality firms are likely to attempt to bring this interdependence under control (Pfeffer & Salancik, 1978; Thompson, 1967). As concentrated ownership arguably ensures a stronger control than exchange across the firm's boundaries, it is natural to ask whether, and under which conditions, task-resource complementarity can lead to the consolidation of resources within a single organization.

This question addresses one of the key concerns of the theory of the firm, namely what determines the scale and scope of firms (Holmström & Tirole, 1989). Organizational economics and the capabilities literature have provided the main frameworks to address questions concerning firm boundaries. Specifically, transaction costs economics has emphasized the superior capability of integrated organizational arrangements to deal with incomplete commitments problems (Williamson, 1975) and with team production (Alchian & Demsetz, 1972). Property rights theory has further developed this line of reasoning, and has formulated predictions as to who should integrate whom (Hart, 1995).

As to the capabilities literature, it has explained the consolidation of resource ownership (and the use of employment contracts, in the case of human resources), with the need for coordination and the integration of resources. Firms are argued to have superior coordination and integration capabilities, due to their ability to provide direction through authority-based relationships (Conner & Prahalad, 1996), routines (Nelson & Winter, 1982), and a context characterized by a common identity (Kogut & Zander, 1996).

Arguably, complementarity poses both governance and coordination problems. It creates governance problems because in a world in which markets are incomplete, and many resources combinations are therefore not priced, the formation of a specific resource bundle can reveal the value of a focal resource, and shed light on the value of its component resources outside the bundle. To the extent that the value so revealed is higher than the value prior to the incorporation of the focal resource into the bundle, the resource owner has an incentive to hold-up the other resource owners and renegotiate their agreements (Lippman & Rumelt, 2003).

Complementarity also creates a coordination game. This is most evident if one explicitly defines complementarity as supermodularity. Under that assumption, the added value of one resource depends on the use of other resources and their individual deployment

has to be consistent (Stieglitz & Heine, 2007). However, also under the less restrictive assumptions of our model the need to coordinate the use of complementary resources is apparent. Given the plausible assumption that resources have indivisibilities, optimizing the use of one resource in a particular task (e.g., using up its services in the task) may require that the level of output and of the other resources are adjusted as well.⁸ In sum, it seems correct to conclude that complementarity raises the need for central direction and centralized property rights (Stieglitz & Heine, 2007).

All of the above defines the fundamental aspects of the question, which were confirmed in recent reviews of the literature on the firm-market boundary (Zenger, Felin & Bigelow, 2011). Therefore, our contribution will consist of two points: reminding the results of certain strands of research that are seldom mentioned in the debate of the firm's boundaries; and, highlighting factors that are best appreciated by concentrating specifically on *resource* complementarity, and on tasks.

As to the first point, some studies have focused not so much on factors that raise the need for control, as on ownership as a solution, and on its supposed incontractibility. In a series of articles, Rajan and Zingales (1998; 2000; 2001) have investigated the mechanisms why transactions take place in the firm rather than in the market. While confirming that ownership is "good" for providing control and coordination, these authors highlighted that ownership also has a "dark side", as it reduces outside options, and therefore the incentives to make specialized investment. To the extent that the making of specialized investment is important for value creation firms may trade-off the control benefits of ownership and its disadvantages, and opt instead for regulating *access* to critical resources.

The superiority of ownership as a means to protect the value created through deliberate investment, or through creative combinations of resources into new complementary configurations, depends on the assumption about the importance of residual

decision rights, and about their non-contractibility. However, empirical research has uncovered settings in which various rights over resources are parsed very finely in contracts, in ways that seem compatible with efficiency (Kaplan & Stroemberg, 2003; Lerner & Merges, 1998). These findings offer some support to a claim, grounded in conceptual reasoning, that ownership is an ambiguous concept, and that it is possible to contract on the entire bundle of residual control rights, thus in principle enabling exercising effective control also over assets that are not formally owned (Demsetz, 1999).

As to addressing the issue of resource complementarity through the lens of task, one implication is that it reinforces the key argument of the governance perspective, that complementarity brings along the risk of holdup, and calls for protection. TCE has typically focused on a bilateral transaction threatened by opportunistic behavior. However, when multiple transactions are interrelated and are occurring simultaneously – as is especially the case of the components of a complex task – the holdup risk for a focal transaction involving a uniquely complementary resource will be considerably greater than for a single bilateral transaction, as any party possessing a resource that is uniquely complementary is in a position to hold up the owner of the focal asset.⁹

By the same token, when tasks entail multiple resources and interdependencies between the activities that they enable, we would expect that superior integration capabilities increase in importance, and that resource consolidation becomes more likely.

However, a focus on tasks and resources also reveals some reasons why complementary resources should *not* be consolidated. First, tasks make apparent that the size of their resource requirements may not align with the size of the units of resource accumulation or acquisition. Therefore the internalization of resources may engender excesses of resource endowments relative to task requirements (Penrose, 1959). Firms may try to solve the problem of excess resources by engaging in related diversification

(Montgomery & Hariharan, 1991) or by creating new tasks. In any case, the deployment of resources in productive tasks is constrained by managerial capabilities, and it is therefore not a matter of course (Stieglitz & Heine, 2007). Hence, the lumpiness of resources may favor resource *access* – utilizing the resources' services without internalizing the resources themselves – over resource consolidation.

A similar conclusion follows from considering that *qua* asset stocks, resources are long lived, and their duration does not necessarily coincide with the expected duration of the task. Therefore, short and shrinking product lifetimes as well as project-like tasks may provide a deterrent against resource consolidation, as they increase the chance that resources will remain underemployed upon completion of the task.

A preference for access over consolidation may originate also from the fact that in an uncertain environment, tasks often need to be modified. While this places a premium on flexibility, the consolidation of resources creates sunk costs that hinder adaptation (Nickerson & Silverman, 2003). Therefore, in situations where changes in customer preferences or in other environmental components frequently impose the need to redesign tasks, firms are likely to be reluctant to internalize task resources (Milgrom & Roberts, 1990).

Finally, a focus on tasks and on resources suggests that if complementarity consists of the interconnectedness of *many* resources it may also engender causal ambiguity (Reed & DeFillippi, 1990), thus safeguarding against full disclosure of the extent to which the value of the resource bundle owes to particular resources, and reducing the risk of hold up.

Some – though by no means all – of the relationships between tasks and resource boundaries that have been argued above are graphically illustrated by the case of a well-known company described by Grant and Neupert (2003), though in a more dynamic perspective than discussed so far. Since its inception in 1889 until the early 1990s, the

Eastman Kodak Company had engaged in the stable task of selling inexpensive cameras and consumable products for the photographic business. The resource requirements for undertaking that task included optical, silver halide and polymer technologies, as well as large scale manufacturing and distribution capability. Thanks to its early start, the company had time to achieve perfect mastery in these technologies, and keeping them tightly integrated helped Kodak achieve operational efficiency in low-cost mass production. However, with the digital revolution Kodak's management identified a new "task" for the firm – "infoimaging" – which eventually replaced the original one.¹⁰ For this new task a variety of new resources and capabilities had to be harnessed together: electronic sensing, file compression, image storage, internet-protocol file transmission, printer connectivity, etc. Obviously the range of these resources and capabilities was too vast, and its difference with Kodak's knowledge base too large, to permit for their autonomous internal development. Moreover, these new technologies had a wide variety of potential applications that could hardly be saturated by Kodak's traditional product positioning. Kodak therefore started engaging in a large number of partnerships, and there are indications that some of them dramatically expedited new product development and Kodak's adaptation to the new task. The company also tried to internalize many of the new technologies through a flurry of M&A deals. It is impossible to know whether Kodak could have relied on partnerships instead, given the kind and the extent of the transactional hazards involved. Certainly these corporate actions severely dented its financial position, and the company failed to become a leader in digital photography.¹¹ Some testimonies and interviews also attest to how Kodak's failure to adapt to the changing customers' needs was partly attributable to its huge commitment to its resource base in general, and to the halide silver technology in particular.¹²

To sum up, an explicit consideration of tasks highlights a number of factors that impact upon the consolidation of complementary resources, in addition to those identified by

extant governance and competence approaches: the amplification of the need for incentive alignment and coordination, brought about by resource interdependence; and the problems created by imbalances between the duration and the amount of task resource requirements on the one hand, and the lifetime and lumpiness of resources on the other.

As this suggests a more nuanced view than the conventional understanding that firms have strong incentives to integrate sets of complementary components, we need to ask how our conclusion aligns with empirical reality, and why some studies have reached more clear-cut conclusions. As to the first point, we note that a growing literature reports that interdependent components are increasingly outsourced or concurrently sourced – outsourced and simultaneously produced in-house (Parmigiani & Mitchell, 2009). While other factors besides complementarity may be involved in this trend, some authors have explained it by reference to the growth of modularity in product markets (Brusoni, Prencipe & Pavitt, 2001; Prencipe, 2003). This indicates that different degrees of interdependence may be associated with a given level of complementarity.

As to the second point, we notice that the literature on complementarity often does not make qualitative distinctions among the types of objects involved in complementary relationships. While undeniably a positive interplay can exist also across different organizational components, this approach obscures the specific characteristics of each type of components, which may be relevant concerns in decisions about the firm's boundaries.¹³ Therefore the discussion may end up ascribing to *resource* complementarity, consequences that are more appropriately explained by the complementarity of *activities*. As noted by Thompson (1967), there are types of interdependence that do not necessarily involve transfers of goods and services between the actors. The interdependence among resources is typically of this type – and certainly it is in our model; whereas interdependent activities often represent more serious contingencies to one another, and are therefore more difficult to

coordinate. Thus, one advantage of focusing the discussion specifically on resource complementarity is that it enables recognizing this point, and the points discussed above concerning the accumulation and duration of resources.

DISCUSSION AND CONCLUSIONS

The idea of complementarity has significantly affected more than two decades of research in the strategic management and organizational theory field and has become a foundation of modern organizational design (Milgrom & Roberts, 1995; Porter & Siggelkow, 2008; Roberts, 2004). The question of complementarity has provided economists with an opportunity to focus more closely on managerial problems. However, while breaking with many assumptions of traditional economic theory, their contributions have typically brought about outcome-oriented models that fail to account for some important empirical aspects, and have only limited design implications. Thus, paradoxically, the resulting complementarity perspective appears to lack the phenomenological plurality and complexity that organization theory has offered the social sciences for so many years.

As regards the application of the concept of complementarity to the inter-organizational context, a very influential part of the literature has not gone beyond considering the role of resource diversity in the shaping of complementarity. It has thus neglected the dimension of objectives, particularly in their more operational version, as well as the content of the activities that the inter-organizational relationship undertakes to perform. Our research was in fact originally encouraged by the evidence that complementarity theory, particularly in the inter-organizational literature, is rather silent with respect to the nature of the tasks that organizations seek to perform by combining their resources.

In response to these limitations we propose the construct of task resource complementarity, which extends and develops ideas disseminated across different fields and

connects these to major theoretical paradigms for the study of organizations. Our theory has been formulated in static terms, but it could be extended to accommodate dynamic aspects of resource accumulation. One way to do so would be to follow Geringer's (1991) suggestion that alliance managers do not assess resource complementarity based only on the *existing* resource position of the parent firms *vis-a-vis* the task requirements, but that they also do it based on the perceived difficulty of filling gaps in task resources through internal resource development.

Even in its static version, our theory contributes one important mechanism for explaining network dynamics. The mechanisms of inter-organizational tie formation that are currently acknowledged, such as homophily, reciprocity, transitivity and repeated ties, overwhelmingly favor the perpetuation of existing relationships and the formation of dense clusters of similar actors (Sorenson & Stuart, 2008). However, distant ties do occur, and they fulfill important functions (Watts & Strogatz, 1998). If inter-organizational resource complementarity were dependent only on organizational resource profiles, given the difficulty to quickly modify them (Dierickx & Cool, 1989) complementarity would constitute yet another mechanism of reinforcement of existing inter-organizational relationships. However, tasks are not entirely endogenous to the firm's extant system of resources and product lines. In their determination also factors such as entrepreneurial imagination (Felin & Zenger, 2009), customers' job orders, or sheer opportunity can play a role (Ahuja, 2000), thus posing ever-changing resource requirements. Consequently, resource complementarity is more contingent than it is implicit in extant conceptualizations, and it helps explain the need for firms to constantly reconfigure their portfolio of inter-firm linkages.¹⁴

Extending the concept of complementarity to include the multidimensional fit between the resources of potential partners and those required by the task is not just a "relativist" addition to the extant perspective. Rather, it is about developing constructs that

are empirically more robust and well-matched with the normative and design origins of the organizational discourse that is “concerned not with the necessary but with the contingent – not with how things are but with how they might be – in short, with design” (Simon, 1969: xii). In light of recent developments in strategic management (Porter, 1996; SMJ special issue on Organizational Architectures, forthcoming), this aspect of our theoretical endeavor seems particularly relevant.

The construct that we have proposed departs from extant conceptualizations in another, important sense. By not assuming supermodularity, that is, that using more of a resource increases the returns of using more of another (Milgrom & Roberts, 1995: 181) our construct entails just a modicum of interdependence across task-complementary resources. Thus our construct certainly does not capture all the possible forms of beneficial interplay across resources. However, our less stringent assumption also has advantages. Among else, it does not presume the possibility to formally estimate the change in value that arises across a business system when one resource in the system changes, a condition that rarely obtains in practice. Thus it enables the exploitation of complementarities without presuming hyper-rational decision makers or, conversely, without depending exclusively on the judgment of managers or scholars.

It should be welcomed from a methodological point of view that our constructs are formulated in ways that quite directly translate into operational measures. Certainly, the information requirements for their measurement are heavy, but not at all impossible to satisfy. Aside from collecting primary data about these items, we think that the best strategy for empirical testing is to focus on settings in which issues of transparency, asymmetric information and accountability make it vital to generate and disclose valid information about task characteristics and firm capabilities. Public procurement is probably the setting in which these conditions most clearly occur. A second methodological contribution consists in the

better discriminant validity that measures of task resource complementarity are likely to have in comparison with extant operationalizations. The fact that the former are based simultaneously on specific information about attributes of actors and activities makes it less likely that they will also sample in the domain of other constructs – a problem that has troubled extant measures of complementarity (Gimeno, 2004).

This study has focused on one inter-organizational consequence of resource complementarity: the probability that two parties establish a collaboration. However, it is important that future research also addresses other consequences, such as the governance and the management of the collaboration, and the collaboration outcomes. For example, it is possible that combining resources that are poorly matched to the task is a source of significant relational conflict. If this is the case, we could expect that alliances that are established despite not being ideally matched to their task resort to more elaborate governance arrangements, and that such arrangements rely less on relational governance and make greater use of contractual and formal means. As to the management of the collaboration, we can expect that a poor match of resources to task will require more frequent managerial intervention during the life of the collaboration, and a recurrent patching of resources. Furthermore, it would be interesting to investigate the implications of task resource complementarity for the typical problems of project-based collaborations, such as cost- and time overruns. While our theory associated our focal constructs with superior effectiveness and efficiency, the consequences of resource complementarity vis à vis cost- and time overruns are no foregone conclusion, since it might well be that an excessive fine-tuning of resource complementarity also brings about lower adaptability. We have also argued that under certain conditions it can be expected that resource complementarity leads to the consolidation of resources within a single organization. Accordingly, some of the questions above could also be reformulated and asked with reference to the management of task

complementary resources within the firm, and to firm-level outcomes, such as the firm's capacity to adapt and the level of interdepartmental conflict.

While we anticipate broad applicability of our constructs, thanks to the metatheoretical nature of the concept of complementarity, we are also aware that our theory is relevant only within precise boundaries. What is necessary for task resource complementarity to be a helpful heuristic for the design of inter-organizational relationships are situations in which tasks are analyzable ex-ante in terms of the resources they require, and that the other advantages afforded by business relationships are not so strong as to make the effectiveness and efficiency advantage of task resource complementarity utterly irrelevant. However, such requirements do not seem to be particularly demanding. Even a cursory look at the types of inter-organizational relationships that are established in a variety of industries reveals how in most cases the objectives they pursue are clearly defined, and are likely to involve rather clear means-end relationships, at least with regard to the level of the resources required. While this is certainly true of inter-organizational collaborations in manufacturing sectors such as automotive or in the construction industry, the illustrations we provided earlier in this study hint at the fact that this condition may occur in a surprisingly high number of joint-R&D collaborations as well. In sum, these conditions may be common enough to warrant the application of our constructs to a wide variety of settings. Finally, the fact that tasks can be described in terms of non-sector-specific dimensions enables cross-sectoral research that is both interesting and consistent with the hybridization and the convergence of many industries.

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FOOTNOTES

¹ “Strategic interdependence between organizations describes a situation in which one organization has resources or capabilities beneficial to but not possessed by the other.” (Gulati, 1995b, 621)

² For example, a call for tenders that outlined the task for the building construction of a waste-to-energy plant in the city of Turin, which also specified five general capabilities and 12 more specialized ones which contractors must collectively possess, including capabilities in the construction of gas and oil pipelines, electricity transformation, railway structure, greenery and street furniture. For each of these areas, the call for tenders also stated the depth of the competence required, in terms of a proven and certified record of execution of works of specified size in those technology fields (retrieved from *Tenders Electronic Daily*, the online version of the 'Supplement to the Official Journal of the European Union', dedicated to European public procurement: <http://ted.europa.eu/TED/misc/aboutTed.do>)

³ The distinction between resources and capabilities is widely adopted throughout the resource-based view (Amit & Schoemaker, 1993). For the specific arguments developed in this paper, it is not so important whether the assets in questions are “based on developing, carrying, and exchanging information” (one trait that distinguishes capabilities from resources) or not. Therefore, for the sake of convenience and conciseness, from now on we will frequently use the term “resources” to refer to both types of factors.

⁴ In allowing the possibility that a partial filling of a resource gap enhances the effectiveness of the parties, and therefore counts as complementarity, we are implicitly assuming that the task is divisible, and that multiple actors can help discharging it. A work of excavation, to be performed within a specified time, could be a case in point. In such context it seems reasonable to consider heavy equipment pooled together by two partners as complementary, even though it does not allow performing the task in its entirety within the allowed time, with the application of a normal degree of exertion. In fact, the parties could compensate for the missing capacity in a variety of way, such as involving other partners, working on multiple shifts and on weekends, and renting equipment. While the incomplete filling of the equipment gap is still compatible with the performance of the task, it makes necessary resorting to extraordinary, more costly measures. Therefore, resource combinations that fill the resource gaps to a greater extent should be regarded as more complementary. Certain tasks may not allow for the conjoint application of the resources of multiple actors. In this case gap filling and depth complementarity, become all-or-nothing properties of the dyad.

⁵ Whereas we advance Proposition 5 with reference to TRC, and therefore to both of its components, it is possible that in practice the stated relationship will be stronger for scope complementarity than for depth complementarity. In fact learning opportunities are likely to be more abundant, and therefore to provide stronger distraction from the objective of matching resources to the task requirements, if the pooled resources and capabilities are of a different than of a similar type.

⁶ In the setting investigated by Lorenz (1993) the overlap of task resources was all the more likely to occur in the probationary collaborations that accompanied the switch to a greater reliance on longer-term subcontracting relationships in the Rhône-Alpes region. In fact, these interorganizational collaborations were part of an industry-wide process of historical change that would have eventually lead to the regular outsourcing of many operations previously performed in-house, such as milling, drilling, turning, and plate bending. Therefore, during the probationary period, and sometimes also afterwards, the outsourcing party still retained capabilities that were required of their partners.

⁷ Once again, we advance a proposition with reference to TRC and therefore to both of its components. Yet it is likely that in practice these spillovers may be more relevant when pooled resources and capabilities are of a different, rather than of a similar type.

⁸ This is the so-called “principle of multiples” that has been discussed by economists for a long time, and was explicitly mentioned by Penrose (1959) as an incentive for firms to expand. In general, indivisibilities, like complementarity à-la Milgrom and Roberts, are one source of non-convexity, which in turn entail that successful resource uses cannot be decided at the margin (Milgrom & Roberts, 1990).

⁹ Argyres and Zenger (2012) made a similar point for transactions connected into strategies, and explained it in terms of the greater likelihood of arriving at Pareto-inefficient equilibria in games with a larger number of participants.

¹⁰ That the new task *had* to be “infoimaging” was not inevitable at all. Fujifilm, Kodak’s closest competitor, seems to have chosen a partially different path to survival, and many commentators have argued that Kodak had

done better to stick to its traditional capabilities, and find new applications for them. With hindsight this seems to have been the case, but the fact that Kodak did not, and the amount of effort it devoted to the shift to digital, shows how strong and consequential the cognitive formulation of a task can be.

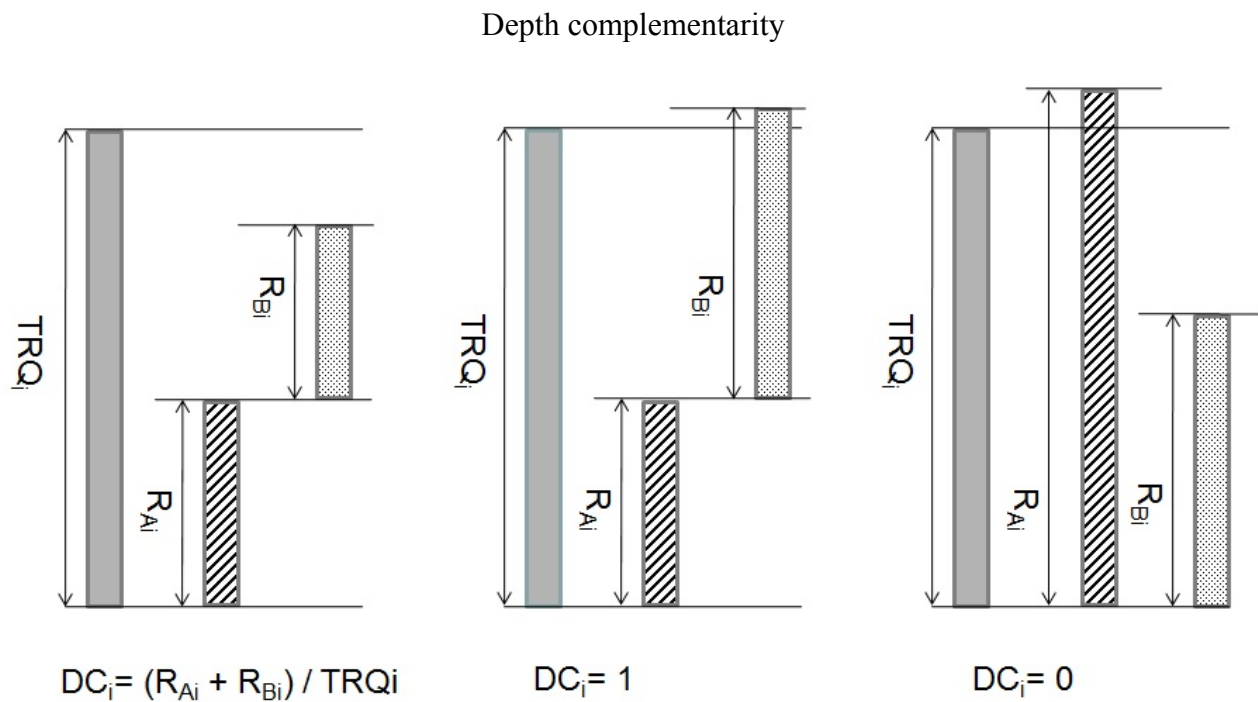
¹¹ “Company News; Moody’S Cuts Rating on Kodak Debt” (2003, September 20), *The New York Times*. Retrieved from <http://www.nytimes.com>.

¹² See for example, Jackson, T. 2011, October 2. “Kodak Fell Victim to Disruptive Technology”. *Financial Times*. Retrieved from www.ft.com.

¹³ In particular, this approach obscures the fact that it is never resources themselves that are the inputs in the production process, but only the services that the resources can render (Penrose, 1959). Obviously, the distinction between resources and their services is irrelevant when discussing the complementarity, say, between the pricing strategy and the breadth of the product line.

¹⁴ This does not mean that firms will change their portfolio of inter-firm linkages at every turn. To the extent that a task retains economic attractiveness, and that the means-ends theory it incorporates remains valid, a firm will have little incentive to adopt different resource combinations, but for exogenous factors and for the natural process of learning. However, the point is not the frequency at which tasks change, but their cognitive nature, hence the possibility that they are not fully determined by economic or social factors. This entails one mechanism of network dynamics that has not yet been adequately appreciated, at least by the network literature.

Figure 1



Notes: In the figure, i indicates the amount of resource required by a certain task (i.e., the task requirement TRQ_i); R_{Ai} and R_{Bi} , the endowments of resource i respectively of firms A and B; and DC_i the depth complementarity between firms A and B with respect to the focal resource. DC_i is defined as follows:

$DC_i = 1$ if $(R_{Ai} + R_{Bi}) \geq TRQ_i$

$DC_i = 0$ if $TRQ_i = 0$ or $R_{Ai} \geq TRQ_i$ or $R_{Bi} \geq TRQ_i$

$DC_i = (R_{Ai} + R_{Bi}) / TRQ_i$ otherwise

As DC_i is dimensionless, it is possible to define depth complementarity at the level of the dyad as an aggregation of the DC_i across all the i 's in the task resource set.

Figure 2

Scope complementarity

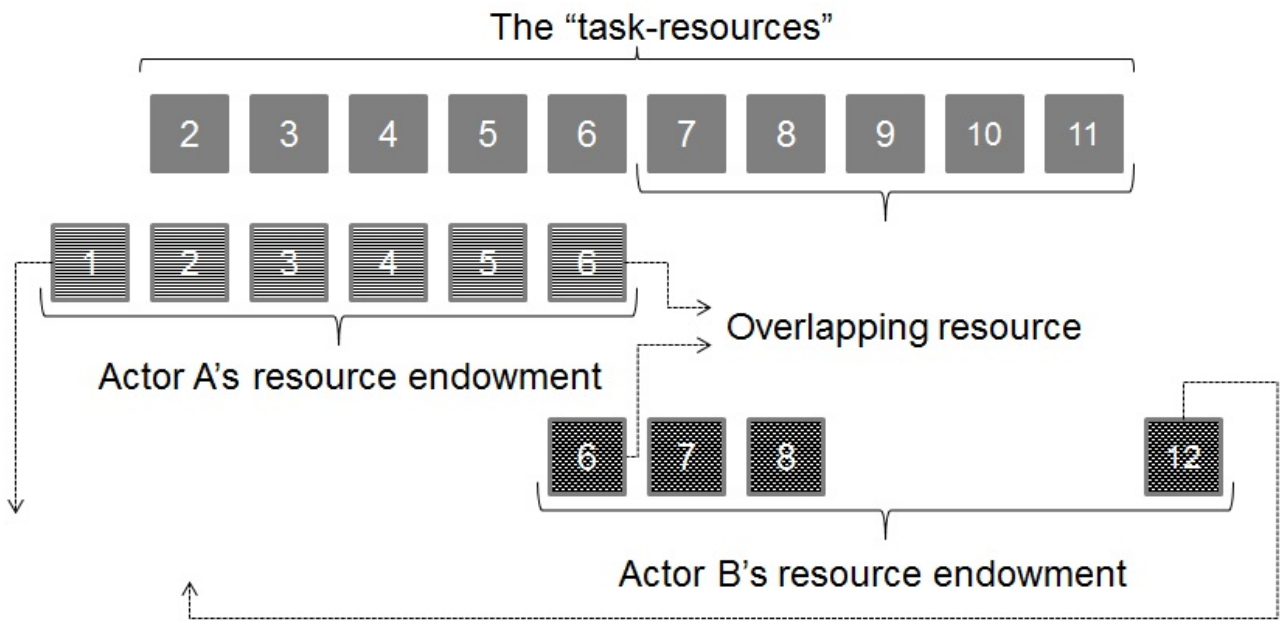


Figure 3

Relationships between Task Resource Complementarity, Partner Selection and Alliance Value Creation

