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ANALYZING COMPETITIVE BEHAVIOR IN (REPEATED) COOPERATIVE RELATIONS: VALUE CREATION, VALUE CAPTURE, AND TRUST IN RESEARCH ALLIANCES

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This analytical investigation studies the strategic interaction between firms that form research alliances and cooperate to create value while also competing to capture it. A dyadic perspective includes both transactional (one-shot) and relational (repeated) exchanges between partner firms that combine competencies and assets to conduct research. A two-stage game, which can be solved explicitly, reveals crucial aspects of interorganizational strategies and also answers some critical questions for theory and practice in research alliances. The same drivers of partners' ability to create value increase their incentives to compete for value and decrease their incentives to trust one another; this article also reveals how the allocation of control over assets can moderate these effects.

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Abstract. This analytical investigation studies the strategic interaction between firms that form research alliances and cooperate to create value while also competing to capture it. A dyadic perspective includes both *transactional* (one-shot) and *relational* (repeated) exchanges between partner firms that combine competencies and assets to conduct research. A two-stage game, which can be solved explicitly, reveals crucial aspects of interorganizational strategies and also answers some critical questions for theory and practice in research alliances. The same drivers of partners' ability to create value increase their incentives to compete for value and decrease their incentives to trust one another; this article also reveals how the allocation of control over assets can moderate these effects.

Keywords: research alliances; incomplete contracts; property rights; co-opetition; value creation and capture; relational exchange and trust.

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INTRODUCTION

Interorganizational relations such as research alliances, collaborations, and technology transfers, have become favored means for expanding resource bases, knowledge bases, and capabilities across organizational boundaries (e.g., Hagedoorn 2002). The exploitation of these relations can enhance a firm's ability to create and sustain a competitive advantage. Yet despite the potential benefits, these relations remain hard to manage (e.g., Kale and Singh 2009), and mutual cooperation is difficult to realize. Research alliances create significant tensions; to create value, partner firms must be willing to commit resources and cooperate in a situation of mutual interdependence, but the fear of opportunism can generate ex post appropriability concerns (Williamson 1979, 1985).

Partner firms may choose different governance modes and contractual arrangements to protect their economic exchange, but many challenges remain. Although contracts are a core element of many economic relations, research contracts are almost invariably incomplete; they cannot fully detail the relation-specific investments, nor can they establish ex ante how realized value will be allocated. Therefore, a key aspect of research alliances and of how the value created by cooperating gets shared involves negotiation and competition for value, which implies that research alliances are *co-opetitive* (Brandenburger and Nalebuff 1996). Repeated interactions may lead to the emergence of relational capital and mutual trust (e.g., Dyer and Singh 1998), which can alleviate fears of opportunistic behavior and the competition between partners. Yet such developments take time to emerge, in conjunction with the *shadow of the past* (experiences) or the *shadow of the future* (transactions) (e.g., Gulati 1998; Pharke 1993; Poppo, Zhou, and Ryu 2008).

Transaction cost economics (Williamson 1985), property rights theory (Grossman and Hart 1986; Hart and Moore 1990), and vast literature on strategic alliances (e.g., Kale, Singh and Perlmutter 2000; Khanna, Gulati, and Nohria 1998; Madhok and Tallman 1998) offer key insights into how partners' behaviors depend on a series of factors, including governance (Oxley 1997), the allocation of property rights (Aghion and Tirole 1994) and decision rights (Gambardella and Panico 2013), tensions due to goal diversion (Doz 1996), coordination and appropriation (Gulati and Singh, 1998), and learning and protection (Khanna 1998), as well as a series of additional elements that appear to matter at different stages (e.g., Gulati 1998). Such studies also reveal that relational capital and mutual trust alleviate the fear of opportunistic behavior, reducing transaction costs (Dyer and Chu 2003) and generating benefits that vary both across (Gulati

and Nickerson 2008) and within (Elfenbein and Zenger 2013) transactional modes. However, understanding of the tensions that emerge from the interplay between cooperation to create value and competition to capture it, of how partners' behavior and willingness to trust one another depend on their ability to create value, and how different transactional modes hamper or facilitate the emergence of relational capital and mutual trust remain superficial.

All these important dimensions are under-researched, which stands in stark contrast for the need to explicate and understand these mechanisms, regardless of the motivation, because of the remarkable frequency and importance of research alliances (and interorganizational relationships more in general). As a step in this direction, this study uses game-theoretical tools to examine the interorganizational rent-generating process of co-opetitive alliances analytically. Building on traditional literature from organizational economics and more recent strategy research, this study proposes a formal model to reflect the challenge of managing the balance between *value creation* and *value capture*. Partners are rational players that, when forming an alliance, engage in a two-stage game. The ex ante value creation and capture decisions take place non-cooperatively, in anticipation of the effects on ex post bargaining outcomes (and possibly on future transactions). Thus the foundation of this study is the classic problem of transacting in an ex post negotiation to allocate quasi-rents (Klein, Crawford and Alchian 1978; Williamson 1979), as well as the question of how the distribution of property rights over assets influences interorganizational strategies (Grossman and Hart 1986). From a dyadic perspective, the analysis starts with *transactional* exchanges in the presence of opportunism before turning to a *relational* perspective to examine repeated interactions and the emergence of mutual trust (Dyer and Singh 1998; Gulati and Nickerson 2008). The formal model highlights several tensions.

First, when partner firms engage in a transactional exchange without being able to specify contractually the relation-specific investments that create value or the ex post division of value, they generate appropriable quasi-rents. Anticipating that they will negotiate ex post, the partners compete to capture a bigger share of value, in the race to gain power and create more advantageous bargaining positions. The first question to answer thus is: *How do partners in a co-opetitive alliance manage the balance between value creation and value capture?*

Second, when committing assets and combining competencies in a world of incomplete contracts, partners' incentives depend on the configuration of control over assets. Following standard arguments, the owner of an asset needed to create value is more protected when negotiating

ex post; by controlling use of the asset, it obtains better alternatives and a better negotiation payoff, which in turn provide greater incentives to make relation-specific investments. The second question thus is, *How does the configuration of control over the assets committed to the co-opetitive alliance affect the balance between value creation and value capture?* To provide insights, this study compares two alternatives: "separation," when partners engage in a relationship to combine their competencies but maintain separate ownership of critical assets, or "integration," when one of the partners owns and controls all the critical assets.

Third, partners' incentives may be modified in the presence of mutual trust. In the study framework, the partners invest only in value creation and do not exert any (wasteful) value capture effort, anticipating that they will behave fairly in the negotiation and divide the value created equally. However, instead of assuming that mutual trust preexists, this study investigates the relational exchange to define the conditions in which the shadow of the future enables trust to be self-sustaining in a setting of repeated interaction. The final question to answer is, *In what conditions does the shadow of the future lead to the emergence of trust, transforming co-opetitive alliances in cooperative ones?*

By drawing attention to the interorganizational rent-generating process and partners' strategic behavior, this investigation highlights the nuanced links among value creation, value capture, relational capital, and control of assets. Several insights emerge from this formal analysis. In a transactional exchange without trust, the parties are trapped in a prisoner's dilemma: Resources get wasted in value capture efforts that are costly but totally ineffective (in equilibrium). A trade-off exists between separation and integration, such that the integration of assets minimizes overall value capture efforts, but separation maximizes overall value creation investments. Both value creation and value capture increase when the partners engage in more valuable alliances; surprisingly though, the latter increase faster and can also overwhelm the former. Passing from transactional to relational exchanges with repeated interaction, the prisoner's dilemma can be resolved only with trust sustained in equilibrium, but trust is harder to achieve when partners engage in more valuable alliances. Finally, a relational exchange is harder to establish through separation than with integration; that is, trust emerges less frequently (in equilibrium) when partners' control over assets is more symmetric.

Instead of developing a full-fledged model of interorganizational relations, this study offers a few insights that prior arguments could not issue. For the purposes of this study, the consistent dyadic perspective focuses on a alliance between two firms and the use of two assets,

distinguishing between separation and integration. The model admits closed-form solutions. After the main results, this article offers some testable implications for developing an empirical analysis or research alliances, along with some suggestions for how the formal model might be extended further.

LITERATURE REVIEW

Vast scholarly research investigates alliances from different perspectives, such as motivation (e.g., Ahuja 2000), performance (e.g., Stuart 2000), and the role of interorganizational routines (e.g., Zollo, Reuer, and Singh 2002). Strategy scholars also note tensions due to goal divergence (Doz 1996), coordination and appropriation (e.g., Gulati and Singh, 1998), and the coexistence of cooperation and competition in learning alliances (Khanna, Gulati, and Nohria 1998). In their literature review, Kale and Singh (2009) discuss the paradox and the managerial dilemmas of strategic alliances. Hagedoorn (2002) also reviews some major sectorial trends for research alliances.

The present analysis appears at the crossroads of strategy and economics literature pertaining to research alliances, the theory of the firm, and research that studies value creation and capture analytically. This effort is consistent with a trend whereby the classic question of how a firm can create a sustainable competitive advantage gets redefined as questions about how the firm can create and capture value (e.g., Nickerson, Silverman, and Zenger 2007). Finally, this study responds to the call to integrate emergent literature on cooperation with more consolidated literature pertaining to competition (Hoffmann, Lavie, Reuer, and Shipilov 2014).

Theoretically, transaction cost economics and property rights theory provide the main components of the theory of the firm used to examine interfirm relations. Since Coase's (1937) ground-breaking article, widespread agreement indicates that such relations can be understood only by considering transaction, coordination, and contracting costs. Klein, Crawford, and Alchian (1978) and Williamson (1979), provide deeper analyses of transactions and consider the problem in terms of an ex post negotiation to allocate quasi-rents. These analyses reveal the inefficiencies due to contract incompleteness, opportunistic behavior, and hold-up threats when firms are locked in a bilateral monopoly. From efficiency and cost minimizing perspectives, scholars also study the choice of alternative governance forms and contractual arrangements (e.g., Oxley 1997).

Whereas transaction cost economics focuses on opportunism and conflict, Zajac and Olsen

(1993) investigate *transactional value* rather than transaction costs, such that the main consideration is joint value maximization rather than opportunism. Their interest is in the emergence of shared interests when opportunities for joint gains emerge and information gets acquired. Ring and Van de Ven (1992) also investigate how firms can rely on repeated transactions and trust to mitigate the risk of transacting. Dyer and Singh (1998) advance a relational view that reveals key aspects of the interorganizational rent-generating process. Vast literature now focuses on relational rather than transactional exchanges, in which the mechanism of trust can be interpreted as willingness to economize on safeguarding behaviors, with the assumption that the counterpart will not exploit any resulting vulnerability (e.g., Lewicky, McAllister, and Bies 1998; Mayer, Davis, and Schoorman 1995; Rousseau et al. 1998).

Pharke's (1993) work is also pertinent, in that he blends transaction cost economics with insights from game-theoretical reasoning. Using a prisoner's dilemma, Pharke derives hypotheses about the emergence of cooperation with an expectation of future transactions. Alternative mechanisms that produce relational capital and trust rest instead on past history and prior transactions (e.g., Gulati 1995). In both cases, time is part of the equation; trust can emerge in the shadow of either the past or the future (Poppo, Zhou, and Ryu 2008). Furthermore, research has addressed how relational capital and trust affect the complexity of contractual agreements, by complementing or substituting their structure (e.g., Poppo and Zenger 2002; Vanneste and Puranam 2010).

Property rights theory more formally describes how firms' incentives change with the distribution of property rights and control. Grossman and Hart (1986) illuminate firms' incentives to make relation-specific investments in a bargaining setting with both "lateral" and "vertical" integration; Hart and Moore (1990) offer a generalization for a multi-agent, multi-asset cooperative setting. Such formal research reveals that in a world of incomplete contracts, property rights protect the owner by conferring ex post control over assets and shifting the parties' next best alternatives in negotiations, which ultimately affect their incentives to invest ex ante. Aghion and Tirole (1994) apply property rights theory to the management of innovation, and Rajan and Zingales (1998) discuss a similar but alternative mechanism based on access rather than ownership.

Whereas property rights theory focuses on incomplete contracts and one-shot transactions, a relational view also allows for repeated interaction. For example, Baker, Gibbons and Murphy (2002) examine the (endogenous) enforcement of agreements, or *implicit* contracts, in a repeated

game model. Game-theoretical reasoning, familiar to industrial economists studying market competition and collusion (e.g., Tirole 1988), suggests that even if players are trapped in a prisoner's dilemma and behave opportunistically in one-time interactions, cooperation may emerge in equilibrium through repeated interaction. The so-called *folk theorem* further states that the prisoner's dilemma can be resolved if the players do not discount future profits too much. Building on this mechanism to characterize relational exchange and trust it becomes possible to establish that in equilibrium, cooperation and mutual trust can emerge, and players rationally expect that the opponents will not behave opportunistically, even though doing so is the dominant strategy for a one-shot game (Pharke 1993).

Traditional organizational economics can reveal the determinants of partners' incentives and contributes to an understanding of how transaction value is generated. Yet it ignores issues pertaining to value capture and co-opetition. Formal strategy literature pertains more directly to this issue. In an important contribution to the foundations of strategy, Branderburger and Stuart (2007) advance a *biform game* that combines value creation, competition, and value capture. Chatain (2011) also studies buyer-supplier relationships, Jia (2013) investigates the decision to invest in relation-specific assets, and Adegbesan and Higgins (2010) predict and test the determinants of value appropriation in research alliances. All these articles use cooperative game theory, offering a value creation and capture perspective that enriches strategy scholars' repertoire of approaches for investigating firm performance.

Alternative game-theoretical approaches in strategy also exist, and Khanna's (1998) analytical assessment of alliances in which partner firms opportunistically attempt to outlearn each other is pertinent. Because they engage in a learning race that creates tensions, firms must manage the balance between trying to learn and trying to protect. In a different race marked by a different tension, the present study proposes that partners engage in competition to maintain or ameliorate their power while investing to create value. Gambardella and Panico (2013) similarly use an incomplete contracts setting to investigate partners' incentives in relation to the allocation of intellectual property rights and decision rights yet they do not account for the co-opetive dimension of research alliances.

Although it resonates with the spirit of analytical works related to value creation and capture, our modelling approach differs. Instead of dealing with a cooperative game approach, this approach addresses bilateral bargaining, to investigate more closely firms' strategic behavior and the tensions due to the simultaneous existence of cooperation and competition. The model

also features vanishing competition for value due to the emergence of trust in a setting with repeated interactions, to reveal the conditions in which partner firms engage in a sequence of cooperative instead of co-opetitive alliances and no longer have to exert wasteful value capture efforts.

Following a standard approach in organizational economics, the model includes two stages: In the first stage, firms make independent and simultaneous (value creation and capture) choices that shape the environment of the second stage. Unlike previous works that consider either a Nash bargaining setting with exogenous power indexes (e.g., Grossman and Hart 1986) or a cooperative setting with exogenous confidence indexes (e.g., Branderburger and Stuart 2007), this approach directly addresses the question of how the power indexes can be endogenously determined by the parties' value capture efforts. The model of the race for power between partners borrows from Tullock's (1980) analysis of the relation between rents generated and resources wasted by rational agents who engage in a contest to capture those rents. The weights of the generalized Nash bargaining solution correspond to power indexes that depend on firms' value capture efforts. Beyond the one-shot alliance game, which reveals equilibrium interorganizational strategies, it is possible to extend the analysis to a repeated game setting, such that the partner firms solve the prisoner's dilemma that underlies a research alliance, and trust emerges in equilibrium.

MODEL SET UP

Consider a situation in which a *company* engages a *counterpart* in an alliance to develop a research project. The project requires a combination of competencies across organizational boundaries and the use of two assets. By committing resources and making joint research investments, the partners can create value, but they also generate a situation of mutual interdependence. The partners can trust each other or not, and to govern the alliance, they must rely on an incomplete contract; they cannot specify the investments or how the alliance value will be allocated. The partners' relative positions in the alliance also depend on the distribution of property rights over the committed assets, which might entail either separation or integration. With separation, each partner owns and controls one of the critical assets, and the company needs the counterpart both for its asset and for its competence. With integration, the company controls both assets, and so it needs the counterpart only for its competence. The partners anticipate that they will negotiate to allocate the alliance value, and more control provides

8

greater incentives to invest. Both parties are risk neutral.

The alliance value V, increases at a decreasing rate with value creation investments, $v_1 \geq 0$ for the company and $v_2 \geq 0$ for the counterpart. Because it is uncertain[2]

$$V(v_1, v_2, \omega) = 2\omega \left(\sqrt{v_1} + \sqrt{v_2} \right), \tag{1}$$

where ω is a stochastic variable, with $\omega \in \mathbb{R}^+$ and $E(\omega) = \hat{\omega}$, introduced to account for future contingencies pertaining to coordination costs and market conditions, and that can affect the value creation process. The partners observe the realization of ω only ex post, after they have invested resources in research.

As an alternative to forming an alliance, the parties may obtain *outside options* corresponding to internal development or the project. With separation, the company and the counterpart use the assets separately, and their value creation investments allow them to obtain deterministic outside options that increase at a decreasing rate and are assumed to be $2\sqrt{v_1}$ and $2\sqrt{v_2}$. With integration, though the company owns both assets, it can effectively use only one of them, because it does not possess the required competence, and so its outside option must still equal $2\sqrt{v_1}$. The counterpart instead owns no asset, so it earns a payoff of zero. With either separation or integration, the partners form an alliance only if they expect to obtain a (equilibrium) payoff that is greater than the outside option associated with internal development.

The partners cannot establish v_1 and v_2 contractually, nor can they allocate V, which instead will be established by negotiating ex post after having observed ω. The partners' negotiation payoffs also depend on their relative bargaining power, which is endogenously determined by the value capture efforts, $e_1 \geq 0$ for the company and $e_2 \geq 0$ for the counterpart. Thus, in addition to the value-creating investments, the parties can devote resources to maintaining their favorable positions, engaging in a race to gain power. The company's and the counterpart's power when negotiating then are determined by the power indexes $\frac{e_1}{e_1+e_2}$ and $\frac{e_2}{e_1+e_2}$.[3]

After having invested in research, instead of negotiating, the partners could terminate the alliance to obtain certain *reservations payoffs*. With separation, if the alliance is terminated, each party can capitalize on the asset it controls, in which case they should obtain the same

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[2] The alliance value is additive separable and symmetric in the investments, to simplify the derivation of the equilibrium results and the exposition of the findings. To account for the asymmetric role of investments and for nonadditivity, Equation (1) could be generalized to the case $V = 2\omega(v_1^\alpha + v_2^\beta)^\gamma$, $\alpha, \beta, \gamma \in (0, 1)$.

[3] Following literature on contests (Tullock 1980), the indexes are contest functions that increase with partner's value capture effort and sum to 1. The model again maintains symmetry. It is also possible to use the more general funtions, $\frac{\rho e_1}{\rho e_1+(1-\rho)e_2}$ and $\frac{(1-\rho)e_2}{\rho e_1+(1-\rho)e_2}$, with $0 \leq \rho \leq 1$ measuring the partners' relative power.

payoffs as in the case of internal development, $2\sqrt{v_1}$ and $2\sqrt{v_2}$. With integration, the counterpart's null reservation payoff coincides with internal development, but the company, after the counterpart has invested, can capitalize on the overall value creation investments, because it owns both assets, to obtain a payoff $2\sqrt{v_1}+2\sqrt{v_2}$. Although the partners might always prefer to negotiate instead of terminating the alliance (see Assumption 1), the ownership pattern matters for the creation and allocation of alliance value, through its effect on the partners' incentives.

Timing and equilibrium concepts. In this study setting, the partners act noncooperatively in the first stage and make choices, both simultaneously and independently, that shape the bargaining environment of the second stage. In the first stage, v_1, v_2, e_1, and e_2 are determined using the *Nash equilibrium* as a solution concept. In the second stage, when they have observed the realization ω and the actual alliance value V, the partners become involved in frictionless bargaining; the negotiation outcome corresponds to the *generalized Nash bargaining* solution, with weights corresponding to the partners' power indexes. To allow for repeated interactions, the *perfect Nash equilibrium* concept also might be applied.

To clarify the configuration of control, the value creation investment v_1 and v_2, the value capture effort e_1 and e_2, and the shock ω, Figure 1 depicts the proposed model of research alliances.

Figure 1 about here.

Payoffs functions. Assuming linear costs for the value creation investments and the value capture efforts, with separation, the outside options and reservation payoffs are

$$2\sqrt{v_1} - v_1 \tag{2}$$

for the company and

$$2\sqrt{v_2} - v_2 \tag{3}$$

for the counterpart. With integration, the counterpart's outside option and reservation payoff are zero, whereas the company obtains the payoff in Equation (2), due to internal development and a payoff

$$2\sqrt{v_1} + 2\sqrt{v_2} - v_1, \tag{4}$$

with termination ex post.

The payoffs corresponding to the Nash bargaining solution are readily obtained by computing

the quasi-rents q, which reflect the difference between the alliance value and the reservation payoffs, equal to

$$
\begin{aligned}
q(v_1, v_2, \omega) &= 2\omega \left(\sqrt{v_1} + \sqrt{v_2} \right) - 2\sqrt{v_1} - 2\sqrt{v_2} \\
&= 2(\omega - 1) \left(\sqrt{v_1} + \sqrt{v_2} \right).
\end{aligned}
\tag{5}
$$

Assumption 1. $\Pr(\omega > 1) = 1$, *such that the alliance is never terminated.*

This assumption indicates that the quasi-rents do not depend on the ownership pattern, which excludes the possibility that, ceteris paribus, separation or integration leads to different alliance value. This assumption has an important economic meaning and supports a clear focus on the *incentive-based* explanation for the creation of alliance value, abstracting from the *efficiency-based* effects due to the allocation of property rights. Assumption 1 also establishes that the reservation payoffs serve as threat points that are never chosen in equilibrium, because the quasi-rents are always positive, and it is always convenient for both partners to continue the alliance (for a similar view, see Grossman and Hart 1986). Finally, Assumption 1 implies that the parties never prefer the option of internal development, such that the alliance is always formed.

The partners' ability to influence the allocation of value is expressed by their power indexes, which are the endogenously determined weights to be used in the generalized Nash bargaining solution. The expected payoffs from forming an alliance with separation of assets are

$$
2\sqrt{v_1} + \frac{e_1}{e_1 + e_2} E[q(v_1, v_2, \omega)] - v_1 - e_1
\tag{6}
$$

for the company, and

$$
2\sqrt{v_2} + \frac{e_2}{e_1 + e_2} E[q(v_1, v_2, \omega)] - v_2 - e_2
\tag{7}
$$

for the counterpart. With integration, the expected payoffs instead are, respectively,

$$
2\left(\sqrt{v_1} + \sqrt{v_2} \right) + \frac{e_2}{e_1 + e_2} E[q(v_1, v_2, \omega)] - v_1 - e_1,
\tag{8}
$$

and

$$
\frac{e_2}{e_1 + e_2} E[q(v_1, v_2, \omega)] - v_2 - e_2.
\tag{9}
$$

If partners engage in a alliance marked by mutual trust, they should be willing to skip

11

safeguarding measures and remain vulnerable, without engaging in a race to gain power, with the assumption that the other party will do the same. In the model, this scenario translates into value capture efforts that equal 0, $e_1 = e_2 = 0$, and equivalent power indexes[4]such that Equations (6) and (7) reduce to

$$2\sqrt{v_1} + \frac{1}{2}E[q(v_1, v_2, \omega)] - v_1, \tag{10}$$

and

$$2\sqrt{v_2} + \frac{1}{2}E[q(v_1, v_2, \omega)] - v_2, \tag{11}$$

and Equations (8) and (9) reduce to

$$2\left(\sqrt{v_1} + \sqrt{v_2}\right) + \frac{1}{2}E[q(v_1, v_2, \omega)] - v_1, \tag{12}$$

and

$$\frac{1}{2}E[q(v_1, v_2, \omega)] - v_2. \tag{13}$$

Benchmark. Having illustrated the model, it now is possible to analyze the strategic interaction between the company and the counterpart. As a benchmark for this analysis, consider the ideal case in which the partners not only cooperate and avoid competition, but also can coordinate their value creation investments. Thus, in addition to having $e_1 = e_2 = 0$, they choose v_1 and v_2 to maximize the aggregate payoff from forming an alliance. Let $v^0(\hat{\omega})$ be the optimal value creation investment in this case. The following result is straightforward, without need for a proof.

Result. *With coordination, the alliance always forms, and the allocation of property rights is irrelevant; the partners make value creation investments $v^0(\hat{\omega}) = \hat{\omega}^2$ and obtain an expected payoff $\hat{\omega}^2$.*

This preliminary result is consistent with the intuitive finding that, absent any transaction costs, the distribution of property rights is irrelevant (Grossman and Hart 1986). Having set the benchmark, the analysis then continues to address the partners' strategic behavior when they make their ex ante decisions noncooperatively, deriving the equilibrium outcomes for separation and integration. The next section starts with a transactional exchange and a one-shot

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[4]The model can be generalized to the case of an asymmetric power distribution, with the firm and the counterpart having power ρ and $1 - \rho$, respectively, $\rho \in [0, 1]$.

interaction, both with and without trust, then addresses the case of relational exchange with (expected) repeated interactions, to study the emergence of trust in equilibrium.

ANALYZING INTERORGANIZATIONAL STRATEGIES

If partners engage in a one-shot alliance, the separate assessments of the cases of separation and integration of assets involve comparisons with and without trust. Then comparison of the equilibrium results highlights the dependence of partners' behavior on the allocation of control and the existence of trust.

Strategizing with separation of assets

When the company and the counterpart control separate assets, they can capitalize on their value creation investments in the hypothetical case in which the alliance is terminated ex post. With the possibility of obtaining a positive reservation payoff, both partners take a reasonable negotiation position, so their incentives are balanced. Two propositions highlight how their decisions depend on the presence of trust.

Proposition 1 *With trust and separation of assets, the alliance always forms; the company and the counterpart make value creation investments $\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega}+1}{2}\right)^2$ and obtain expected payoffs $\frac{1}{4}(\hat{\omega}+1)(3\hat{\omega}-1)$.*

Proposition 2 *Without trust and with separation of assets, the alliance always forms; the company and the counterpart make value creation investments $\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega}+1}{2}\right)^2$, exert value capture efforts $\bar{e}(\hat{\omega}) = \frac{1}{2}(\hat{\omega}^2 - 1)$, and obtain expected payoffs $\left(\frac{\hat{\omega}+1}{2}\right)^2$.*

Comparing Propositions 1 and 2, value creation investments thus do not depend on whether there is trust or not, because the partners always invest $\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega}+1}{2}\right)^2$ in equilibrium. Both with and without trust, the quasi-rents are shared equally, because absent trust the partners exert the same value capture efforts and obtain equal power indexes. That is, absent trust, the parties are trapped in a prisoner's dilemma: It is individually rational to exert value capture efforts, but in equilibrium these costly tactics are ineffective. Both parties would gain if they focuses on creating value, but this strategy is strictly dominated by a strategy in which the partners balance value creation and value capture. Despite the waste or resources, forming an alliance with separation of assets is preferred to internal development.

With separation of assets, the partners' relative positions in the alliance are symmetric, as reflected in the equal investments and efforts observed in equilibrium.

Strategizing with integration of assets

With integration, the company can capitalize overall value creation investments even if the alliance is terminated, whereas the counterpart receives nothing. This asymmetry in the reservation payoffs changes the partners' relative bargaining position and affects incentives to invest in value creation and capture. Two propositions arise:

Proposition 3 *With trust and integration of assets, the alliance always forms; the company makes a value creation investment* $\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega}+1}{2}\right)^2$ *and obtains an expected payoff* $\frac{1}{4}(\hat{\omega}+1)(3\hat{\omega}-1)$, *whereas the counterpart makes a value creation investment* $\underline{v}(\hat{\omega}) = \left(\frac{\hat{\omega}-1}{2}\right)^2$ *and obtains an expected payoff* $\frac{1}{4}(\hat{\omega}-1)(3\hat{\omega}+1)$.

Proposition 4 *Without trust and with integration of assets, the alliance always forms; both partners exert value capture efforts* $\underline{e}(\hat{\omega}) = \frac{1}{2}\hat{\omega}(\hat{\omega}-1)$; *the company makes a value creation investment* $\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega}+1}{2}\right)^2$ *and obtains an expected payoff* $\frac{\hat{\omega}^2-1}{4} + \hat{\omega}$; *the counterpart makes a value creation investment* $\underline{v}(\hat{\omega}) = \frac{1}{4}(\hat{\omega}-1)^2$ *and obtains an expected payoff* $\frac{1}{4}(\hat{\omega}^2-1)$.

Similar to the case of separation of assets, the partners' value creation investments do not depend on whether there is trust, and absent trust, they face a prisoner's dilemma. Yet both parties prefer to form an alliance. Integration presents a few additional features though in that the company acquires a stronger bargaining position when negotiating. Whereas the counterpart's incentives to invest diminish, because it does not control any asset and $\underline{v}(\hat{\omega}) < \bar{v}(\hat{\omega})$, the company makes always the same value creation investment, $\bar{v}(\hat{\omega})$. According to the additive separable assumption, even if the change of one party's investment affects the level of value created, it has no effect at the margin on the partner's incentives.

Comparing integration and separation of assets

The comparison between Propositions 2 and 4 illuminates a trade-off in the different configurations of control. On the one hand, the integration of assets reduces the partners' value capture efforts, fewer resources are wasted on costly, ineffective tactics in the race for power. On the other hand, the integration of assets reduces value, because the partners invest less overall in value creation. Moreover, proportionally more resources are wasted in value capture. Therefore,

Corollary 1 *Integration minimizes the partners' value capture efforts,* $\underline{e}(\hat{\omega}) < \bar{e}(\hat{\omega})$, *whereas separation maximizes overall value creation investments,* $\underline{v}(\hat{\omega}) + \bar{v}(\hat{\omega}) < 2\bar{v}(\hat{\omega})$.

Corollary 2 *Separation minimizes the ratio between total value capture efforts and total value creation investments, $\frac{\bar{e}(\hat{\omega})}{\bar{v}(\hat{\omega})} < \frac{2\underline{e}(\hat{\omega})}{\bar{v}(\hat{\omega})+\underline{v}(\hat{\omega})}$.*

Whereas Corollary 1 indicates that the total value capture efforts are minimal in absolute terms with integration of assets, Corollary 2 clarifies that such efforts are greater than the value creation investments.

Another interesting point is how partners' expectation about the alliance value influences their decision to invest in value capture relative to value creation, as well as how these choices change in relation to the allocation of control. Propositions 2 and 4 immediately prove the following:

Corollary 3 *As $\hat{\omega}$ increases, with both integration and separation, the partners invest proportionally more in value capture than in value creation, $\frac{d}{d\hat{\omega}}\bar{e}(\hat{\omega}) > \frac{d}{d\hat{\omega}}\bar{v}(\hat{\omega})$ and $\frac{d}{d\hat{\omega}}\underline{e}(\hat{\omega}) > \frac{d}{d\hat{\omega}}\bar{v}(\hat{\omega}) > \frac{d}{d\hat{\omega}}\underline{v}(\hat{\omega})$.*

Figures 2 and 3 depict the scenarios described by Corollaries 1, 2, and 3.

Figure 2, 3, and 4 about here.

Specifically, Figure 2 represents equilibrium efforts and investments with separation of assets. Both $\bar{e}(\hat{\omega})$ and $\bar{v}(\hat{\omega})$ increase with $\hat{\omega}$, but the former increases faster than the latter, $\frac{d}{d\hat{\omega}}\bar{e}(\hat{\omega}) > \frac{d}{d\hat{\omega}}\bar{v}(\hat{\omega})$. In Figure 3, with integration of assets, the company's investment increases faster than the counterpart's, but both parties focus relatively more on value capture, $\frac{d}{d\hat{\omega}}\underline{e}(\hat{\omega}) > \frac{d}{d\hat{\omega}}\bar{v}(\hat{\omega}) > \frac{d}{d\hat{\omega}}\underline{v}(\hat{\omega})$. Finally, comparing Figure 2 and 3 reveals that the ratio between value capture and value creation is always larger with integration, $\frac{\bar{e}(\hat{\omega})}{\bar{v}(\hat{\omega})} = 2\frac{\hat{\omega}-1}{\hat{\omega}+1} < \frac{2\underline{e}(\hat{\omega})}{\bar{v}(\hat{\omega})+\underline{v}(\hat{\omega})} = 2\frac{\hat{\omega}}{\hat{\omega}+1}$.

The last comparison between integration and separation pertains to partners' equilibrium payoff when engaging in the alliance. Specifically,

Corollary 4 *With trust, the company obtains the same payoff with separation and integration, whereas the counterpart obtains a greater payoff with separation.*

Corollary 5 *Without trust, the company obtains a greater payoff with integration, whereas the counterpart obtains a greater payoff with separation.*

Whether there is trust or not, the counterpart always prefers separation, because it can maintain a more favorable bargaining position and thus obtain a larger payoff. The company's

payoffs instead change. With trust, the company is indifferent, because integration of assets allows it to capture more of the value created, but that value is lower, and the two effects offset each other in equilibrium. Absent trust, the company obtains a greater payoff with integration, because in addition to maintaining a better bargaining position, it exerts a lower value capture effort in equilibrium. Also, the aggregate payoffs are larger with separation of assets, whether there is trust or not. Figure 4 depicts the company's equilibrium payoffs.

FROM *CO-OPETITION* TO *COOPERATION*: RELATIONAL EXCHANGE AND THE EMERGENCE OF TRUST

This section extends the preceding analysis to the case in which partner firms expect to form alliances repeatedly over time. Using standard techniques from the theory of repeated games, it is possible to study the conditions in which a trust equilibrium emerges, that is, an equilibrium in which the partners engage in a sequence of alliances without value capture concerns, $e_1 = e_2 = 0$.

Formally, this investigation refers to the strategic interaction between partners that repeat the one shot-game. Each time the partners form a alliance, they expect to be interacting again in the next period, with a probability of $\delta \in (0, 1)$.[5] With this extension, the shadow of the future can provide the right incentives to the parties, such that they exert no value capture effort each time they form a alliance, which would resolve the prisoner's dilemma.

In line with most game-theoretical literature, the partners likely use the following strategy each time they form a alliance: They exert no value capture effort if the partner did the same in the previous alliance, but otherwise they exert value capture efforts and pursue the Nash equilibrium of the one-shot game in all future alliances.[6] Each time they form an alliance, the partners make a choice between two options. The first option is to focus on collaborating and avoid the competition for value, in anticipation of the future payoffs in the presence of mutual trust. The second option is to deviate from such strategy, fooling the partner and capturing the full alliance value at first, and then obtaining lower payoffs in the future alliances because there will be no trust. For trust equilibrium with separation:

Proposition 5 *With separation of assets, a trust equilibrium emerges if the probability of a repeated interaction is $\delta > \delta^0(\hat{\omega}) \in (0, 1)$, with $\frac{d\delta^0(\hat{\omega})}{d\hat{\omega}} > 0$.*

In addition to the familiar reasoning that the prisoner's dilemma can be resolved if it is

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[5] Equivalently, the assumption could be that the parties interact for an infinite number of periods, and δ is the intertemporal discount rate.

[6] In game theory, this strategy constitutes an example of a *trigger, grim, Nash-reverting strategy*.

very likely that partners will form future alliances, or δ is close enough to 1, $\delta^0(\hat{\omega})$ increases with $\hat{\omega}$ (see Figure 5). Therefore, for trust to emerge, the probability of repeated alliances must increase with the potential value of the alliance. When $\hat{\omega}$ increases, the payoff from deviating and capturing all the value created in the alliance increases faster than the expected payoff from future alliances.

Because of the symmetry of the model, separation of assets provides a unique condition over δ for both partners. With integration though, the partners have different payoffs and incentives, and thus,

Proposition 6 *With integration of assets, a trust equilibrium emerges if the probability of a repeated interaction is $\delta > \max\left\{\delta^1(\hat{\omega}), \delta^2(\hat{\omega})\right\} \in (0,1)$.*

With the two different conditions over δ – one for the company, $\delta > \delta^1(\hat{\omega})$, and one for the counterpart, $\delta > \delta^2(\hat{\omega})$ – trust can be sustained in equilibrium if both conditions are satisfied. As illustrated in Figure 5, when $\hat{\omega}$ is low, the company has a greater incentive than the counterpart to deviate and capture the full value in the short run, and $\delta^1(\hat{\omega}) > \delta^2(\hat{\omega})$. As $\hat{\omega}$ increases, the counterpart's deviation payoff increases faster, and eventually $\delta^1(\hat{\omega}) < \delta^2(\hat{\omega})$. Also note that $\delta^1(\hat{\omega})$ has an inverted-U shape, whereas $\delta^2(\hat{\omega})$ is monotonic.

Figure 5 about here.

Another interesting aspect to investigate is which configuration of control facilitates the emergence of mutual trust between partners. This question can be answered immediately by comparing the thresholds $\delta^0(\omega)$, $\delta^1(\omega)$, and $\delta^2(\omega)$, such that

Proposition 7 *A trust equilibrium is more likely to emerge with integration than with separation, $\delta^0(\omega) > \max\left\{\delta^1(\omega), \delta^2(\omega)\right\}$.*

Trust likely can be sustained more easily in equilibrium if the partners' bargaining positions and payoffs are less similar, as with integration. Also, according to Corollary 4, the counterpart always prefers separation when there is trust. Nevertheless, Corollary 1 indicates that the value created is greater with separation, implying that the parties have more incentives to deviate and capture the full value. For this reason, $\delta^0(\omega)$ is larger than $\delta^1(\omega)$ and $\delta^2(\omega)$, and trust is more likely to emerge with integration of assets. Figure 5 depicts these findings.

THEORETICAL FINDINGS AND TESTABLE IMPLICATIONS: THE CASE OF ALLIANCES IN THE BIOPHARMACEUTICAL INDUSTRY

Research alliances create significant tensions, because partners commit resources and cooperate to create value in a situation of mutual interdependence, but they also compete to maintain their power positions. In a world of incomplete contracts, partners' equilibrium behavior within co-opetitive alliances also depends on their control of the assets, through the influence of modifications to the reservation payoffs when bargaining ex post. The proposed model reveals the key economic drivers of interorganizational strategies, shedding light on the managerial challenge associated with balancing value creation and value capture.

First, partner firms are trapped in a classical prisoner's dilemma: They would be better off avoiding costly and totally ineffective power-seeking tactics, and yet each party has the incentive to try to outpower the partner to capture more value (Propositions 1-4). It is exactly when alliances are more valuable that the tension between cooperation and competition becomes stronger (Corollaries 1-3). Thus, though partners invest more in value creation, they invest proportionally more in value capture, meaning that more and more resources are wasted.

Second, the equilibrium analysis reveals a trade-off between separation and integration. Alliances between partners that have more balanced positions, when assets are separated, can generate greater value because the investments are greater relative to the case of integration. Nevertheless, with separation, more resources get wasted in equilibrium, because partners also have greater incentives to compete (Corollary 1). This result sends an important message to firms that are in the position to choose between transacting with a separate party or vertically integrating it by acquiring its assets.

Third, the results reveal the mechanisms of relational capital and trust. Whereas with a one-shot alliance, the fear of opportunism is inevitable, partners that expect to engage in patterns of repeated alliances may have the appropriate incentives to turn co-opetitive alliances into cooperative ones, coordinating over a trust equilibrium. Trust has the greatest impact when an alliance is more valuable, because the tension between cooperation and competition becomes stronger. Nevertheless, trust is rarely established for more valuable alliances, because partners have greater incentives to capture the value created. Furthermore, trust is less likely with separation of assets, because the competition for value grows stronger when partners have more balanced positions.

The empirical phenomenon: alliances in the biopharmaceutical industry

The findings have clear positive implications for the function of research alliances and offer a fertile ground for empirical analyses of research alliances. To put some of these implications in perspective, consider the context of a well-investigated setting, namely, alliances between pharmaceutical companies and fully dedicated biotechnology firms (Pisano 1996). The biopharmaceutical industry is a favorite target of empirical contract theory (e.g., Lerner and Merges 1998) and strategy and innovation scholars (e.g., Arora and Gambardella 1990, 1994; Reuer and Zollo 2005; Rothaermel and Boeker 2008; Shan, Walker and Kogut 1994), though few of these works adopt a value creation and capture perspective (e.g., Adegbesan and Higgins 2010; Diestre and Rajagopalan 2012; Panico 2011).

Pharma companies are large, established firms that own assets for conducting research, manufacturing, and commercialization; biotechs are research-intensive firms that possess biotech-based competencies and technologies. Many are new biotechnology firms (NBFs) that do not own (substantial) assets, but a few bigger firms have become or are on their way to becoming integrated biotech companies (IBCs; e.g., Amgen, Genentech). By combining their assets and competencies, big pharma companies and smaller biotechs can develop viable drug candidates. The alliances that they form are crucial for the success of both early-stage and late-stage R&D projects. Suppose that the scope of the alliance is to develop a project that calls for a combination of competencies across organizational boundaries and for the use of two critical assets or technologies. The partners' research efforts can create alliance value while possibly opening the door to future collaborations.

The partners' interorganizational strategies may differ, according to two scenarios.

First scenario: combining competencies with integration of assets.

In this scenario the pharma company owns and controls the assets that are needed to carry out the research project, and it forms an alliance with a NBF that possesses biotech-based competencies but no critical assets. Thus the company grants regulated access to its assets and only needs the biotech to tap new sources of knowledge. The asymmetric nature of the alliance is such that the NBF is in an unfavorable position, whereas the company that controls all the assets has a much better bargaining position.

Second scenario: combining competencies with separation of assets.

In this second scenario, the pharma company forms an alliance with a bigger research firm that is on its way to becoming an IBC and that owns one asset. The company owns the second

asset, so the partners share their assets in addition to combining their competencies. The IBC enjoys a better position for negotiating ex post with the company; it now controls a critical asset and therefore it has a reasonable next best alternative.

How do the pharma company and the biotech behave in the two scenarios? Intuition and standard property rights theory suggest that the company and the biotech have different incentives. But the important demand is to understand how the pharma company and the biotech manage the balance between value creation and value capture. In the scenario with asset integration, the company and the biotech invest less in value capture and value creation relative to the case of asset separation, which suggests an important trade-off: If the assets used to conduct research remain fixed, alliances between pharma companies and IBCs have the potential to create greater value, because they induce greater overall investments, whereas more resources get wasted in the competition for capturing alliance value. The model also predicts that for both separation and integration, when the pharma company and the biotech have the ability to create more, value they invest relatively more in value capture than in value creation. In more profitable alliances, even though firms obtain greater profits, proportionally more resources are wasted when they compete instead of cooperate.

The next goal is to understand the pharma and the biotech's strategies when, due to the prospects of future collaborations, they abandon a transactional perspective and embrace a relational one. If mutual trust emerges, the competition for value vanishes, so the company and the biotech can focus on creating value. But it is unclear if trust arises more easily in an alliance between a company and a NBF that owns no critical asset, or in an alliance between a company and an IBC that share assets. The partners also could be more or less willing to trust each other depending on the value associated with the alliance. The proposed model predicts that in the first scenario (company and biotech invest less in value capture), relational capital forms more easily, and trust emerges more readily. These findings inform the development of testable hypotheses that can reveal how the same drivers that define pharmas' and biotechs' ability to create value also enhance incentives to compete but lower incentives to trust. Control over the assets also moderates these effects.

Prior empirical findings show that the research alliances between pharma companies and biotechs generate more value when there is greater *technological relatedness* between partners and when the pharma company has greater *development experience* (e.g., Rothaermel and Boeker 2008). These two dimensions can affect the partners' value creation and appropriation

concerns, as in Diestre and Rajagopalan's (2012) analysis of partner selection in biotechnology ventures. Moving beyond the probability of alliance formation studied by Diestre and Rajagopalan, the present analysis provides value creation and capture arguments for hypothesizing about partners' behavior when an alliance forms.

By relating the expectation of the alliance's value to the technological relatedness between the pharma company and the biotech in the focal alliance and to the pharma's development experience, the theoretical findings lead to the following testable implications.

Hypothesis 1a. *Greater technological relatedness and greater development experience have positive effects on partners' incentives for value creation.*

Hypothesis 1b. *Greater technological relatedness and greater development experience have a positive effect on partners' incentives for value capture.*

Hypothesis 2a. *The overall value creation investments are greater when the pharma company and the biotech have more equal control over the assets committed to the alliance.*

Hypothesis 2b. *The overall value capture efforts are greater when the pharma company and the biotech have more equal control over the assets committed to the alliance.*

Hypothesis 3a. *Mutual trust is negatively associated with greater technological relatedness and greater development experience.*

Hypothesis 3b. *Mutual trust is negatively associated with more equal control over the assets committed to the alliance.*

These hypotheses suggest that value creation and capture covary when relatedness and experience increase (Hypotheses 1a and 1b), and when the pharma company and the biotech have more equal control over assets (Hypotheses 2a and 2b). Moreover, according to Hypotheses 3a and 3b, pharma companies and biotechs that share control and engage in high value, low frequency alliances have a harder time trusting each other, because the greater emphasis on cooperation to create value is accompanied by greater competition for value. Instead, partners firms that engage in low value, high frequency alliances invest less in value creation but face less competitive pressure, leaving them ultimately more willing to trust each other.

The theoretical findings and testable implications reveal important strategic mechanisms of research alliances. Further refinements could address other drivers of firms' incentives for value capture. For example, following Diestre and Rajagopalan's (2012) reasoning, attributes such as diversity in the pharma's therapeutic areas and the biotech's breadth of knowledge

21

can moderate the effect of technological relatedness and development experience on partners' incentives.

LIMITATIONS AND EXTENSIONS

This model focuses on some key drivers of interorganizational strategies but also does not account for some other important aspects; before concluding this analysis, it is important to suggest three possible extensions.

First, this study included the standard assumption that partners always prefer to negotiate as opposed to terminating the alliance, but in reality, termination may occur. For example, there can be unmet expectations (Doz 1996), or firms may want to obtain private benefits (Khanna 1998), and many such relationships are prone to disintegration (Kale and Singh 2009). The proposed framework could be modified to account for termination potential, such as by allowing the alliance value to fall below the aggregate reservation payoff, such that the quasi-rents are negative. Even with the assumption that the alliance will not be terminated on average, two possible scenarios arise. In the first scenario, the partners negotiate as described in the model. But if the quasi-rents are negative, the partners agree to terminate the alliance. Symmetrically, allowing for the extra costs of managing interorganizational relations, beyond those of internal development, the parties could prefer not to form an alliance. Allowing for these simple extensions to the model, further investigations might reveal how considerations due to alliance formation and termination potential add to the tension between value creation and capture.

Second, it may be possible to account for private benefits that are realized only by individual firms, in addition to the common benefits based on the alliance's objective (Dyer and Singh 1998; Khanna, Gulati, and Nohria 1998). Private benefits could result from spillovers to activities not related to the alliance. Such private benefits also could be considered exogenous, or endogenously determined by the partners' behavior when they engage in value appropriation, or else might be driven by the details of the contractual governance (Gambardella and Panico 2013). By allowing for the coexistence of private and common benefits, an extended model could reveal how other attributes (e.g., partners' breadth of knowledge) affect the value creation and capture incentives.

Third, further research should relax the risk neutrality assumption. Introducing risk aversion in the analysis would reveal how partner firms react to greater variance in the alliance value,

adding to the comparative statics exercise about the expected value of ω. This analysis could also overlap with the case of termination potential. With both extensions to the model, it would be interesting to study how they influence value creation and capture incentives and the emergence of trust.

CONCLUSIONS

This article contributes to the formal strategy literature, offering a value creation and capture model of research alliances in an incomplete contracts setting. The findings reveal that the elements that drive partners' ability to create value also affect their incentives to compete for value, which in turn influences the partners' willingness to trust each other. In high value, low frequency alliances with symmetric control over assets, the greater emphasis on value creation is accompanied by a even greater tension due to the competition for value, and partners ultimately are less willing to trust each other.

This study also expands on insights from classical theories of the firm. Neither transaction cost economics nor property rights theory is primarily concerned with firms' strategic responses to the tension between value creation and capture, or with the emergence and role of trust. The model in this study instead reveals some nuanced links among value creation, value capture, trust, and control, adding more depth to previous studies.

Finally, the theoretical findings suggest the need for hypothesis building in empirical research on alliances. The proposed model of value creation and capture is also amenable to several extensions that could further illuminate the function of interorganizational relations. The empirical analysis and the theoretical extensions remain for further research.

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Appendix

Proof of Proposition 1

The partners' decisions at the first stage are based on the negotiation output that they expect to obtain in the second stage. The model is solved by backward reasoning, and because it is symmetric, it suffices to consider the problem faced by the company. With internal development, by maximizing Equation (2) it is immediately observed that the company obtains an expected payoff of 1. When instead it forms an alliance with the counterpart, the company must choose v_1 to solve

$$\max_{v_1} \quad 2\sqrt{v_1} + \frac{1}{2}E(q(v_1, v_2, \omega)) - v_1 = 2\sqrt{v_1} + (\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) - v_1. \qquad (A1)$$

The solution to Equation $(A1)$ is

$$\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega} + 1}{2}\right)^2, \qquad (A2)$$

which is also the solution to the equivalent problem of the counterpart. Substituting Equation $(A2)$ into $(A1)$, the partners' expected payoff from the alliance is

$$\frac{1}{4}(\hat{\omega} + 1)(3\hat{\omega} - 1), \qquad (A3)$$

which is larger than 1 because $\hat{\omega} > 1$. Therefore, with trust the alliance with separation of assets is preferred by both parties to internal development.

Proof of Proposition 2

The company now must choose e_1 and v_1 to solve

$$\max_{e_1, v_1} \quad 2\sqrt{v_1} + \frac{e_1}{e_1 + e_2}E(q(v_1, v_2, \omega)) - v_1 - e_1$$

$$= 2\sqrt{v_1} + \frac{e_1}{e_1 + e_2}2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) - v_1 - e_1. \quad (A4)$$

Taking the first-order conditions, the optimal value of e_1 and v_1, given e_2 and v_2, correspond to the solution of the following system of two equations:

$$\frac{e_2}{(e_1 + e_2)^2}2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) = 1, \text{ and} \qquad (A5)$$

$$\frac{1}{\sqrt{v_1}} + \frac{1}{\sqrt{v_1}} \frac{e_1}{e_1 + e_2}(\hat{\omega} - 1) = 1. \tag{A6}$$

Equivalently, for the counterpart, the optimal values of e_2 and v_2, given e_1 and v_1, correspond to the solution of the following system of two equations:

$$\frac{e_1}{(e_1 + e_2)^2} 2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) = 1, \text{ and} \tag{A7}$$

$$\frac{1}{\sqrt{v_2}} + \frac{1}{\sqrt{v_2}} \frac{e_2}{e_1 + e_2}(\hat{\omega} - 1) = 1. \tag{A8}$$

The symmetry of the model prompts a search for the symmetric Nash equilibrium. Imposing $e_1 = e_2 = \bar{e}$, $v_1 = v_2 = \bar{v}$, and solving Equations $(A5)$ and $(A6)$, the equilibrium values are

$$\bar{e}(\hat{\omega}) = \frac{\hat{\omega}^2 - 1}{2}, \text{ and} \tag{A9}$$

$$\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega} + 1}{2}\right)^2. \tag{A10}$$

Finally, substituting Equations $(A9)$ and $(A10)$ into $(A4)$, the equilibrium payoff for both partners is

$$\frac{(\hat{\omega} + 1)^2}{4}, \tag{A11}$$

which is larger than 1. Therefore, without trust, the alliance with separation of assets is preferred by both parties to internal development.

Proof of Proposition 3

Similar to the proof of Proposition 1, the company must choose v_1 to solve

$$\max_{v_1} \quad 2(\sqrt{v_1} + \sqrt{v_2}) + \frac{1}{2}E(q(v_1, v_2, \omega)) - v_1$$

$$= 2(\sqrt{v_1} + \sqrt{v_2}) + (\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) - v_1. \tag{A12}$$

The solution to Equation $(A12)$ is

$$\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega} + 1}{2}\right)^2, \tag{A13}$$

which coincides with Equation $(A2)$. The counterpart instead must choose v_2 to solve

$$\max_{v_2} \quad \frac{1}{2}E(q(v_1, v_2, \omega)) - v_2 = (\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) - v_2, \qquad (A14)$$

and the solution is

$$\underline{v}(\hat{\omega}) = \left(\frac{\hat{\omega} - 1}{2}\right)^2. \qquad (A15)$$

Substituting Equations $(A13)$ and $(A15)$ into Equations $(A12)$ and $(A14)$, the company and the counterpart obtain payoffs of

$$\frac{1}{4}(\hat{\omega} + 1)(3\hat{\omega} - 1) \qquad (A16)$$

and

$$\frac{1}{4}(\hat{\omega} - 1)(3\hat{\omega} + 1), \qquad (A17)$$

respectively; Equation $(A16)$ coincides with Equation $(A3)$. By Equation $(A17)$, the company prefers forming an alliance to internal development if

$$\frac{1}{4}(\hat{\omega} + 1)(3\hat{\omega} - 1) \geq 1, \qquad (A18)$$

which is always true.

Proof of Proposition 4

Similar to the proof of Proposition 2, the company chooses e_1 and v_1 to solve

$$\max_{e_1, v_1} \quad 2(\sqrt{v_1} + \sqrt{v_2}) + \frac{e_1}{e_1 + e_2}E(q(v_1, v_2, \omega)) - v_1 - e_1$$
$$= 2(\sqrt{v_1} + \sqrt{v_2}) + \frac{e_1}{e_1 + e_2}2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) - v_1 - e_1. \quad (A19)$$

Taking the first-order conditions, the optimal values of e_1 and v_1, given e_2 and v_2, correspond to the solution of the following system of two equations:

$$\frac{e_2}{(e_1 + e_2)^2}2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) = 1, \text{ and} \qquad (A20)$$

$$\frac{1}{\sqrt{v_1}} + \frac{1}{\sqrt{v_1}}\frac{e_1}{e_1 + e_2}2(\hat{\omega} - 1) = 1. \qquad (A21)$$

The counterpart instead must choose v_2 and e_2 to solve

$$\max_{e_2, v_2} \quad E\left[\frac{e_2}{e_1 + e_2} q(v_1, v_2, \omega) - v_2 - e_2\right]$$

$$= \frac{e_2}{e_1 + e_2} 2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) - v_2 - e_2. \quad (A22)$$

Taking the first-order conditions, the optimal values of e_2 and v_2, given e_1 and v_1, correspond to the solution of the following system of two equations:

$$\frac{e_1}{(e_1 + e_2)^2} 2(\hat{\omega} - 1)\left(\sqrt{v_1} + \sqrt{v_2}\right) = 1, \text{ and} \quad (A23)$$

$$\frac{1}{\sqrt{v_2}} \frac{e_1}{e_1 + e_2}(\hat{\omega} - 1) = 1. \quad (A24)$$

Comparing Equations $(A20)$ and $(A23)$, we can impose $e_1 = e_2 = \underline{e}$; then, solving Equations $(A20)$, $(A21)$, and $(A24)$, in equilibrium the value capture efforts and the value creation investments of the company and the counterpart are

$$\underline{e}(\hat{\omega}) = \frac{1}{2}\hat{\omega}(\hat{\omega} - 1), \quad (A25)$$

$$\bar{v}(\hat{\omega}) = \left(\frac{\hat{\omega} + 1}{2}\right)^2, \text{ and} \quad (A26)$$

$$\underline{v}(\hat{\omega}) = \frac{(\hat{\omega} - 1)^2}{4}. \quad (A27)$$

Finally, substituting Equations $(A25)$, $(A26)$, and $(A27)$ into Equations $(A19)$ and $(A22)$, the equilibrium payoffs are

$$\frac{\hat{\omega}^2 - 1}{4} + \hat{\omega} \quad (A28)$$

for the company, and

$$\frac{\hat{\omega}^2 - 1}{4} \quad (A29)$$

for the counterpart. By Equation $(A29)$, the company prefers forming an alliance to autarky internal development if

$$\frac{\hat{\omega}^2 - 1}{4} + \hat{\omega} > 1, \quad (A30)$$

which is always true.

Proof of Corollaries 1, 2, 3, 4, and 5

Immediate by Propositions 1, 2, 3, and 4.

Proof of Proposition 5

The symmetry of the model makes it sufficient to consider the problem of the company. If the parties set $e_1 = e_2 = 0$, by Proposition 1, they obtain an uniperiod payoff as in Equation $(A3)$, and an expected intertemporal payoff equal to

$$\frac{1}{4}(\hat{\omega} + 1)(3\hat{\omega} - 1)(1 + \delta + \delta^2 + ...) = \frac{1}{4(1 - \delta)}(\hat{\omega} + 1)(3\hat{\omega} - 1). \qquad (A31)$$

Consider the company's incentives to deviate. By exerting an arbitrarily small value capture effort, it obtains a power index of 1 and thus appropriates all the quasi-rent when negotiating. By Proposition 1, the counterpart makes an investment $\bar{v}(\hat{\omega})$, and the company's short-run deviation payoff is

$$2\hat{\omega}(\sqrt{v_1} + \sqrt{\bar{v}(\hat{\omega})}) - 2\sqrt{\bar{v}(\hat{\omega})} - v_1. \qquad (A32)$$

The solution to Equation $(A32)$ is $v_1 = \hat{\omega}^2$, and the optimal deviation payoff is $2\hat{\omega}^2 - 1$. After deviating, in future alliances there is no trust, and by Proposition 2, the parties obtain payoffs as in Equation $(A11)$. Thus, the expected intertemporal deviation payoff is

$$\left(2\hat{\omega}^2 - 1\right) + (\delta + \delta^2 + ...)\frac{(\hat{\omega} + 1)^2}{4} = 2\hat{\omega}^2 - 1 + \frac{\delta}{4(1 - \delta)}(\hat{\omega} + 1)^2. \qquad (A33)$$

By Equations $(A31)$ and $(A33)$, trust can be sustained in equilibrium if

$$\frac{1}{4(1 - \delta)}(\hat{\omega} + 1)(3\hat{\omega} - 1) > 2\hat{\omega}^2 - 1 + \frac{\delta}{1 - \delta}\frac{(\hat{\omega} + 1)^2}{4}, \qquad (A34)$$

or if

$$\delta > \delta^0(\hat{\omega}) = \frac{5\hat{\omega}^2 - 2\hat{\omega} - 3}{7\hat{\omega}^2 - 2\hat{\omega} - 5}. \qquad (A35)$$

It also is possible to confirm that $\delta^0(\hat{\omega}) \in (0, 1)$, increases with $\hat{\omega}$, and converges to $\frac{5}{7}$.

Proof of Proposition 6

If the parties set $e_1 = e_2 = 0$, by Proposition 3, the company and the counterpart obtain uniperiod payoffs as in Equations $(A16)$ and $(A17)$, with expected intertemporal payoffs equal

33

to Equation $(A31)$ for the company and to

$$\frac{1}{4(1-\delta)}(\hat{\omega}-1)(3\hat{\omega}+1) \qquad (A36)$$

for the counterpart. Unlike Proposition 5, the partners have different incentives to deviate.

If the company deviates, by Proposition 3, the counterpart makes an investment $\underline{v}(\hat{\omega})$, and the short-run deviation payoff is

$$2\hat{\omega}(\sqrt{v_1} + \sqrt{\underline{v}(\hat{\omega})}) - v_1. \qquad (A37)$$

The solution to Equation $(A32)$ is $v_1 = \hat{\omega}^2$, and the optimal deviation payoff is $\hat{\omega}^2 + \hat{\omega} - 1$. After deviating, by Proposition 4, the company obtains an uniperiodal payoff as in Equation $(A28)$, and the expected intertemporal deviation payoff is

$$\left(\hat{\omega}^2 + \hat{\omega} - 1\right) + (\delta + \delta^2 + ...) \left(\frac{\hat{\omega}^2 - 1}{4} + \hat{\omega}\right) = \left(\hat{\omega}^2 + \hat{\omega} - 1\right) + \frac{\delta}{1-\delta}\left(\frac{\hat{\omega}^2 - 1}{4} + \hat{\omega}\right). \qquad (A38)$$

By Equations $(A31)$ and $(A38)$, the company does not deviate if

$$\frac{1}{4(1-\delta)}(\hat{\omega}+1)(3\hat{\omega}-1) > \left(\hat{\omega}^2 + \hat{\omega} - 1\right) + \frac{\delta}{1-\delta}\left(\frac{\hat{\omega}^2 - 1}{4} + \hat{\omega}\right), \qquad (A39)$$

or if

$$\delta > \delta^1(\hat{\omega}) = \frac{\hat{\omega}^2 + 2\hat{\omega} - 3}{3\hat{\omega}^2 + 2\hat{\omega} - 4}. \qquad (A40)$$

It is possible to confirm that $\delta^1(\hat{\omega}) \in (0,1)$, is non-monotonic and converges to $\frac{1}{3}$.

If the counterpart deviates, by Proposition 3, the company makes an investment $\bar{v}(\hat{\omega})$, and the short-run deviation payoff is

$$2(\hat{\omega} - 1)(\sqrt{\bar{v}(\hat{\omega})} + \sqrt{v_2}) - v_2. \qquad (A41)$$

The solution to Equation $(A41)$ is $v_1 = (\hat{\omega} - 1)^2$, and the optimal deviation payoff is $2\hat{\omega}(\hat{\omega} - 1)$. After deviating, by Proposition 4, the counterpart obtains an uniperiod payoff as in Equation $(A29)$, and the expected intertemporal deviation payoff is

$$2\hat{\omega}(\hat{\omega} - 1) + (\delta + \delta^2 + ...) \left(\frac{\hat{\omega}^2 - 1}{4}\right) = 2\hat{\omega}(\hat{\omega} - 1) + \frac{\delta}{1-\delta}\left(\frac{\hat{\omega}^2 - 1}{4}\right). \qquad (A42)$$

By Equations $(A36)$ and $(A42)$, the counterpart does not deviate if

$$\frac{1}{1-\delta}\frac{1}{4}(\hat{\omega}-1)(3\hat{\omega}+1) > (2\hat{\omega}(\hat{\omega}-1)) + \frac{\delta}{1-\delta}\left(\frac{\hat{\omega}^2-1}{4}\right), \qquad (A43)$$

or if
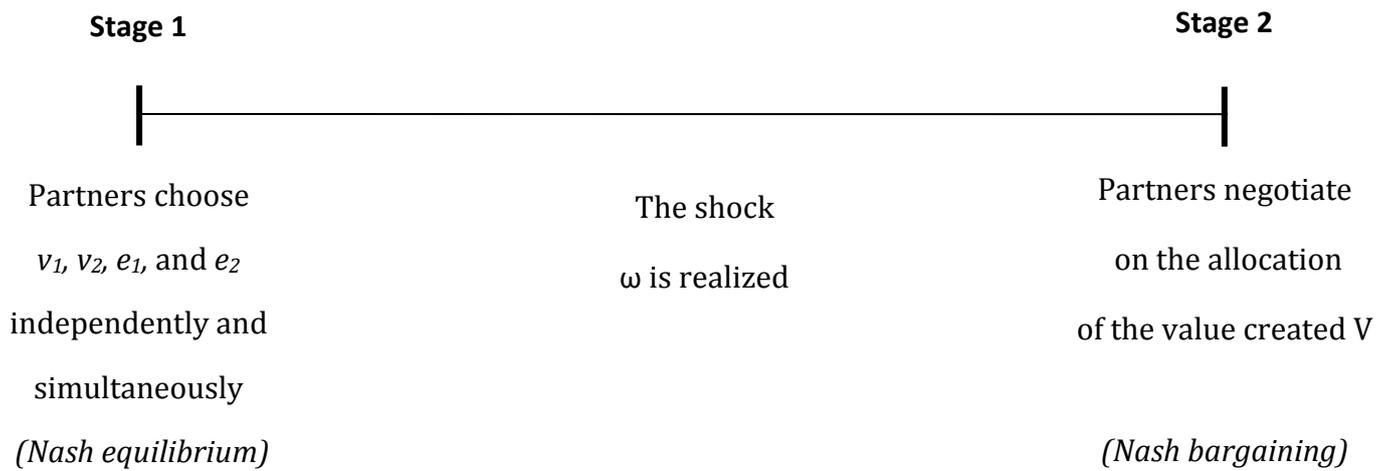
$$\delta > \delta^2(\hat{\omega}) = \frac{5\hat{\omega}^2-6\hat{\omega}-1}{7\hat{\omega}^2-4\hat{\omega}+1}. \qquad (A44)$$

It can be checked that $\delta^2(\hat{\omega}) \in (0,1)$, is monotonic and converges to $\frac{5}{7}$, and that there exists a δ' such that $\delta^1(\hat{\omega}) > \delta^2(\hat{\omega})$ if $\delta < \delta'$, and $\delta^1(\hat{\omega}) \geq \delta^2(\hat{\omega})$ otherwise.
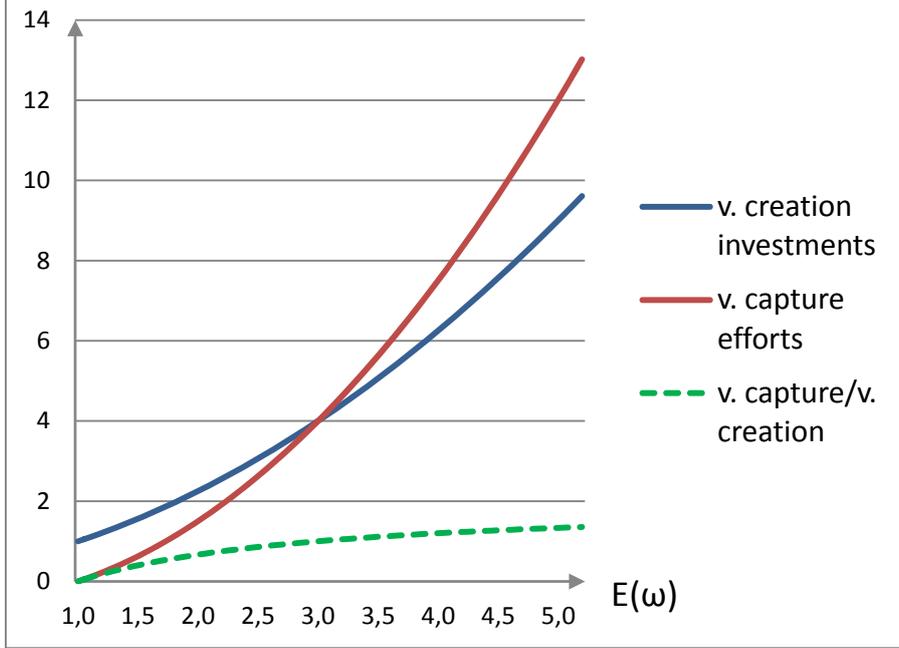
Proof of Proposition 7

Immediate by Propositions 5 and 6.

Figure 1: Timing and description of the model

Stage 1   Stage 2

Partners choose   The shock   Partners negotiate

$v_1, v_2, e_1,$ and e_2 ω is realized   on the allocation

independently and   of the value created V

simultaneously

(Nash equilibrium)   *(Nash bargaining)*

(With relational exchange, a new alliance is formed with a probability δ).

Figure 2: Separation of assets

Figure 3: Integration of assets

Figure 4: Company's payoffs

Figure 5: The thresholds for δ