

INSEAD

The Business School
for the World®

Faculty & Research Working Paper

Value Creation and Value Capture
under Moral Hazard:
Exploring the Micro-Foundations of
Buyer-Supplier Relationships

Tomasz OBLOJ
Peter ZEMSKY
2014/23/STR
(Revised version of 2012/111/ST)

Value Creation and Value Capture under Moral Hazard: Exploring the Micro-Foundations of Buyer-Supplier Relationships

Tomasz Obloj*

Peter Zemsky**

March 2014

Revised version of 2012/111/ST

Forthcoming in *Strategic Management Journal*

Acknowledgements: We thank Ramon Casadesus-Masanel, Jan Obloj, Eloic Peyrache, participants at the 2012 SRI-SMS Workshop, 2013 Academy of Management Annual Meeting, and 2013 Strategic Human Capital Conference, associate editor Richard Bettis, and two anonymous reviewers for helpful comments and suggestions. Special thanks go to Sam Aflaki. All errors are our own.

* Assistant Professor, Strategy and Business Policy at HEC Paris, 1 Rue de la Liberation Jouy-en-Josas, 78351 France. Email: obloj@hec.fr Corresponding author

** The Eli Lilly Chaired Professor of Strategy and Innovation, Deputy Dean of INSEAD, Dean for Strategic Initiatives and Innovation, Professor of Strategy at INSEAD Boulevard de Constance 77305 Fontainebleau Cedex, France. Email: peter.zemsky@insead.edu

A Working Paper is the author's intellectual property. It is intended as a means to promote research to interested readers. Its content should not be copied or hosted on any server without written permission from publications.fb@insead.edu

Find more INSEAD papers at http://www.insead.edu/facultyresearch/research/search_papers.cfm

Abstract

We combine the formalism of a principal–agent framework with a value-based analysis in order to investigate the micro-foundations of business partner selection and the division of value in contracting relationships. In particular, we study how the key contracting parameters such as efficiency, transactional integrity, incentive alignment and gaming affect outcomes when buyers face competing suppliers. We show that integrity and efficiency increase value creation and capture for all parties and are complements. While incentive gaming is unambiguously bad for value creation, and reduces buyers' value capture, it can benefit some suppliers. For alignment, we find that neither party has an incentive to use fully aligned performance measures that maximize total value creation. We conclude by analyzing buyers' and suppliers' incentives to invest in integrity.

Keywords: Value-Based Strategy; Organizational Incentives; Agency Theory; Rivalry; Moral-Hazard.

INTRODUCTION

The study of productive relationships is of central interest to scholars of strategy and organizations. Agency theory has proved a highly influential lens for analyzing the structure and outcomes of such relationships (Levinthal, 1988; Zenger, 1994; Makadok and Coff, 2009; Ethiraj and Levinthal, 2009; Postrel, 2009). However, formal theorizing and empirical studies within this research stream focus predominantly on the efficiency of contracting and the resulting value creation in a given relationship (see Prendergast, 1999, and Gibbons, 2005a, for reviews). Recent theoretical developments in the strategy literature have emphasized the joint analysis of value creation and value capture, while abstracting from micro-level contracting considerations (Brandenburger and Stuart, 1996; Nickerson, Silverman, and Zenger, 2007; Chatain and Zemsky, 2011). This value-based approach starts with an explicit characterization of value creation possibilities for a group of productive agents and then specifies how competition and bargaining among the parties affects the value that each can capture (MacDonald and Ryall, 2004).

This paper integrates the agency and value-based perspectives to study how contracting considerations between agents can shape competitive outcomes. In particular, we characterize how competitive advantage can arise not just from the efficiency but also the integrity of suppliers. As in many business settings, we allow for both imperfectly aligned performance measures and the possibility that agents can partially game the incentive system. We show how these various factors interact to determine which contracting partners are chosen, how much total value is created, and how that value is ultimately divided among the parties based on their added values.

Value Creation and Value Capture under Moral Hazard

It is an important feature of many business settings that firms choose partners not solely based on production efficiency, but also on additional attributes related to contracting (Williamson, 1975; Poppo and Zenger, 2002; Nickerson and Silverman, 2003) and the division of rents (Kogut, 1988; Coff, 1997; Blyler and Coff, 2003). For example Koerner (2011) describes the example of SleekAudio, a manufacturer of high-end and customized earphones. While the company initially moved production to China to reduce costs, it returned those operations to the United States in 2010. The company CEO cited quality problems and contractual hazards as the core reasons for returning to geographically proximate suppliers. Prior work has emphasized that, such 'hidden' contractual costs can play a crucial role in a decision to change business partners and relocate activities (Barthelemy, 2001; Larsen, Manning, and Pedersen, 2011). These considerations apply more broadly including to the hiring of individual employees, where higher worker productivity may be coupled with a higher ability to extract value through incentive gaming (Frank and Obloj, 2013), as well as to the choice of potentially less efficient but more controllable internal supplier rather than market sourcing (Zenger, 2002). Hence, when choosing contracting partners, firms often have to weight the benefits of productive efficiency against potential costs of contracting.

In many settings, a key driver of tradeoffs is that the contracts underlying productive relationships are invariably incomplete and subject to moral hazard (Milgrom and Roberts, 1990). This may be especially true for choosing suppliers in emerging economies, where excessive agency costs are a well-documented risk (Child and Tse, 2001; Hoskisson et al. 2000). Midler (2009) argues that because some Chinese contractors have a higher ability and propensity to game the incentives that shape productive relationships, they may be less attractive partners than their low

Value Creation and Value Capture under Moral Hazard

production costs initially indicate, especially when performance is not easily measurable. Zhao (2006) analyzes the trade-off that firms face when conducting R&D in developing economies. On the one hand, access to low-cost, high-quality human capital in developing economies makes such investments potentially very attractive, and promises high value creation. On the other hand, weak market institutions in these countries raise concerns about appropriability, leading to a moral hazard problem that might discourage companies from contracting in these settings.

The presence of *ex ante* moral hazard problems does not however imply that contracting partners will exploit these possibilities at the cost of their business counterparts. While we focus in this paper on the effects of transactional integrity on contracting arrangements, we are explicit about heterogeneity in opportunism at the actor level and resulting competitive advantage that may arise as a result of differential contracting frictions. Existing research shows that, even when holding geography and industry constant, there are great differences among market actors in the extent to which they are prone to exploit their business partners (Camerer and Thaler, 1995; Sliwka, 2007; Bridoux, Coeurderoy, and Durand, 2011). This is consistent with transaction cost theory, which, while it focuses on the role of moral hazard in contracting arrangements, does not in fact assert that all parties are opportunistic (Williamson, 1993). In a similar vein, Becker (1993) argues that the assumptions underlying classical models of ‘homo economicus’ and the corresponding ‘rational cheater’ represent a *method of analysis* rather than a belief about how all economic actors actually behave. For example, recent work in behavioral economics finds that the effects of others’ losses may create an intrinsic disutility from cheating, which in turn may prevent or discourage opportunism, gaming, and what is perceived as lack of transactional integrity in settings where

Value Creation and Value Capture under Moral Hazard

cheating would be justified by a pure calculus based on economic benefits. In an experimental setting, Gneezy (2005) showed that when lying increased one party's payoff by \$10 at the expense of another, unknown party, only 52% of his subjects exploited the opportunity.

Agency theory² provides a powerful methodology for studying the role of incentive contracts in vertical relationships under the threat of moral hazard (Holmstrom, 1979, 1982; Zenger, 1994; Foss, 2003). It specifically emphasizes the importance of the structure and strength of incentives for maximizing the total value created in a vertical relationship (Azoulay and Shane, 2001; Poppo and Zenger, 2002; Postrel, 2009). The central assumption underlying agency theory is that contracting partners respond to incentives even when those are imperfect and distorted, and that such behavior could ultimately hinder value creation (Oyer, 1997; Prendergast, 1999; Gino and Pierce, 2009). There are many potential sources of such frictions. Early work in agency theory focused on the trade-off between insurance and incentives due to the risk-aversion of economic actors. However, recent formal developments have shifted attention to the problem of multitasking and what Kerr (1975) described as 'the folly of rewarding A, while hoping for B'. Consequently, a central focus in this research stream in recent years has been multitasking and the associated role of misalignment, distortion, and incentive gaming in providing efficiency (Holmstrom and Milgrom, 1991; Baker, 2002; Gibbons, 2005a). This strand of agency theory lends itself naturally to studying the joint problem of transactional integrity and incentive gaming in productive relationships.

In the theoretical strategy literature, too, the issue of micro-level contracting problems has recently received more attention. Postrel (2009) formally analyzes

² Following Gibbons (2005a), we treat 'agency theory' and the 'economic theory of incentives' as theoretical synonyms, fully recognizing that the problem of incentives spans a much greater domain than motivating effort-averse agents in the presence of moral hazard.

Value Creation and Value Capture under Moral Hazard

contractual hazards (including two of the issues we focus on here, incentive gaming and alignment) and the corresponding wasted-effort problem in a setting where multiple agents cooperate within an organization to produce output jointly. Drawing on a different modeling tradition, Makadok (2003) integrates an analysis of manager-level competences with the contractual design and hazards issues. Rob and Zemsky (2002) analyze the role of preferences for cooperation in a principal – agent setting. Pierce (2012) shows how misaligned incentives can hamper knowledge transfer within hierarchies. Makadok and Coff (2009) analyze how cross-task synergies can lead to the emergence of hybrid governance forms in a multi-task setting. Finally, Gottschalg and Zollo (2007) develop a theoretical framework to classify interactions between various drivers and impediments of incentives, and discuss their impact on rents.

While existing work drawing on agency theory has offered an increasingly rich analysis of multiple dimensions of micro-level contracting problems, it abstracts away from competition among potentially heterogeneous business partners. Accordingly, it is generally agnostic with respect to the central question in the field of business strategy: How does competition affect the division of total value among market actors in productive relationships?

In recent years, the value-based approach has provided a unifying framework for analyzing the dual problem of value creation and value capture. In particular, the value-based framework explicitly models how market competition interacts with value creation possibilities to determine the appropriation of value by heterogeneous actors (Chatain, 2011). In principle, value capture opportunities are bounded by the value that each of the actors adds (Brandenburger and Stuart, 1996). This in turn is largely dependent on available alternatives and possible frictions in access to

contracting partners (Makadok, 2010; Chatain and Zemsky, 2011). However, the value-based approach, while it focuses on important industry- and firm-level phenomena, takes value creation (a central interest of agency theory) as a given, and remains silent on the role of incentive contracts. Hence it tends to emphasize differences in production costs rather than differences among the attributes influencing contracting arrangements and other transaction costs. Indeed, as MacDonald and Ryall (2004) note, by focusing on given value creation possibilities, the value-based approach is only “implicitly accounting for limitations implied by information and *agency considerations*, transactions costs, configuration of productive resources, barriers to technology transfer, institutional structure, regulation, and so on” (p. 1324, emphasis added). By explicitly focusing on micro-level contracting problems and their associated impact on the distribution of value in a competitive setting, we bridge these two important streams of literature.

We do this by formally analyzing the determinants of value creation and value capture in a situation where a buyer selects a contracting partner from among competing suppliers. Value is contingent not only on suppliers’ productive efficiency but also on critical agency dimensions that affect contractual design and the strength of incentives. We use a multi-task principal-agent model closely patterned after Gibbons (2005a).³ We extend this model along several dimensions, including task space, which allows us to study the issues of alignment and distortion independently, as well as to introduce competition between heterogeneous suppliers. We assume supplier heterogeneity along two dimensions: production costs and integrity.⁴g These dimensions jointly correspond to our earlier discussion about the potential

³ Gibbons (2005a) is a version of a model proposed by Baker (2002), who in turn built on insights from Feltham and Xie (1994).

⁴ Integrity determines disutility from engaging in incentive gaming. Incentive gaming occurs when an agent intentionally increases its performance measure (and resulting payments) without contributing to value creation.

Value Creation and Value Capture under Moral Hazard

attractiveness of, for example, offshore contracting partners. Following the value-based approach, we allow for rent sharing between the buyer and supplier that is dependent on suppliers' added value and their bargaining power (Brandenburger and Stuart, 2007). We characterize contract design, the choice of suppliers, and the creation and distribution of value.

We find that buyers trade-off between suppliers' production efficiency and integrity. Only when the threat of gaming is sufficiently great, does it pay to select a supplier with higher transactional integrity but lower efficiency. We find that buyers offer stronger incentives to suppliers with higher transactional integrity regardless of relative efficiency levels.. We also show that while incentive gaming is unambiguously bad for value creation, and while it reduces the value captured by the buyer, it benefits some types of suppliers, but only to a point. More precisely, for suppliers with higher levels of integrity we find that value capture is maximized at intermediate levels of possible gaming, unless this supplier also has a sufficiently large efficiency advantage. We find, however, that increasing gaming opportunities unambiguously hurts suppliers who have lower transactional integrity. In keeping with earlier work, we find that perfectly aligned incentives maximize overall efficiency when there is no threat of incentive gaming. However, in contrast to standard agency models, we show that both buyers and suppliers want to move away from the optimal alignment level—in opposite directions, of course—to maximize their own value capture. We conclude by analyzing the incentives of a buyer to search for suppliers with high levels of integrity and of a supplier to invest in a reputation for trustworthiness.

MODEL

Value Creation and Value Capture under Moral Hazard

We consider a formal model with two competing suppliers and a single buyer. The buyer is denoted by B , while the suppliers are indexed by $s = \{G, H\}$. There are three key components to our model: the agency problem, supplier heterogeneity, and the specification of value creation possibilities.

Agency Problem

When serving a buyer, suppliers can exert effort on three tasks, the first two of which are productive while the third is an unproductive task that captures the possibility to game the incentive system. The effort exerted by Supplier s on each task is given by: $\mathbf{a}_s = \{a_{s1}, a_{s2}, a_{s3}\}$. Each supplier bears a quadratic cost of effort $c_s(\mathbf{a}_s)$ specified below. The total output O generated for the buyer depends on the effort as follows:

$$O(\mathbf{a}_s) = a_{s1} + f a_{s2}, \quad (1)$$

where f parameterizes the productivity of task two relative to task one. We follow recent developments in agency theory (Baker, 2002; Kaplan and Henderson, 2005; Gibbons, 2005a) and assume that output is non-contractible. In general it is intuitive that O may not be contractible in many business settings. For example, it may be difficult to disentangle how one individual's actions contribute to the overall performance of the organization as it can encompass outcomes of synergies, cooperation, mentoring, or team-based production. Similarly, while legally enforceable contracts are often based on short-run observables, the true objective function is typically oriented to the long-term. Our modeling approach therefore assumes that "an organization's inability to use total value as the basis for incentive contracts often leads it to use a wide array of alternative performance measures" (Baker, 1992: 599). Hence, the parties to our contract rely on an imperfect measure for suppliers' contribution to the objective function, performance measure P :

$$P(\mathbf{a}_s) = a_{s1} + \lambda f a_{s2} + g a_{s3}. \quad (2)$$

P can be any contractible information that both parties can observe and that provides a signal for a supplier's effort. For example, it could be a composite measure of the quality and quantity of the goods supplied.⁵

The parameter λ captures the extent to which the performance measure P is aligned with the firm's objective function; for $\lambda = 1$ there is perfect alignment as productive efforts have the same relative marginal impact on P and on O . The closer the two measures are, the more aligned will be incentives of both parties.⁶

The parameter g captures the extent to which the performance measure is vulnerable to gaming by a supplier. The greater is g the more effective is effort a_3 allocated to the gaming task at increasing the performance measure even though it has no impact on actual output. Examples of such gaming tasks are common and include, among many others, substituting ingredients of a shampoo with water when a supplier is compensated based on the volume of shampoo produced (Midler, 2009); changing perfectly functional car parts when an agent is paid by the number of new components installed (Gibbons, 2005a); supplying a faulty component when a supplier is compensated based on the total number of components; striking keys randomly when a supplier is compensated for the number of characters typed (Fast and Berg, 1975); and misrepresenting financial returns when managers are compensated based on accounting indices (Harris and Bromiley, 2007).⁷

⁵ It is straightforward to extend our analysis to the general functional forms of O and P ($O(\mathbf{a}_s) = f_1 a_{s1} + f_2 a_{s2}$; $P(\mathbf{a}_s) = g_1 a_{s1} + g_2 a_{s2} + g_3 a_{s3}$). All our results hold under this more general model. We are grateful to an anonymous reviewer for suggesting this simplified model structure, which is more convenient for exposition.

⁶ If we were to plot vectors of the objective function and the performance measure, then the angle between these vectors is a very useful way of illustrating alignment. When vectors are overlaying one another, incentives on the productive actions are fully aligned (Baker, 2002). The larger is the angle, the greater the misalignment. Note that because of the inclusion of the third task, for $g \neq 0$ the absolute alignment will never be perfect even if $\lambda = 1$.

⁷ Note that our model, as it is based on three tasks, allows for independent characterization of alignment and gaming, which is not the case for the two-task model used by, for example, Baker (2002). In this paper, we refer to gaming possibilities as the extent to which incentives can be gamed via an unproductive task. In contrast, we refer to alignment as the extent to which the marginal impact of effort on productive tasks differs across the objective function (output) and the performance measure.

As is standard in multi-task agency models (Holmstrom and Milgrom, 1991), we assume that the incentive contract a buyer signs with a supplier is linear and based on the performance measure P .⁸ The payment (wage) to a supplier is hence given by:

$$w_s(P) = w_{0s} + b_s \times P, \quad (3)$$

where the intercept w_{0s} represents the fixed salary and slope b_s is the bonus rate.

Supplier Heterogeneity

A key innovation of our model is to analyze contracting and competition across heterogeneous suppliers. We consider two types of suppliers. The *gaming supplier*, denoted with G , is most closely described as classic homo economicus, or a rational cheater (Nagin et al. 2002). This supplier type therefore “makes economically rational decisions that maximize their payoffs” (Vroom and Gimeno, 2007: 901), including optimal use of the gaming task.

The *honest supplier*, denoted with H , is also a rational optimizer that will choose actions that, given the incentive contract, maximize his or her own value capture. However, the honest supplier has a higher sense of transactional integrity, meaning he or she experiences higher disutility from gaming the incentive system. A growing literature supports our assumption that agents differ in their willingness to engage in gaming. Nagin et al. (2002) argue that the extent to which actors engage in gaming behavior differs with their identification with the employer and their perception of the contract’s fairness. Frank and Obloj (2013) find that gaming differences are correlated with an agent’s cognitive abilities. The economic sociology literature emphasizes the role of social norms in inducing behavior that is seen as consistent with transactional arrangements (Bendor and Swistak, 2001; Di Stefano, King, and Verona, 2013). Finally, a large body of research in the behavioral

⁸ While the literature usually assumes a linear contract structure, some non-linear schemes may be more efficient (Gibbons, 2005a). In particular, linear incentives are optimal under some assumptions about the utility function (e.g. CARA) and distribution of output (Laffont and Martimort, 2002: 384).

Value Creation and Value Capture under Moral Hazard

economics literature argues, and shows in laboratory settings, that human agents heterogeneously experience disutility from cheating or from what they perceive as unfair behavior (Gneezy, 2005; Gneezy and List, 2006). We model this heterogeneity explicitly by allowing the disutility from engaging in incentive gaming to differ across suppliers. We also incorporate into our model a second, more traditional, dimension of heterogeneity: efficiency differences across suppliers.

Both dimensions are represented in suppliers' cost of effort, which takes the following functional form:

$$c_s(\mathbf{a}_s) = \frac{1}{2\theta_s} a_{s1}^2 + \frac{1}{2\theta_s} a_{s2}^2 + \frac{\rho_s}{2\theta_s} a_{s3}^2. \quad (4)$$

We operationalize transactional integrity with a parameter ρ adjusting agents' cost of effort on the gaming task. If $\rho_s = 1$, the supplier will treat the gaming task, a_3 , in an identical fashion as the two productive tasks. This value of integrity (or lack thereof) corresponds to the ideal type of a 'rational cheater' (cf. Nagin et al., 2002). However as ρ_s increases, engaging in incentive gaming becomes increasingly costly so that, in the limit, the supplier would not engage in the gaming task at all. To make the model as general as possible, we allow for $\rho_s \in (0, \infty)$. Note that values of ρ_s less than one describe a particularly perverse agent: one that has lower cost for the cheating task than for the productive task. Without loss of generality and consistent with our notation of *gaming* and *honest* suppliers, we assume $\rho_H \geq \rho_G$.

Differences in pure production efficiency are represented with a parameter θ_s . Heterogeneity in production efficiency can arise as a result of resource and technology differences or wage differences across labor markets (Lambert et al., 1999; Adner and Zemsky, 2006), among other reasons. As θ_s increases, a given supplier becomes more and more efficient (i.e., its cost of effort decreases). Without

Value Creation and Value Capture under Moral Hazard

loss of generality, we set $\theta_H = 1$ and then θ_G represents the relative efficiency of the gaming Supplier.

Value Creation Possibilities

At the heart of a value-based analysis is a characterization of the value creation possibilities of any set of agents. These possibilities are given by a characteristic function $V(R)$ where R is any subset of the contracting parties $N = \{B, G, H\}$. We assume that non-zero value creation requires a buyer and at least one supplier so that: $V(\emptyset) = V(B) = V(H) = V(G) = V(H, G) = 0$.

We now turn to the value created by the Buyer and Supplier S . Value creation is simply given by the difference between output and costs: $O(\mathbf{a}_S) - c_S(\mathbf{a}_S)$.

In a value-based model *without* agency, effort would be selected so as to maximize value creation. That is, one would have $V(B, S) = \max_{\mathbf{a}_S} (O(\mathbf{a}_S) - c_S(\mathbf{a}_S))$.

What happens with agency? Given our assumption of transferable utility through w_0 , the optimal contract will still seek to optimize total value creation $O(\mathbf{a}_S) - c_S(\mathbf{a}_S)$ (Holmstrom and Milgrom, 1991). However, the vector of effort \mathbf{a}_S is now determined based on the agents' optimal response to the strength of the incentives b_S . As

suppliers will be maximizing their payments, the resulting effort of the suppliers is given by: $\mathbf{a}_S^*(b_S) = \operatorname{argmax}_{\mathbf{a}_S} (w_{0S} + b_S \times P(\mathbf{a}_S) - c_S(\mathbf{a}_S))$, and the corresponding value creation from transacting with that supplier becomes

$V(B, S) = \max_{b_S} (O(\mathbf{a}_S^*(b_S)) - c_S(\mathbf{a}_S^*(b_S)))$, where the incentive intensity is chosen to optimize value given the agents' optimal response to those incentives. Finally, we assume the the buyer only needs one supplier so that

$$V(B, G, H) = \max\{V(B, G), V(B, H)\}.$$

One of the key features of the cooperative game approach used in value-based analysis is that it allows actors to freely bargain over the value that they create.

Following Brandenburger and Stuart (2007), outcomes of this bargaining can be parameterized with a single parameter α ($0 \leq \alpha \leq 1$), which reflects the relative bargaining power of a buyer vis-a-vis a supplier. Note that, for simplicity, we do not introduce heterogeneity in bargaining power across honest and gaming suppliers.⁹

We analyze the model in three steps. In the first step, we perform the principal-agent analysis. In the second step, we nest the principal-agent results in a value-based model and solve for the allocations of value between contracting partners. In the third step, we characterize the impact of changes in the contracting parameters on the competitive outcomes derived in stage two.

PRINCIPAL-AGENT ANALYSIS

The timing of events is as follows. First, the Buyer offers the Supplier an incentive contract. As in (3), the compensation has a linear form with a fixed component (w_{0s}) and a variable component that is contingent on the performance measure ($b_s \times P$). The intensity of the incentives is measured by the variable component: the bonus rate (b_s). Second, in response to the incentive intensity, the Supplier chooses how much effort to allocate to each of the available tasks. Finally, both parties in the relationship observe performance measure (P) and the Supplier receives compensation as specified in the incentive contract. We analyze, in turn, the choice of incentives the Buyer offers to each Supplier and the corresponding allocations of effort.

Suppliers choose their effort levels to maximize expected payments net of their cost of effort. The solutions to these effort choice problems are presented below in

Lemma 1. Proofs of all lemmas and propositions are in the online Appendix.

Lemma 1: For a given incentive intensity b_s , the equilibrium effort of each type of supplier is as follows:

⁹ Note that our model satisfies three general conditions in Chatain in Zemsky (2007) such that we can interpret α as supplier bargaining power. The three conditions are (1) both a buyer and a supplier are required for the creation of surplus, (2) independent value creation when there are multiple buyers, which is hence trivially satisfied in our single buyer model, and (3) a lack of complementarity when using of multiple suppliers.

Value Creation and Value Capture under Moral Hazard

- i. *gaming Supplier*: $\mathbf{a}_G^* = \{\theta_G b_G, \theta_G \lambda f b_G, \frac{\theta_G}{\rho_G} g b_G\}$
- ii. *honest Supplier*: $\mathbf{a}_H^* = \{b_H, \lambda f b_H, \frac{1}{\rho_H} g b_H\}$

Having characterized, in Lemma 1, the Suppliers' effort allocation in response to any incentive intensity, we now turn to the Buyer's actual choice of incentives. Given the expected effort allocations by the Suppliers, the Buyer chooses the incentive intensity that maximizes total expected surplus. The problem is hence as follows: the Buyer, depending on the type of Supplier, wants to choose an optimal incentive intensity level (b_s^*), such that $b_s^* = \text{argmax}_{b_s} O(\mathbf{a}_s^*) - c_s(\mathbf{a}_s^*)$.¹⁰ The solution to this incentive problem is presented in Lemma 2 below.

Lemma 2: Conditional on Suppliers' type, the Buyer offers the following incentive intensity:

- i. $b_G^* = \frac{1+f^2\lambda}{1+f^2\lambda^2+\frac{g^2}{\rho_G}}$, for the gaming Supplier.
- ii. $b_H^* = \frac{1+f^2\lambda}{1+f^2\lambda^2+\frac{g^2}{\rho_H}}$, for the honest Supplier.

Corollary 1: The Buyer offers stronger incentives to the honest Supplier than to the gaming Supplier ($b_H^ \geq b_G^*$).*

To understand the drivers of Corollary 1, note first that it is intuitive that the optimal incentive intensity is falling in a supplier's propensity to game. The greater is ρ_s the more effort is allocated to value destroying gaming. Second, the optimal incentive intensity is independent of a suppliers' efficiency. The effect of θ_s is already reflected in the supplier's response to the incentive intensity (Lemma 1). Hence, the honest supplier receives stronger incentives.¹¹

VALUE-BASED ANALYSIS

¹⁰ Recall that \mathbf{a}_s^* is a function of incentive strength.

¹¹ This result also underlines the property of our model that the power of incentives does not change the relative effort on the three available tasks. Postrel (2009), for example, shows that when incentives can shape agents' beliefs about what the true objective function is, results may change. In our model we do not analyze changing beliefs and therefore the gaming Supplier will always be facing weaker incentives than the honest Supplier.

Value Creation and Value Capture under Moral Hazard

In our model, the value created in a productive relationship is an outcome of a buyer offering suppliers an optimal incentive contract (b_s^*) as derived above, and suppliers responding with an optimal effort allocation (a_s^*). The value created when the Buyer transacts with Supplier S is thus given by:

$$\begin{aligned} V(B, S) &= V(a_s^*(b_s^*)) = O(a_s^*(b_s^*)) - c_s(a_s^*(b_s^*)) = & (5) \\ &= \frac{1}{2} \frac{\theta_s(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_s}}. \end{aligned}$$

As the Buyer needs only one supplier, the total value creation is simply:

$$V(N) = \max_s V(a_s^*(b_s^*)) \quad (6)$$

Note that if the gaming Supplier has no production cost advantage ($\theta_G = \theta_H = 1$) and the honest Supplier has the same disutility from cheating as the gaming Supplier ($\rho_G = \rho_H$), our model becomes trivial, as there are no value creation differences between suppliers and hence neither of the suppliers adds value relative to the other.

We now proceed to the stage of the game where value is allocated among the contracting parties. We first specify core allocations of value. These core allocations satisfy the standard efficiency and stability conditions (MacDonald and Ryall, 2004), so that:

$$\sum_{j \in N} A_j = V(N) \quad (\text{efficiency condition})$$

$$\sum_{j \in R} A_j \geq V(R), \text{ for all } R \subset N \quad (\text{stability condition}),$$

where the value appropriated by each of the transactional partners is given by function A . The efficiency condition assures that all of the value created by the players is allocated amongst them. The stability condition ensures that no subset of players can do better than their allocation by contracting separately. In the setting that we analyze, Chatain and Zemsky (2007) show that the supplier that has positive added value is chosen and participates in the exchange. We represent the value-

sharing rule with an earlier introduced bargaining parameter α . The outcome of bargaining has a simple property where a supplier participating in the exchange captures a $(1 - \alpha)$ share of its value added and the buyer appropriates the rest of the value created. This implies that the buyer appropriates at least its outside option (i.e., the value created in a relationship with the less productive supplier) and all value created at the most.¹² In an extreme case, when $\alpha = 1$, the Buyer always appropriates all of the value. Note that this is consistent with the general result that added value is a necessary but not sufficient condition for value capture (MacDonald and Ryall, 2004). The sharing rule is reflected in the following lemma.

Lemma 3: The value-adding Supplier participates in the exchange and captures a proportion $(1 - \alpha)$ of its added value $(|V(B,H)-V(B,G)|)$; the Buyer captures the remainder of any value created.

Therefore, because at most one supplier participates in the exchange, if it is the gaming Supplier that adds value in the relationship, the honest Supplier captures no value: $A_H = 0$. The value captured by the gaming Supplier is a function of the bargaining parameter α and value added such that: $A_G = (1 - \alpha)[V(B, G) - V(B, H)]$. As stated above, and satisfying the efficiency condition, the Buyer captures the remaining part of the value created: $A_B = V(B, H) + \alpha[V(B, G) - V(B, H)]$.

An alternative scenario in which the honest Supplier adds value is a mirror image of the one presented above. In this case, the gaming Supplier captures no value, the honest Supplier captures a proportion of its value added $A_H = (1 - \alpha)[V(B, H) - V(B, G)]$, and the Buyer retains the rest: $A_B = V(B, G) + \alpha[V(B, H) - V(B, G)]$.

Having presented these general results, we proceed now to an explicit analysis of the contracting and heterogeneity parameters and their impact on buyers' choice of

¹² This is true assuming that the participation constraints of both suppliers are the same. This assumption does not affect generalizability of our results.

Value Creation and Value Capture under Moral Hazard

contracting partners, value creation, and value capture by each participant in an exchange.

EFFICIENCY, INCENTIVE GAMING, AND SUPPLIER CHOICE

What parameters affect relative value creation by honest and gaming suppliers, and therefore affect a buyer's choice of contracting partner? We now study how contractual frictions could moderate the attractiveness of, for example, offshoring or a potentially hazardous decision to switch suppliers. As we defined the gaming Supplier as having lower transactional integrity, the core advantage that a gaming Supplier could have over its counterpart is production cost efficiency. Indeed, most offshoring decisions are driven by the desire to lower production and/or labor costs by using suppliers in developing countries. This effect is formalized in Lemma 4 below.

Lemma 4: When the gaming Supplier has no production cost advantage over the honest Supplier (i.e., $\theta_G \in (0,1)$), the honest Supplier always adds value and is selected.

The smaller this production cost advantage, the more likely a Buyer is to transact with an honest Supplier, holding all else constant. Other contractual frictions, however, are likely to affect the magnitude of production cost advantage that would be required for the gaming Supplier to participate in the exchange. Proposition 1 formalizes these relationships with respect to integrity parameters and the importance of incentive gaming.

Proposition 1:

Value Creation and Value Capture under Moral Hazard

- i. *There exists a critical value of production cost advantage for the gaming Supplier $\bar{\theta}_G$, such that the honest Supplier adds value for $\theta_G \in (0, \bar{\theta}_G)$ and the gaming Supplier adds value for $\theta_G \in (\bar{\theta}_G, \infty)$ where $\bar{\theta}_G = \frac{1+f^2\lambda^2+\frac{g^2}{\rho_G}}{1+f^2\lambda^2+\frac{g^2}{\rho_H}}$.*
- ii. *As the transactional integrity of the honest Supplier increases, the gaming Supplier requires a higher production cost advantage to be selected by the Buyer: $\frac{\partial \bar{\theta}_G}{\partial \rho_H} > 0$.*
- iii. *As the transactional integrity of the gaming Supplier increases, the gaming Supplier requires a lower production cost advantage to be selected by the Buyer: $\frac{\partial \bar{\theta}_G}{\partial \rho_G} < 0$.*
- iv. *As gaming possibilities increase, the gaming Supplier requires a higher production cost advantage to be selected by the Buyer: $\frac{\partial \bar{\theta}_G}{\partial g} > 0$.*

 Insert Figures 1, 2, and 3 about here

Figures 1, 2, and 3 present graphically the relationships between the critical value of production cost efficiency and the parameters of interest as detailed in proposition 1.¹³

Note that, intuitively, the gaming Supplier needs at least some production cost advantage to be selected. This is apparent from Lemma 4, which states that absent such advantage, the gaming Supplier never adds value.¹⁴ Moreover, as the integrity of the honest Supplier increases, the gaming Supplier would require a higher production cost advantage to be selected ($\bar{\theta}_G$ is larger). This relationship is reversed when we analyze changing integrity on the side of the gaming Supplier, i.e., the smaller the difference in integrity, the lower the $\bar{\theta}_G$. Similarly, as the distortion in performance

¹³ For all figures, except when a parameter is on the horizontal axis, we use the following parameter values: $f = 1, g = 1, \lambda = \frac{1}{2}, \alpha = \frac{1}{2}, \theta_G = 1.1, \rho_H = 2, \rho_G = 1$.

¹⁴ Note that Lemma 4 is subject to some assumptions. A less efficient gaming supplier would not always be locked out of an exchange, for example if suppliers had capacity constraints and the honest supplier were not able to fully meet the buyer's needs.

measurement and gaming opportunities increase (g), the relative attractiveness of the gaming Supplier decreases. This is because as gaming opportunities increase, the relative cost of transacting with the gaming Supplier also rises.

INTEGRITY, VALUE CREATION, AND VALUE CAPTURE

We have shown above that for sufficiently low levels of transactional integrity of the gaming Supplier, even substantive production efficiency advantage may not yield a competitive advantage. In general, the threat of dishonest or exploitative behavior presents a very important source of economic inefficiency (Williamson, 1975).

Economic relationships that are characterized by trust (and hence a low probability of opportunistic behavior) last longer and can be more beneficial to both sides of the relationship (Kale, Singh, and Perlmutter, 2000; Tsai and Goshal, 1998; Casadesus-Masanell, 2004).¹⁵ In incentive theory, too, distortion in performance measures and high threats of incentive gaming have been shown to result in incentives of sub-optimal strength and forgone opportunities of value creation and capture (Holmstrom and Milgrom, 1991; Baker, 2002).

However, the role that transactional integrity plays is likely to differ across market actors: it need not be symmetric across buyers and suppliers. The proposition below details how changing the transactional integrity of honest and gaming suppliers affects value creation and value capture for all three potential parties to a productive relationship.

Proposition 2: As the transactional integrity of the focal Supplier increases

- i. The value created increases: $\frac{\partial V(B,H)}{\partial \rho_H} > 0$; $\frac{\partial V(B,G)}{\partial \rho_G} > 0$.*
- ii. The value created when transacting with the other Supplier remains constant: $\frac{\partial V(B,G)}{\partial \rho_H} = 0$; $\frac{\partial V(B,H)}{\partial \rho_G} = 0$.*

¹⁵ See in particular Casadesus-Masanell (2004) for a formal account of the role of trust in agency relationships.

- iii. *The value captured by the Buyer (independent of the Supplier chosen) increases:* $\frac{\partial A_B}{\partial \rho_H} > 0$; $\frac{\partial A_B}{\partial \rho_G} > 0$.
- iv. *The value captured by the focal Supplier, whenever used, increases:* $\frac{\partial A_H}{\partial \rho_H} > 0$; $\frac{\partial A_G}{\partial \rho_G} > 0$.
- v. *The value captured by the other Supplier, whenever used, decreases:* $\frac{\partial A_H}{\partial \rho_G} < 0$; $\frac{\partial A_G}{\partial \rho_H} < 0$.

 Insert Figure 4 about here

Figure 4 graphically represents the relationships detailed in Proposition 2 for the integrity of the honest Supplier.¹⁶ We first consider a case where the transactional integrity of the honest Supplier increases when the gaming Supplier adds value in the relationship and the Buyer chooses to transact with this Supplier. Note that over this region the value created is independent of ρ_H . This is intuitive, as the value created in a relationship with the gaming Supplier should not be affected by the integrity of the honest Supplier, which is not participating in the exchange. However, as ρ_H increases, the value added by the gaming Supplier decreases because the honest Supplier creates more value. Therefore, we observe that the gaming Supplier's share of value decreases while the value captured by the Buyer increases. When the honest Supplier adds value, the effect is different. Over this range, value creation increases with ρ_H . This is because the Buyer can offer stronger incentives to this Supplier and, consequently, induce more effort. The value capture of the honest Supplier and the Buyer can then both increase.

INCENTIVE GAMING, VALUE CREATION, AND VALUE CAPTURE

We now consider the extent to which the effect of parameter g on value creation and value capture is similar to that of transactional integrity. In essence, while

¹⁶ Graphical representation of the integrity of gaming Supplier is omitted due to similarity.

Value Creation and Value Capture under Moral Hazard

transactional integrity corresponds to the disutility from cheating and hence the exploitation of gaming opportunities, parameter g is best described as affecting the magnitude of these gaming possibilities that allow agents to increase the performance measure but not the objective function (Baker, 2002). Prior literature has typically focused on the negative consequences of gaming for value creation (Gibbons, 2005a; Frank and Obloj, 2013). We found in Lemma 1 that the greater the gaming possibilities, the lower the strength of optimal incentives. Consequently, in our model too, the amount of value created in the relationship decreases with gaming possibilities. Over and above this effect, we find however that the effects of gaming possibilities can be ambiguous for suppliers' value capture as shown in the following proposition.

Proposition 3: As the magnitude of gaming possibilities (g) increases

- i. The value created decreases: $\frac{\partial V(B,G,H)}{\partial g} < 0$.*
- ii. The value captured by the Buyer (independent of which Supplier is chosen) decreases: $\frac{\partial A_B}{\partial g} < 0$.*
- iii. The value captured by the honest Supplier, whenever used, increases and then decreases (there is an inverted-U shaped relationship between gaming possibilities and value captured by the honest Supplier) for $\rho_H > \frac{\rho_G}{\theta_G}$ while it is everywhere decreasing for $\rho_H < \frac{\rho_G}{\theta_G}$.*
- iv. The value captured by the gaming Supplier, whenever used, decreases: $\frac{\partial A_G}{\partial g} < 0$.*

Corollary 2. Value captured by the gaming Supplier is maximized when there are no incentive gaming possibilities ($g = 0$). Value captured by the honest Supplier is maximized at an intermediate level of g when the gaming Supplier is more efficient.

Proposition 3 offers first some intuitive results about value creation and value capture in buyer–supplier relationships. Consistent with prior literature, we find that incentive gaming is unambiguously bad for performance, i.e., value created in the relationship always decreases with gaming possibilities. As one would expect, we see that the

Value Creation and Value Capture under Moral Hazard

Buyer is best off if incentives cannot be gamed. However, the effect of gaming on the two suppliers is different.

This specific effect of gaming on two suppliers might initially appear surprising. The gaming Supplier captures the most value when there are no gaming possibilities ($g = 0$). Therefore, this supplier would prefer the performance measure to be as close as possible to the objective function. The gaming Supplier is hurt for two reasons. First, because costly effort is allocated to a non-productive task, the incentives are muted and so are the value capture opportunities. Second, the effect of increasing gaming opportunities is more pronounced for this supplier than for its honest counterpart. Hence, despite lower disutility from cheating, the gaming Supplier has a competitive disadvantage vis-a-vis the competitor in terms of relative changes to value creation. What does it mean for the honest Supplier? Our results suggest that the honest Supplier is best off when some threat of gaming is present (always when the gaming Supplier is more efficient as well as for sufficiently low-cost disadvantage of the gaming Supplier). The honest Supplier benefits from the distortion created because the power of incentives and value creation possibilities initially fall more sharply for the gaming Supplier. The honest Supplier consequently benefits from the fact that, as gaming possibilities increase, its added value also increases, as detailed above. Beyond a certain point, however, and similar to the case of the gaming Supplier, decreasing incentives result in the honest Supplier being hurt from gaming threats though decreasing value creation. When the gaming Supplier is sufficiently less efficient than the honest Supplier or shows sufficiently low integrity, the honest Supplier is also best off when no gaming possibilities are present. Figure 5 illustrates these relationships.

Insert Figure 5 about here

ALIGNMENT, VALUE CREATION AND VALUE CAPTURE

We now turn to the question of the role of incentive alignment in buyer–supplier relationships. Alignment has been invoked as one of the core properties of incentive contracts (Baker, 2002; Gibbons, 2005a). In general, optimal incentive strength and corresponding value creation decreases with the extent of misalignment. Lower alignment can also act in a detrimental manner on value creation indirectly by, for example, hampering cooperation (Postrel, 2009). In our setting, following Gottschalg and Zollo (2007), we define alignment as the extent to which suppliers are motivated to behave in line with a buyer’s productive goals. We hence treat alignment as a property of the performance measure (Holmstrom and Milgrom, 1994; Gibbons, 2005a).

In this section we focus exclusively on the alignment in productive tasks – parameter λ . In particular, we analyze the importance of the extent to which the weights on productive tasks in the performance measure reflect the importance of these tasks for the outcomes. Therefore, if, for example, the Buyer cares equally about quality and quantity (corresponding to two productive tasks in our model), we will analyze the value creation and value capture consequences of the relative importance of quality and quantity in the performance measure, keeping the level of gaming possibilities (g) fixed.

The extent to which the performance measure (P) and the objective function (O) are aligned is likely to affect the choice and power of incentives and consequently affect how the total value pie is split. Intuitively, and consistent with a large body of research in agency theory, value creation is likely to be maximized at

full alignment (Prendergast, 1999; Baker, 2002, Postrel, 2009). Yet, while optimal alignment might be good for value creation, its impact on value capture, both for a buyer and for suppliers, need not be so straightforward. In particular, in the presence of gaming possibilities, both a buyer and a supplier may benefit from a deviation from the optimal alignment on the productive tasks.

We begin this part of the analysis by focusing on the overall value creation. If there are no opportunities for incentive gaming ($g = 0$), value is maximized when the relative marginal contribution of the two productive tasks to the output and performance measures are proportional: the vector of marginal benefit to the supplier from productive actions and the vector of these actions' marginal contribution to the buyer's objective function are overlaid (Baker, 2002). This condition would ensure that both available productive tasks receive appropriate (from the value creation perspective) relative effort allocation and implies that λ should be equal to unity in our reduced form model. We refer to this alignment level as baseline: $\lambda^{baseline} = 1$. What happens in the presence of incentive gaming? We begin by looking at the value creation possibilities when the Buyer transacts with each of the suppliers.

Lemma 5: Optimal alignment level (i.e., maximizing total value creation) is given by:

- i. $\lambda_H^{opt} = 1 + \frac{g^2}{\rho_H}$, if the Buyer transacts with the honest Supplier.
- ii. $\lambda_G^{opt} = 1 + \frac{g^2}{\rho_G}$, if the Buyer transacts with the gaming Supplier.

Note that when the honest Supplier shows the same integrity as the gaming Supplier, both alignment levels are equal: $\lambda_H^{opt} = \lambda_G^{opt}$ as they are independent of the production efficiency. Contrarily, when a Supplier S shows full transactional integrity and never games incentives ($\rho_S \rightarrow \infty$) the alignment level maximizing total value creation simplifies to $\lambda_S^{opt} \rightarrow \lambda^{baseline}$.

Optimal alignment levels derived in Lemma 5, however, show that if incentives can be gamed, welfare is maximized when the second productive task receives more weight in the performance measure, compared to the baseline level. The greater the extent of gaming possibilities and the lower the transactional integrity, the greater the departure from the baseline alignment level. The intuition is that a higher weight on task two may distort incentives relative to task one, but it also takes relative effort away from the value destroying gaming task.

From the value capture perspective, what alignment level would maximize each actors' share? In particular we are interested in the following question: in a buyer–supplier relationship, does the same alignment level maximize value capture for all contracting parties?

Proposition 4:

- i. *Value capture by the Buyer (independent of which Supplier is chosen) is maximized at an alignment level between λ_H^{opt} and λ_G^{opt} , such that $\lambda_B^* \in (\lambda_H^{opt}, \lambda_G^{opt})$.*
- ii. *Value capture by the honest Supplier is maximized at an alignment level lower than the one that maximizes value created, such that $\lambda_H^* \in (0, \lambda_H^{opt})$.*
- iii. *Value capture by the gaming Supplier is maximized at an alignment level higher than the one that maximizes value created, such that $\lambda_G^* \in (\lambda_G^{opt}, \infty)$.*

In Figure 6 we present the ordering of alignment levels that lead to maximum value creation in a transaction as well as levels maximizing value capture for each of the contracting parties. In Figure 7, we plot the results presented in Proposition 4.

Insert Figures 6 and 7 about here

In our model we assumed that the alignment level is exogenous to the contracting parties. However, it is common in an organizational setting that

Value Creation and Value Capture under Moral Hazard

contracting parties are not exogenously presented with a performance measure but rather either construct it for a given transaction or choose from among multiple possible metrics (Ethiraj and Levinthal, 2009). Under an assumption that the same performance measure is used to write a contract with both types of suppliers, we show that a buyer and suppliers may have radically divergent interests with respect to the alignment of the performance measure with a non-contractible objective function. In particular, Proposition 4 shows that, in order to maximize individual value capture, all contracting parties have an incentive to deviate from the alignment level that maximizes transactional efficiency. The Buyer's value capture is maximized at the alignment level between the ones maximizing efficiency of the transaction with two suppliers. Compared to the most efficient alignment level, the honest Supplier is best off when the performance measure is under-aligned, while the gaming Supplier is best off when the performance measure is over-aligned.

These results also have important implications for the analysis of incentives for information sharing (Shavell, 1979; Holmstrom and Milgrom, 1991; Dyer and Singh, 1998; Poppo and Zenger, 2002). If the suppliers have superior information about the performance measure, they could share it with the Buyer in order to enhance total value creation. Our analysis shows that the honest Supplier and the gaming Supplier actually have conflicting incentives for such information sharing. Our results suggest that the honest Supplier would be likely to share information resulting in under-alignment, while the gaming Supplier would likely volunteer information leading to over-alignment.

INVESTING IN INTEGRITY

In the preceding sections, we have shown that the transactional integrity of suppliers improves both social and individual outcomes. Hence both the buyer and suppliers

would benefit from finding ways to increase transactional integrity. In this section, we characterize the strength of such incentives and how they might systematically vary across industry settings.

There are various ways in which firms might make investments to increase transactional integrity. Partners may choose to behave in a more trustworthy way the more the transactions are socially embedded (Granovetter, 1985). Senior management may allocate a significant amount of time to creating strong social ties with its partners. Another driver of transactional integrity are the corporate culture and social norms fostered by the supplier's senior management (Di Stefano *et al.*, 2013). Creating a strong corporate culture and sustaining social norms is a challenging and potentially time and resource-consuming activity. Finally, various frictions can create missing linkages between buyers and suppliers (Chatain and Zemsky, 2011). Hence, the more effort a buyer puts into search and relationship building, the more likely it is to have access to suppliers with high integrity for a given contract. The stronger a firm's incentives to increase integrity, the more we expect firm management to invest in the above areas.

Formally, we characterize the cross partial of buyer and supplier value capture with respect to integrity (ρ_S) and other parameters of our model. This allows us to characterize how investments in social embeddedness, corporate culture and supplier network vary based on the opportunities for gaming in an industry (g), the efficiency of the supplier base (θ_S) and the extent to which there is incentive alignment (λ).¹⁷ We know that a supplier's value capture is increasing in its own integrity and that the value capture of a buyer increases in the integrity of the supplier that it uses. The sign of the cross partial identifies whether a given parameter increases or decreases

¹⁷ We are grateful to an anonymous reviewer for suggesting the cross partial analysis. Please see the concluding section of the online appendix for formal derivations of the results presented here.

the effect of integrity on value capture and hence whether it strengthens or weakens the incentives to invest in integrity.

Supplier efficiency unambiguously increases the incentives to invest for both the buyer and the focal supplier: $\frac{\partial^2 A_B}{\partial \theta_s \partial \rho_s} > 0$ and $\frac{\partial^2 A_S}{\partial \theta_s \partial \rho_s} > 0$. The greater the efficiency of suppliers, the greater the effect of integrity on value capture. In other words, supplier efficiency and transactional integrity are complements (Milgrom and Roberts, 1995). Intuitively, lack of integrity leads to lower powered incentives and less ability to leverage the supplier efficiency. Our result echoes Makadok (2003), who shows that managers' forecasting ability and lower effort aversion are complements.

One might expect that integrity and opportunities for gaming would also be complements so that the greater the opportunities for gaming the greater the returns to integrity. In fact, we find that both $\frac{\partial^2 A_B}{\partial g \partial \rho_H} > 0$ and $\frac{\partial^2 A_S}{\partial g \partial \rho_S} > 0$ if and only if $\rho_S(1 + f^2 \lambda^2) > g^2$. Thus, if gaming opportunities are sufficiently great, it shifts from being a complement to being a substitute that reduces the incentives to invest. The reason is that as gaming becomes sufficiently large, value creation is reduced so much that the impact of integrity is necessarily compressed as well. Hence, our theory predicts that the incentives to invest in integrity are greatest in settings with intermediate levels of gaming. Similarly, we find that the incentives to invest in integrity are greatest for intermediate levels of alignment. Formally, we find that

$$\frac{\partial^2 A_B}{\partial \lambda \partial \rho_H} > 0 \text{ and } \frac{\partial^2 A_S}{\partial \lambda \partial \rho_S} > 0 \text{ if and only if } \lambda(\lambda f^2 + 2) < \frac{g^2}{\rho_S} + 1.$$

SUMMARY AND DISCUSSION

In this paper we start with a multi-task principal-agent model that captures the incentive problem in a buyer-supplier relationship. We consider a stylized situation

Value Creation and Value Capture under Moral Hazard

where a buyer transacts with a supplier that can vary in terms of production efficiency and transactional integrity. We then nest the results of the principal–agent analysis in a value–based model of competition among heterogeneous suppliers. The model structure allows us to jointly consider issues of contract design, value creation, and value capture in a competitive setting. We show the non-trivial impact of production efficiency, transactional integrity, incentive alignment, and incentive distortion on competitive outcomes. We therefore illustrate the importance of analyzing the contracting micro–foundations when considering key outcomes in an industry value chain.

Our theory and findings contribute to a broad stream of research on the drivers of competitive advantage of firms. Prior work has equated competitive advantage with firm’s value added (Adner and Zemsky, 2006; Adegbesan, 2009). In our model we show explicitly how competitive advantage varies not only with production efficiency but also with the properties of performance measurement and the resulting incentive structure, and with the transactional integrity of the contracting parties. We also show that the link between transactional characteristics, incentive design, and competitive advantage has important determinants at the industry level.

Our analysis assumes that all parameters are exogenous. However, given our explicit formalization of the characteristic function V , our model can be used to analyze efficiency and integrity as choice variables for suppliers in the long run. Indeed, market actors can invest in technology to lower production costs. Similarly, they can spend resources to signal their contracting behavior as well as to alter the contracting culture and hence the transactional integrity. Our results indicate that, given the investment costs and competitive landscape, there can exist an optimal level of productive efficiency and contracting integrity.

Supplementary analysis of these parameters in our model indicates that productive efficiency and integrity are complements in value creation and value capture. This result has important consequences for the analysis of the link between competitive advantage and business ethics. Indeed, existing research reports mixed results with respect to the relationship between ethical commitment or corporate social responsibility and subsequent financial performance (McWilliams and Siegel, 2000). While in our model, increasing transactional integrity leads to superior outcomes, our results highlight that such investments may be particularly beneficial to firms that also excel in productive efficiency. They also indicate that in the presence of moral hazard, there may be limits to business strategies based solely on cost efficiency.

In recent years, the social sciences have increasingly focused on behavioral issues. In strategy, an emerging research stream, drawing on early work in evolutionary economics, focuses on the micro-foundations of competitive behavior across firms (Gavetti, Levinthal, and Ocasio, 2007; Felin et al. 2012). The micro-foundational literature aspires to understand the fundamentals of the capabilities, routines, and processes at the individual level and link them to subsequent, higher-level competitive outcomes (Gavetti, 2005). We do not directly contribute to the micro-foundational debate because the basic unit of analysis in our study is the organization rather than the individual. While we also analyze different behavioral issues, explicitly focusing on incentives and transactional integrity, we seek to complement this literature by accounting for micro-level contracting problems, and unpacking higher-level outcomes, such as value creation possibilities and the division of value. Indeed, when analyzed at the individual level, the theory of incentives is explicit about the drivers of choice and trade-offs made by employees (Gibbons,

2005b). We believe that an analysis of incentives and of cognition, which is one of the main pillars of the micro-foundational inquiry, need not be disjointed, and that these two constructs are likely to mutually affect individual-level and organizational-level behavior. We are not the first ones to make this claim. Kaplan and Henderson (2005) provide a discussion of how cognitive inertia may constrain the use of efficient incentives. Postrel (2009) takes a different approach and formally shows not only that incentive design can be driven by existing beliefs but also analyzes how design instruments can be used to shape these beliefs in pursuit of value creation. Hence we see the inquiry into behavioral foundations and micro-level contracting attributes and outcomes as mutually reinforcing in creating avenues for future research.

Our model also has clear predictions that could be leveraged in empirical work. In particular, and distinguishing our work from that in the economic theory of incentives, our focus is to jointly consider issues of competition, value creation, and value capture rather than solely the efficiency of a productive relationship. The most obvious empirical tests pertain to the choice of contracting partners, contract design, and the trade-off between production efficiency and transactional integrity. Corollary 1 offers an empirical prediction with respect to incentive intensity across different suppliers and Proposition 1 with respect to the choice of contracting partners. Another useful and novel empirical test can be directly inferred from Proposition 4. While we assume that contracting partners face an exogenous performance proxy for a non-contractible objective function, organizations may in fact choose from a variety of measures. Our model offers predictions about that choice. Similarly, the results of our model can be used to further the analysis of the link between ethical behavior and corporate social responsibility and firm-level outcomes. The cross-partial analysis

also offers some novel predictions about the incentives of buyers to search for suppliers with high levels of integrity as well as suppliers to invest in building reputation for trustworthiness, depending on various industry settings. Overall, we present formal results with respect to the division of value between contracting parties, taking into account the importance of multiple contracting dimensions. These results complement recent empirical research in this domain such as Ethiraj and Garg (2011) and Obloj and Sengul (2012).

We designed our model to provide a general framework. For example, it allows for an analysis of value creation and value capture with suppliers holding any combination of transactional integrity and productive efficiency. Similarly, while our analysis is limited to one buyer and two suppliers, our results hold for multiple actors on the demand and supply side (cf. Chatain and Zemsky, 2011).¹⁸ The model does, however, have several limitations. For instance, in line with previous incentive models of this type, we constrain the number of potential tasks. While this structure of the model helps tractability, it would be useful for future research to generalize the structure of the model. Apart from restricting the number of tasks, we also treat tasks as substitutes in the objective function and hence abstract away from the impact of task complementarity on the parameters of interest. Similarly, we do not treat the issue of risk preferences of contracting parties. As any other formal model, ours is a stylized and simplified representation of an economic exchange. At the same time, we believe the model offers sufficient richness and uncovers interesting determinants of value creation and value capture in a productive relationship.

¹⁸ This is subject to some important conditions. In particular, because an analysis of value added consists of comparing value created by the focal supplier and the marginal supplier, important discontinuities may occur when multiple competing suppliers are of varying types.

BIBLIOGRAPHY

- Adegbesan J. A. 2009. On the origins of competitive advantage: Strategic factor markets and heterogeneous resource complementarity. *Academy of Management Review* **34**(3): 463–475.
- Adner R, Zemsky P. 2006. A demand-based perspective on sustainable competitive advantage. *Strategic Management Journal* **27**(3): 215–239.
- Azoulay P, Shane S. 2001. Entrepreneurs, contracts, and the failure of young firms. *Management Science* **47**(3): 337–358.
- Baker G. 2002. Distortion and risk in optimal incentive contracts. *Journal of Human Resources* **37**(4): 728–751.
- Barthélemy J. 2001. The hidden costs of IT outsourcing. *MIT Sloan Management Review* **42**(3): 60–69.
- Becker GS. 1993. Nobel lecture: The economic may of looking at behavior. *Journal of Political Economy* **101**(3): 385–409.
- Bendor J, Swistak P. 2001. The Evolution of Norms. *American Journal of Sociology* **106**(6): 1493–1545.
- Bridoux, F., R. Coeurderoy, R. Durand. 2011. Heterogeneous Motives and the Collective Creation of Value. *Academy of Management Review* **36**(4) 711–730.
- Blyler M, Coff R. W. 2003. Dynamic capabilities, social capital, and rent appropriation: ties that split pies. *Strategic Management Journal* **24**(7): 677–686.
- Brandenburger AM, Stuart HW. 1996. Value-based business strategy. *Journal of Economics & Management Strategy* **5**: 5–24.
- Brandenburger A, Stuart H. 2007. Biform games. *Management Science* **53**(4): 537–549.
- Camerer CF, Thaler RH. 1995. Ultimatums, dictators and manners. *Journal of Economic Perspectives* **9**(2): 209–19.
- Casadesus-Masanell R. 2004. Trust in agency. *Journal of Economics & Management Strategy* **13**: 375–404.
- Chatain O. 2011. Value creation, competition, and performance in buyer-supplier relationships. *Strategic Management Journal* **32**(1) 76–102.
- Chatain O, Zemsky P. 2007. The horizontal scope of the firm: Organizational tradeoffs vs. buyer–supplier relationships. *Management Science* **53**(4) 550–565.
- Child J, Tse DK. 2001. China’s transition and its implications for international business. *Journal of International Business Studies* **32**(1): 5–21.
- Coff RW. 1997. Human assets and management dilemmas: Coping with hazards on the road to resource-based theory. *Academy of Management Review* **22**(2): 374–402.
- Dencker JC. 2009. Relative bargaining power, corporate restructuring, and managerial incentives. *Administrative Science Quarterly* **54**(3): 453–485.
- Di Stefano, G., King, A. A. and Verona, G. 2013. Kitchen confidential? Norms for the use of transferred knowledge in gourmet cuisine. *Strategic Management Journal*. doi: 10.1002/smj.2179
- Dryer JH, Singh H. 1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review* **23**(4): 660–679.
- Ethiraj SK, Levinthal D. 2009. Hoping for A to Z while rewarding only A: Complex organizations and multiple goals. *Organization Science* **20**(1): 4–21.
- Ethiraj SK, Garg P. 2012. The Division of Gains from Complementarities in Human-Capital-Intensive Activity. *Organization Science* **23**(3): 725–742.

- Fast N, Berg NA. 1975. *The Lincoln Electric Company*. Harvard Business School Case #376-028.
- Felin T, Foss NJ, Heimeriks KH, Madsen TL. 2012. Microfoundations of routines and capabilities: Individuals, processes, and structure. *Journal of Management Studies* **49**(8): 1351–1374.
- Feltham GA, Xie J. 1994. Performance measure congruity and diversity in multi-task principal/agent relations. *Accounting Review* **69**(3): 429–453.
- Foss NJ. 2003. Selective intervention and internal hybrids: Interpreting and learning from the rise and decline of the oticon spaghetti organization. *Organization Science* **14**(3): 331–349.
- Frank D, Obloj T. 2013. Firm-specific human capital, agency costs, and adverse learning: Evidence from retail banking. *Strategic Management Journal*. n.a./n.a. DOI: 10.1002/smj.2148.
- Gavetti G. 2005. Cognition and hierarchy: Rethinking the microfoundations of capabilities' development. *Organization Science* **16**(6): 599–617.
- Gavetti G, Levinthal D, Ocasio W. 2007. Perspective--Neo-Carnegie: The Carnegie School's past, present, and reconstructing for the future. *Organization Science* **18**(3): 523–536.
- Gibbons R. 2005a. Incentives between firms (and within). *Management Science* **51**(1): 2–17.
- Gibbons R. 2005b. Four formal(izable) theories of the firm? *Journal of Economic Behavior & Organization* **58**(2): 200–245.
- Gino F, Pierce L. 2009. Dishonesty in the name of equity. *Psychological Science* **20**(9): 1153–1160.
- Gneezy U. 2005. Deception: The role of consequences. *American Economic Review* **95**(1): 384–394.
- Gneezy U, List JA. 2006. Putting behavioral economics to work: Testing for gift exchange in labor markets using field experiments. *Econometrica* **74**(5): 1365–1384.
- Gottschalg O, Zollo M.. 2007. Interest alignment and competitive advantage. *Academy of Management Review* **32**(2): 418–437.
- Granovetter M. 1985. Economic action and social structure: the problem of embeddedness. *American Journal of Sociology* **91**(3) 481-510.
- Harris JD, Bromiley P. 2007. Incentives to cheat: The influence of executive compensation and firm performance on financial misrepresentation. *Organization Science* **18**(3): 350–367.
- Holmstrom B. 1979. Moral hazard and observability. *Bell Journal of Economics* **10**(1): 74–91.
- Holmstrom B. 1982. Moral hazard in teams. *Bell Journal of Economics* **13**(2): 324–340.
- Holmstrom B, Milgrom P. 1991. Multitask principal-agent analyses: Incentive contracts, asset ownership, and job design. *Journal of Law, Economics, and Organization* **7**: 24–52.
- Hoskisson RE, Eden L, Lau CM, Wright M. 2000. Strategy in emerging economies. *Academy of Management Journal* **43**(3): 249–267.
- Kale P, Singh H, Perlmutter H. 2000. Learning and protection of proprietary assets in strategic alliances: Building relational capital. *Strategic Management Journal* **21**(3): 217–237.
- Kaplan R, Norton D. 1992. The balanced scorecard: Measures that drive performance. *Harvard Business Review* **70**(1): 71–79.

- Kaplan S, Henderson R. 2005. Inertia and incentives: Bridging organizational economics and organizational theory. *Organization Science* **16**(5): 509–521.
- Kerr S. 1975. On the folly of rewarding A while hoping for B. *Academy of Management Journal* **18**(4): 769–783.
- Koerner B. 2011. Made in America: Small businesses buck the offshoring trend. *Wired*, February 28: http://www.wired.com/magazine/2011/02/ff_madeinamerica/.
- Kogut B. 1988. *Joint ventures: Theoretical and empirical perspectives*. Strategic Management Journal **9**(4): 319–332.
- Laffont J, Martimort D. 2002. *The Theory of Incentives: The Principal-Agent Model*. Princeton University Press.
- Lambert RA, Larcker DF, Weigelt K. 1993. The structure of organizational incentives. *Administrative Science Quarterly* **38**(3): 438–461.
- Larsen M, Manning S, Pedersen T. 2011. The hidden costs of offshoring: The impact of complexity, design orientation and experience. *Academy of Management Best Paper Proceedings 2011*.
- Levinthal DA. 1988. A survey of agency models of organizations. *Journal of Economic Behavior and Organization*. **9**(2): 153–185.
- MacDonald G, Ryall MD. 2004. How do value creation and competition determine whether a firm appropriates value? *Management Science* **50**(10): 1319–1333.
- Makadok R. 2003. Doing the right thing and knowing the right thing to do: Why the whole is greater than the sum of the parts. *Strategic Management Journal* **24**(10): 1043–1055.
- Makadok R, Coff R. 2009. Both market and hierarchy: An incentive-system theory of hybrid governance forms. *Academy of Management Review* **34**(2): 297–319.
- Makadok R. 2010. The interaction effect of rivalry restraint and competitive advantage on profit: Why the whole is less than the sum of the parts. *Management Science* **56**: 356–372.
- Makowski L, Ostroy JM. 1995. Appropriation and efficiency: A revision of the first theorem of welfare economics. *The American Economic Review* **85**(4): 808–827.
- Makowski L, Ostroy JM. 2012. Appropriation in a competitive theory of value. *Papers in Political Economy* **63**(2): 25–76.
- Margolis JD, Walsh JP. 2003. Misery loves companies: Rethinking social initiatives by business. *Administrative Science Quarterly* **48**(2): 268–305.
- Midler P. 2011. *Poorly Made in China: An Insider's Account of the China Production Game*. John Wiley & Sons. New Jersey
- Milgrom P, Roberts J. 1990. Bargaining costs, influence costs, and the organization of economic activity. *Perspectives on Positive Political Economy*, Alt, J., Shepsle, A. (eds.). Cambridge University Press: New York.
- Milgrom P, Roberts J. 1995. Complementarities and fit strategy, structure, and organizational change in manufacturing. *Journal of Accounting and Economics* **19**(2-3) 179–208.
- Nagin DS, Rebitzer JB, Sanders S, Taylor LJ. 2002. Monitoring, motivation, and management: The determinants of opportunistic behavior in a field experiment. *American Economic Review* **92**(4) 850–873.
- Nickerson J, Silverman, B, Zenger, T. The ‘problem’ of creating and capturing value. *Strategic Organization* **5**(3) 211–225.
- Obloj T, Sengul M. 2012. Incentive life-cycles: Learning and the division of value in firms. *Administrative Science Quarterly* **57**(2): 305–347.
- Oyer P. 1998. Fiscal year ends and nonlinear incentive contracts: The effect on business seasonality. *Quarterly Journal of Economics* **113**(1): 149–185.

- Pierce L. 2012. Organizational structure and the limits of knowledge sharing: Incentive conflict and agency in car leasing. *Management Science* **58**(6): 1106–1121.
- Poppo L, Zenger T. 2002. Do formal contracts and relational governance function as substitutes or complements? *Strategic Management Journal* **23**(8): 707–725.
- Postrel S. 2009. Multitasking teams with variable complementarity: Challenges for capability management. *Academy of Management Review* **34**(2): 273–296.
- Prendergast C. 1999. The provision of incentives in firms. *Journal of Economic Literature* **37**(1): 7–63.
- Rob, R., P. Zemsky. 2002. Social capital, corporate culture, and incentive intensity. *Rand Journal of Economics* **33**(2) 243–257.
- Shavell S. 1979. Risk sharing and incentives in the principal and agent relationship. *Bell Journal of Economics* **10**(1): 55–73.
- Sliwka D. 2007. Trust as a signal of a social norm and the hidden costs of incentive schemes. *American Economic Review* **97**(3): 999–1012.
- Tsai W, Ghoshal S. 1998. Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal* **41**(4): 464–476.
- Vroom G, Gimeno J. 2007. Ownership form, managerial incentives, and the intensity of rivalry. *Academy of Management Journal* **50**(4): 901–922.
- Williamson OE. 1975. *Markets and Hierarchies*. Free Press: New York.
- Williamson, OE. 1993. Calculativeness, trust, and economic organization. *Journal of Law and Economics* **36**(1): 453-486.
- Zenger TR. 1994. Explaining organizational diseconomies of scale in R&D: Agency problems and the allocation of engineering talent, ideas, and effort by firm size. *Management Science* **40**(6): 708–729.
- Zenger TR. 2002. Crafting internal hybrids: Complementarities, common change initiatives, and the team-based organization. *International Journal of the Economics of Business* **9**(1): 79-95.
- Zhao M. 2006. Conducting R& D in countries with weak intellectual property rights protection. *Management Science* **52**(8): 1185–1199.

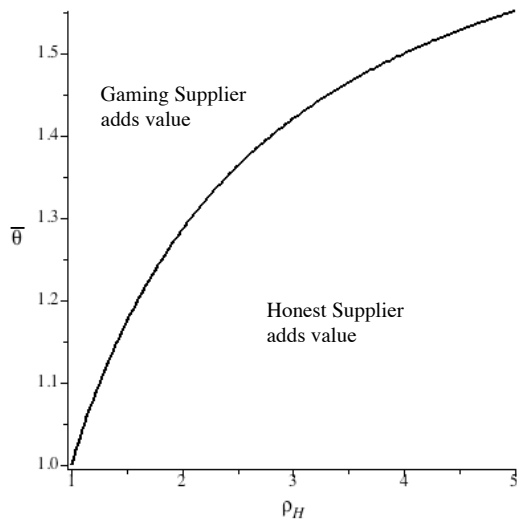


Figure 1. The effect of an honest Supplier's transactional integrity (ρ_H) on critical production cost advantage ($\bar{\theta}_G$)

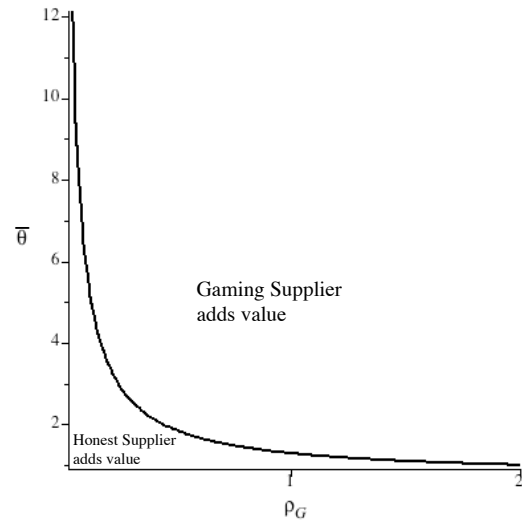


Figure 2. The effect of a gaming Supplier's transactional integrity (ρ_G) on critical production cost advantage ($\bar{\theta}_G$)

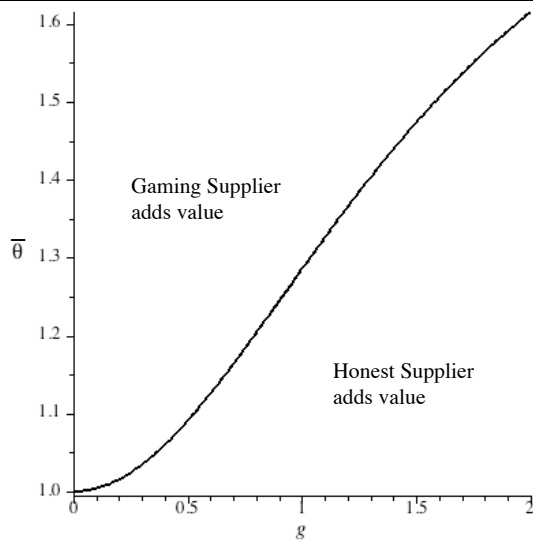


Figure 3. The effect of gaming possibilities (g) on critical production cost advantage ($\bar{\theta}_G$)

Value Creation and Value Capture under Moral Hazard

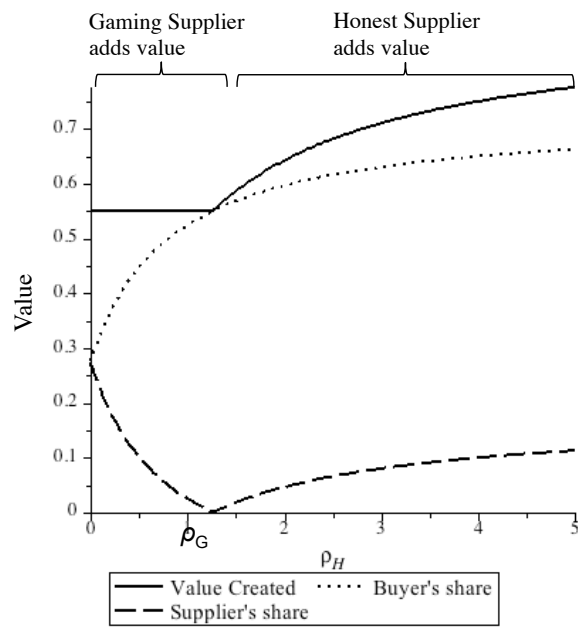


Figure 4. The effect of transactional integrity of the honest Supplier (ρ_H) on value creation and value capture (vertical axis)

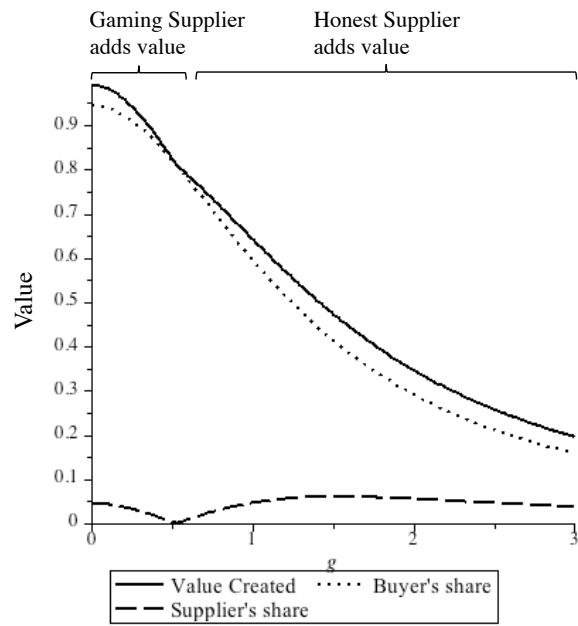


Figure 5. The effect of gaming possibilities (g) on value creation and value capture (vertical axis)

Value Creation and Value Capture under Moral Hazard

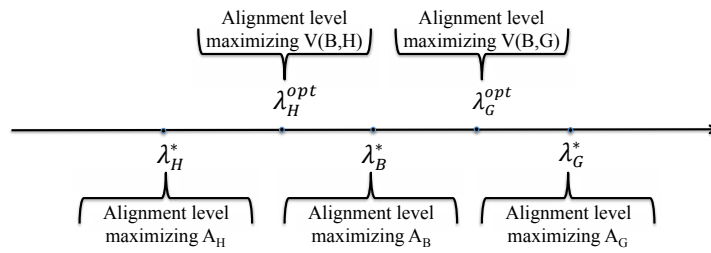


Figure 6. Ordering of the optimal alignment levels

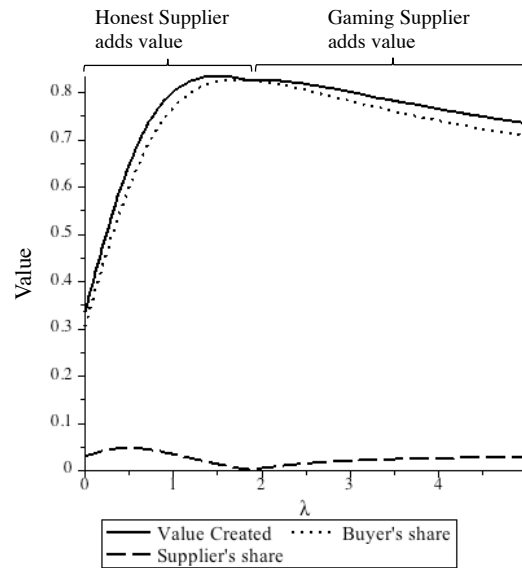


Figure 7. The effect of incentive alignment (λ) on value creation and value capture (vertical axis)

Value Creation and Value Capture under Moral Hazard: Exploring the Micro-Foundations of Buyer-Supplier Relationships

APPENDIX. Proofs

All proofs are for the following values of the parameters (as assumed in the model):

$$f, g, \lambda > 0; \rho_H > \rho_G > 0, \theta_G > 0; \theta_H = 1; \alpha \in [0, 1].$$

Proof of Lemma 1

The supplier maximizes own payments (3) less own cost of effort (4). Substituting (2) into (3) and subtracting cost of effort, we can re-write a suppliers' maximand as: $w_{0s} + b_s(a_{s1} + \lambda f a_{s2} + g a_{s3}) - \frac{1}{2\theta_s} a_{s1}^2 - \frac{1}{2\theta_s} a_{s2}^2 - \frac{\rho_s}{2\theta_s} a_{s3}^2$. This objective function is separable across all variables so it is easy to check that the Hessian matrix is negative semi-definite and therefore the individual first order conditions are sufficient. FOC for each of the tasks is respectively given by: $b_s - \frac{a_{s1}}{\theta_s} = 0$; $b_s f \lambda - \frac{a_{s2}}{\theta_s} = 0$; $b_s g - \frac{a_{s3} \rho_s}{\theta_s} = 0$. Solving for the vector of optimal effort allocations a_{si} we get: $a_s^* = \{\theta_s b_s, \theta_s \lambda f b_s, \frac{\theta_s}{\rho_s} g b_s\}$.

Proof of Lemma 2

Using the results derived in Lemma 1, we can write the Buyer's incentive problem when transacting with each of the Suppliers as follows:

$$b_s^* = \arg \max_{b_s} [O(a_s^*) - c_s(a_s^*)] = \arg \max_{b_s} [\theta_s b_s + f^2 \lambda \theta_s b_s - \frac{1}{2\theta_s} (\theta_s b_s)^2 - \frac{1}{2\theta_s} (\theta_s \lambda f b_s)^2 - \frac{\rho_s}{2\theta_s} (\frac{\theta_s}{\rho_s} g b_s)^2].$$

It is straightforward to check that the second order conditions hold, so by solving the first order conditions we can derive the desired results: $b_H^* = \frac{1+f^2\lambda}{1+f^2\lambda^2+\frac{g^2}{\rho_H}}$ and $b_G^* = \frac{1+f^2\lambda}{1+f^2\lambda^2+\frac{g^2}{\rho_G}}$.

Proof of Corollary 1

By inspection of b_H^* and b_G^* .

Proof of Lemma 3

Omitted. See Chatain and Zemsky (2007) Corollary 2.

Proof of Lemma 4

It is enough to show that the condition $\theta_G \in (0, 1)$ implies that $V(B, H) > V(B, G)$. Using solutions for optimal incentive intensity and corresponding effort allocations derived in Lemmas 1 and 2, this inequality can be re-written as:

$$\frac{1}{2} \frac{(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} > \frac{1}{2} \frac{(1+f^2\lambda)^2\theta_G}{1+f^2\lambda^2+\frac{g^2}{\rho_G}}.$$

Given that $\rho_G < \rho_H$ by assumption, this inequality always holds for $\theta_G < 1$.

Proof of Proposition 1

i. Honest Supplier adds value iff $V(B, H) \geq V(B, G)$. Solving this inequality for θ_G , we get the following condition:

$$\theta_G \leq \bar{\theta}_G = \frac{1+f^2\lambda^2+\frac{g^2}{\rho_G}}{1+f^2\lambda^2+\frac{g^2}{\rho_H}}.$$

ii. The derivative of $\bar{\theta}_G$ with respect to ρ_H is calculated as:

$$\frac{\partial \bar{\theta}_G}{\partial \rho_H} = \frac{(1+f^2\lambda^2+\frac{g^2}{\rho_G})g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2\rho_H^2} > 0.$$

iii. The derivative of $\bar{\theta}_G$ with respect to ρ_G is calculated as:

$$\frac{\partial \bar{\theta}_G}{\partial \rho_G} = -\frac{g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2\rho_G^2} < 0.$$

iv. The derivative of $\bar{\theta}_G$ with respect to λ is calculated as:

$$\frac{\partial \bar{\theta}_G}{\partial \lambda} = \frac{2f^2\lambda g^2 \rho_H (\rho_G - \rho_H)}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2 \rho_G} < 0.$$

v. The derivative of $\bar{\theta}_G$ with respect to g is calculated as:

$$\frac{\partial \bar{\theta}_G}{\partial g} = \frac{2g\rho_H(1+f^2\lambda^2)(\rho_H - \rho_G)}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2 \rho_G} > 0.$$

Proof of Proposition 2

i. The derivative of value created in a transaction where the Buyer transacts with Supplier s with respect to ρ_s is calculated as:

$$\frac{\partial V(B, S)}{\partial \rho_s} = \frac{1}{2} \frac{(1+f^2\lambda)^2 g^2 \theta_s}{(1+f^2\lambda^2+\frac{g^2}{\rho_s})^2 \rho_s^2} > 0.$$

ii. Because $V(B, H)$ is independent of ρ_G and $V(B, G)$ is independent of ρ_H : $\frac{\partial V(B, G)}{\partial \rho_H} = 0$ and $\frac{\partial V(B, H)}{\partial \rho_G} = 0$.

iii. We will prove this part of the proposition by considering two cases depending on whether the Buyer transacts with the honest or gaming Supplier (depending on which has greater value

creation).

Case 1. $V(B, H) \geq V(B, G)$. Value appropriated by the Buyer is given by:

$$A_B = V(B, G) + \alpha(V(B, H) - V(B, G)) = \frac{1}{2} \frac{\theta_G(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} + \alpha \left(\frac{1}{2} \frac{(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} - \frac{1}{2} \frac{\theta_G(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} \right).$$

Accordingly,

$$\frac{\partial A_B}{\partial \rho_H} = \frac{1}{2} \alpha \frac{(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2 \rho_H^2} > 0.$$

$$\frac{\partial A_B}{\partial \rho_G} = \frac{1}{2} (1-\alpha) \frac{\theta_G(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2} > 0.$$

Case 2. $V(B, G) \geq V(B, H)$. Value appropriated by the Buyer is given by:

$$A_B = \frac{1}{2} \frac{(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} + \alpha \left(\frac{1}{2} \frac{\theta_G(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} - \frac{1}{2} \frac{(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} \right).$$

Accordingly,

$$\frac{\partial A_B}{\partial \rho_H} = \frac{1}{2} (1-\alpha) \frac{(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2} > 0.$$

$$\frac{\partial A_B}{\partial \rho_G} = \frac{1}{2} \alpha \frac{\theta_G(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2 \rho_G^2} > 0.$$

iv. If $V(B, G) \geq V(B, H)$ then $A_H = 0$. If $V(B, H) \geq V(B, G)$, then the value appropriated by Supplier H is given by:

$$A_H = (1-\alpha) \left(\frac{1}{2} \frac{(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} - \frac{1}{2} \frac{\theta_G(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} \right).$$

Accordingly,

$$\frac{\partial A_H}{\partial \rho_H} = \frac{1}{2} (1-\alpha) \frac{(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2 \rho_H^2} > 0.$$

If $V(B, H) \geq V(B, G)$ then $A_G = 0$. If $V(B, G) \geq V(B, H)$, then the value appropriated by Supplier G is given by:

$$A_G = (1-\alpha) \left(\frac{1}{2} \frac{\theta_G(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} - \frac{1}{2} \frac{(1+f^2\lambda)^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} \right).$$

Accordingly,

$$\frac{\partial A_G}{\partial \rho_G} = \frac{1}{2} (1-\alpha) \frac{\theta_G(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2 \rho_G^2} > 0.$$

v. If $V(B, H) \geq V(B, G)$, then

$$\frac{\partial A_H}{\partial \rho_G} = -\frac{1}{2} (1-\alpha) \frac{\theta_G(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2 \rho_G^2} < 0.$$

If $V(B, G) \geq V(B, H)$, then

$$\frac{\partial A_G}{\partial \rho_H} = -\frac{1}{2} (1-\alpha) \frac{(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2 \rho_H^2} < 0.$$

Proof of Proposition 3 and Corollary 2

i. Recall that $V(B, G, H) = \max V(B, G), V(B, H)$. If the Buyer transacts with the honest Supplier, then:

$$\frac{\partial V(B, H)}{\partial g} = -\frac{(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_H})^2 \rho_H} < 0.$$

If the Buyer transacts with the gaming Supplier, then:

$$\frac{\partial V(B, G)}{\partial g} = -\frac{\theta_G(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_G})^2 \rho_G} < 0.$$

Hence, $\frac{\partial V(B, G, H)}{\partial g} < 0$.

ii. We will prove this part of the proposition by considering two cases depending on whether the Buyer transacts with the honest or gaming Supplier.

Case 1. $V(B, H) \geq V(B, G)$.

$$\frac{\partial A_B}{\partial g} = (\alpha - 1) \frac{\theta_G(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_G})^2 \rho_G} - \alpha \frac{(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_H})^2 \rho_H} < 0.$$

Case 2. $V(B, G) \geq V(B, H)$.

$$\frac{\partial A_B}{\partial g} = (\alpha - 1) \frac{(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_H})^2 \rho_H} - \alpha \frac{\theta_G(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_G})^2 \rho_G} < 0.$$

iii. We will show that A_H first increases, reaches a maximum and then decreases in g , i.e., that there exists $\hat{g} > 0$ such that $\forall_{g < \hat{g}} \frac{\partial A_H}{\partial g} > 0$ and $\forall_{g > \hat{g}} \frac{\partial A_H}{\partial g} < 0$ for $\rho_H > \frac{\rho_G}{\theta_G}$. For $\rho_H < \frac{\rho_G}{\theta_G}$, A_H achieves a maximum at $g = 0$. Accordingly, we will show that for $\rho_H > \frac{\rho_G}{\theta_G}$, $\frac{\partial A_H}{\partial g}$ single crosses zero from above.

$$\frac{\partial A_H}{\partial g} = (1 - \alpha) \left(\frac{\theta_G(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_G})^2 \rho_G} - \frac{(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_H})^2 \rho_H} \right).$$

First, for $\rho_H > \frac{\rho_G}{\theta_G}$ there exists a unique $\hat{g} > 0$ solving the FOC. Second, note that for $\rho_H > \frac{\rho_G}{\theta_G}$, $\forall_{g < \hat{g}}, \frac{\partial A_H}{\partial g} > 0$. Hence $\frac{\partial A_H}{\partial g} > 0$ for $g \in (0, \hat{g})$ and $\frac{\partial A_H}{\partial g} < 0$ for $g \in (\hat{g}, \infty)$. For $\rho_H < \frac{\rho_G}{\theta_G}$, $\frac{\partial A_H}{\partial g} < 0$, for all $g > 0$.

iv. In Proposition 1 we proved that the gaming Supplier only participates in the exchange for $\theta_G > \bar{\theta}_G$. As,

$$\frac{\partial A_G}{\partial g} = (1 - \alpha) \left(\frac{(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_H})^2 \rho_H} - \frac{\theta_G(1 + f^2\lambda)^2 g}{(1 + f^2\lambda^2 + \frac{g^2}{\rho_G})^2 \rho_G} \right)$$

and $\frac{\partial A_G}{\partial g}$ is decreasing in θ_G it is sufficient to show that $\frac{\partial A_G}{\partial g} \Big|_{\theta_G = \bar{\theta}_G} < 0$. Indeed:

$$\frac{\partial A_G}{\partial g} \Big|_{\theta_G = \bar{\theta}_G} = (1 - \alpha) \frac{(1 + f^2\lambda)^2 (1 + f^2\lambda^2) \rho_H g (\rho_G - \rho_H)}{((1 + f^2\lambda^2) \rho_H + g^2)^2 \rho_G (1 + f^2\lambda^2 + g^2)} < 0.$$

Therefore $\frac{\partial A_G}{\partial g} < 0$ when this Supplier participates in the exchange.

Proof of Lemma 5

i. The optimal alignment level maximizing value creation when the Buyer contracts with honest Supplier is given by λ_H^{opt} such that:

$$\lambda_H^{opt} = \arg \max_{\lambda} V(B, H).$$

The FOC is given by:

$$\frac{(1 + f^2 \lambda) f^2}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_H})} - \frac{(1 + f^2 \lambda)^2 f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_H})^2} = 0.$$

For $\lambda > 0$, it has a unique solution given by:

$$\lambda_H^{opt} = 1 + \frac{g^2}{\rho_H}.$$

Note also that derivative of $V(B, H)$ with respect to λ evaluated at $\lambda = 0$ is positive and hence $V(B, H)$ is increasing, achieves a maximum in λ_H^{opt} and is decreasing thereafter. This property of $V(B, H)$ will be used again in the proof of Proposition 4 below.

ii. The optimal alignment level maximizing value creation when the Buyer contracts with gaming Supplier is given by λ_G^{opt} such that:

$$\lambda_G^{opt} = \arg \max_{\lambda} V(B, G).$$

The FOC is given by:

$$\frac{(1 + f^2 \lambda) \theta_G f^2}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_G})} - \frac{(1 + f^2 \lambda)^2 \theta_G f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_G})^2} = 0.$$

For $\lambda > 0$, it has a unique solution given by:

$$\lambda_G^{opt} = 1 + \frac{g^2}{\rho_G}.$$

Note also that derivative of $V(B, G)$ with respect to λ evaluated at $\lambda = 0$ is positive and hence $V(B, G)$ is increasing, achieves a maximum in λ_G^{opt} and is decreasing thereafter. This property of $V(B, G)$ will be used again in the proof of Proposition 4 below.

Proof of Proposition 4

To prove all parts of this Proposition, we need to show that the following ordering holds:

$$\lambda_H^* \leq \lambda_H^{opt} \leq \lambda_B^* \leq \lambda_G^{opt} \leq \lambda_G^*,$$

where ordered values are the alignment levels that maximize value creation and value capture of the transactional parties. In particular: $\lambda_H^* = \arg \max_{\lambda} A_H$, $\lambda_H^{opt} = \arg \max_{\lambda} V(B, H)$, $\lambda_B^* = \arg \max_{\lambda} A_B$, $\lambda_G^{opt} = \arg \max_{\lambda} V(B, G)$, $\lambda_G^* = \arg \max_{\lambda} A_G$.

We first show that $\lambda_H^{opt} \leq \lambda_G^{opt}$. Using the results presented in Lemma 5, this inequality can be re-written as: $1 + \frac{g^2}{\rho_H} \leq 1 + \frac{g^2}{\rho_G}$, which always holds as $\rho_H > \rho_G$.

Second, we show that $\lambda_H^{opt} \leq \lambda_B^* \leq \lambda_G^{opt}$. Note that:

$$\frac{\partial A_B}{\partial \lambda} = (1 - \alpha) \frac{\partial V(B,G)}{\partial \lambda} + \alpha \frac{\partial V(B,H)}{\partial \lambda}, \text{ if the honest Supplier adds value.}$$

$$\frac{\partial A_B}{\partial \lambda} = (1 - \alpha) \frac{\partial V(B,H)}{\partial \lambda} + \alpha \frac{\partial V(B,G)}{\partial \lambda}, \text{ if the gaming Supplier adds value.}$$

Based on results presented in Lemma 5, independent of which Supplier is chosen, the following holds: $\frac{\partial A_B}{\partial \lambda} > 0$ for $\lambda \in (0, \lambda_H^{opt})$ and $\frac{\partial A_B}{\partial \lambda} < 0$ for $\lambda \in (\lambda_G^{opt}, \infty)$. Because A_B seen as a function of λ is continuous, it achieves a maximum at $\lambda_{1B}^* \in (\lambda_H^{opt}, \lambda_G^{opt})$. Hence: $\lambda_H^{opt} \leq \lambda_B^* \leq \lambda_G^{opt}$.

Third, we show that $\lambda_H^* \leq \lambda_H^{opt}$. Note that if the honest Supplier participates in the exchange:

$$\frac{\partial A_H}{\partial \lambda} = (1 - \alpha) \left(\frac{\partial V(B,H)}{\partial \lambda} - \frac{\partial V(B,G)}{\partial \lambda} \right), \text{ hence } \text{sign} \left(\frac{\partial A_H}{\partial \lambda} \right) = \text{sign} \left(\frac{\partial V(B,H)}{\partial \lambda} - \frac{\partial V(B,G)}{\partial \lambda} \right). \text{ Furthermore,}$$

$\frac{\partial A_H}{\partial \lambda} < 0$ for $\lambda \in (\lambda_H^{opt}, \lambda_G^{opt})$ because in this region $\frac{\partial V(B,G)}{\partial \lambda} > 0$ and $\frac{\partial V(B,H)}{\partial \lambda} < 0$. We will now show that A_H is first increasing, reaching a maximum and then decreasing on the region $\lambda \in (0, \lambda_H^{opt})$.

$$\frac{\partial A_H}{\partial \lambda} = (1 - \alpha) \left(\frac{(1 + f^2 \lambda) f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_H}} - \frac{(1 + f^2 \lambda)^2 f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_H})^2} - \frac{(1 + f^2 \lambda) \theta_G f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_G}} + \frac{(1 + f^2 \lambda)^2 \theta_G f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_G})^2} \right)$$

Observe that $\left. \frac{\partial A_H}{\partial \lambda} \right|_{\lambda=0} = (1 - \alpha) f^2 \left(\frac{1}{1 + \frac{g^2}{\rho_H}} - \frac{\theta_G}{1 + \frac{g^2}{\rho_G}} \right) > 0$, for λ such that $\theta_G < \bar{\theta}_G$ (so that honest Supplier adds value). As $\frac{\partial A_H}{\partial \lambda} < 0$ for $\lambda \in (\lambda_H^{opt}, \lambda_G^{opt})$ and A_H is a continuous function, it achieves a maximum at $\lambda^* \in (0, \lambda_H^{opt})$.

To complete this part of the proof, we just need to show that A_H does not achieve a different maximum on $(\lambda_G^{opt}, \infty)$. In fact, we will show that $\frac{\partial A_H}{\partial \lambda} \leq 0$ for $\lambda \in (\lambda_G^{opt}, \infty)$. To show this, it is sufficient that on this region $\frac{\partial V(B,G)}{\partial \lambda} > \frac{\partial V(B,H)}{\partial \lambda}$. This inequality can be re-written as:

$$\frac{(1 + f^2 \lambda) \theta_G f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_G}} - \frac{(1 + f^2 \lambda)^2 \theta_G f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_G})^2} > \frac{(1 + f^2 \lambda) f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_H}} - \frac{(1 + f^2 \lambda)^2 f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_H})^2}.$$

As $\frac{(1 + f^2 \lambda) \theta_G f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_G}} - \frac{(1 + f^2 \lambda)^2 \theta_G f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_G})^2}$ is decreasing in θ_G for $(\lambda_G^{opt}, \infty)$, it is sufficient to show that:

$$\frac{(1 + f^2 \lambda) \bar{\theta}_G f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_G}} - \frac{(1 + f^2 \lambda)^2 \bar{\theta}_G f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_G})^2} > \frac{(1 + f^2 \lambda) f^2}{1 + f^2 \lambda^2 + \frac{g^2}{\rho_H}} - \frac{(1 + f^2 \lambda)^2 f^2 \lambda}{(1 + f^2 \lambda^2 + \frac{g^2}{\rho_H})^2},$$

which simplifies to: $\frac{(1 + f^2 \lambda)^2 f^2 \lambda g^2 (\rho_H - \rho_G)}{\rho_G (1 + f^2 \lambda^2 + \frac{g^2}{\rho_G}) (1 + f^2 \lambda^2 + \frac{g^2}{\rho_H})^2} > 0$.

Finally, we show that $\lambda_G^* \geq \lambda_G^{opt}$. Note that if the gaming Supplier participates in the exchange:

$$\frac{\partial A_G}{\partial \lambda} = (1 - \alpha) \left(\frac{\partial V(B,G)}{\partial \lambda} - \frac{\partial V(B,H)}{\partial \lambda} \right), \text{ hence } \text{sign} \left(\frac{\partial A_G}{\partial \lambda} \right) = \text{sign} \left(\frac{\partial V(B,G)}{\partial \lambda} - \frac{\partial V(B,H)}{\partial \lambda} \right). \text{ Furthermore, as we}$$

have shown earlier, for $\lambda \in (\lambda_H^{opt}, \lambda_G^{opt})$, $\frac{\partial V(B,H)}{\partial \lambda} < 0$ and $\frac{\partial V(B,G)}{\partial \lambda} > 0$. Therefore $\frac{\partial A_G}{\partial \lambda} > 0$ for $\lambda \in$

$(\lambda_H^{opt}, \lambda_G^{opt})$.

We will now show that A_G is also increasing in λ for $\lambda \in (0, \lambda_H^{opt})$. To see this, note that $\frac{\partial A_G}{\partial \lambda} > 0$ iff $\frac{\partial V(B,G)}{\partial \lambda} > \frac{\partial V(B,H)}{\partial \lambda}$ in this region. This inequality can be again re-written as:

$$\frac{(1+f^2\lambda)\theta_G f^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} - \frac{(1+f^2\lambda)^2\theta_G f^2\lambda}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2} > \frac{(1+f^2\lambda)f^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} - \frac{(1+f^2\lambda)^2 f^2\lambda}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2}.$$

Note that $\frac{(1+f^2\lambda)\theta_G f^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} - \frac{(1+f^2\lambda)^2\theta_G f^2\lambda}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2}$ increases in θ_G for $\lambda \in (0, \lambda_H^{opt})$. Therefore, as the gaming Supplier only participates in the exchange for $\theta_G > \bar{\theta}_G$ it is again sufficient to show that this inequality holds for the lowest values of θ_G that allow the gaming Supplier to participate in the exchange:

$$\frac{(1+f^2\lambda)\bar{\theta}_G f^2}{1+f^2\lambda^2+\frac{g^2}{\rho_G}} - \frac{(1+f^2\lambda)^2\bar{\theta}_G f^2\lambda}{(1+f^2\lambda^2+\frac{g^2}{\rho_G})^2} > \frac{(1+f^2\lambda)f^2}{1+f^2\lambda^2+\frac{g^2}{\rho_H}} - \frac{(1+f^2\lambda)^2 f^2\lambda}{(1+f^2\lambda^2+\frac{g^2}{\rho_H})^2}.$$

As proved above, this condition always holds for assumed parameter range. Therefore if A_G achieves a maximum, it is given by $\lambda_G^* \in (\lambda_G^{opt}, \infty)$.

Hence: $\lambda_H^* \leq \lambda_H^{opt} \leq \lambda_B^* \leq \lambda_G^{opt} \leq \lambda_G^*$.

Derivations of cross-partial results

First, we characterize the cross-partials of value creation and value capture with respect to θ_S and ρ_S . Note that $\frac{\partial^2 V(B,S)}{\partial \theta_S \partial \rho_S} = \frac{1}{2} \frac{(1+f^2\lambda)^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_S})^2 \rho_G^2} > 0$. Also note that $\frac{\partial^2 A_B}{\partial \theta_S \partial \rho_S} = \alpha \frac{\partial^2 V(B,S)}{\partial \theta_S \partial \rho_S}$ and $\frac{\partial^2 A_S}{\partial \theta_S \partial \rho_S} = (1-\alpha) \frac{\partial^2 V(B,S)}{\partial \theta_S \partial \rho_S}$. Therefore, and given that $\alpha \in (0, 1)$, $\frac{\partial^2 A_B}{\partial \theta_S \partial \rho_S} > 0$ and $\frac{\partial^2 A_S}{\partial \theta_S \partial \rho_S} > 0$.

Second, we characterize the cross-partials of value creation and value capture with respect to g and ρ_S . Note that $\frac{\partial^2 V(B,S)}{\partial g \partial \rho_S} = \frac{(1+f^2\lambda)^2 \theta_S g}{(1+f^2\lambda^2+\frac{g^2}{\rho_S})^2 \rho_G^2} - \frac{2(1+f^2\lambda)^2 \theta_S g^3}{(1+f^2\lambda^2+\frac{g^2}{\rho_S})^3 \rho_G^3}$. Hence $\frac{\partial^2 V(B,S)}{\partial g \partial \rho_S} > 0 \iff \rho_S(1+f^2\lambda^2) - g^2 > 0$. Given that $\frac{\partial^2 A_B}{\partial g \partial \rho_S} = \alpha \frac{\partial^2 V(B,S)}{\partial g \partial \rho_S}$ and $\frac{\partial^2 A_S}{\partial g \partial \rho_S} = (1-\alpha) \frac{\partial^2 V(B,S)}{\partial g \partial \rho_S}$, the same condition as above holds for $\frac{\partial^2 A_B}{\partial g \partial \rho_S}$ and $\frac{\partial^2 A_S}{\partial g \partial \rho_S}$.

Finally, we characterize the cross-partials of value creation and value capture with respect to λ and ρ_S . Note that $\frac{\partial^2 V(B,S)}{\partial \lambda \partial \rho_S} = \frac{(1+f^2\lambda)\theta_S f^2 g^2}{(1+f^2\lambda^2+\frac{g^2}{\rho_S})^2 \rho_G^2} - \frac{2(1+f^2\lambda)\theta_S f^2 g^2 \lambda}{(1+f^2\lambda^2+\frac{g^2}{\rho_S})^3 \rho_G^3}$. Hence $\frac{\partial^2 V(B,S)}{\partial \lambda \partial \rho_S} > 0 \iff g^2 - \rho_S(f^2\lambda^2 + 2\lambda - 1) > 0$. The same condition holds for $\frac{\partial^2 A_B}{\partial \lambda \partial \rho_S}$ and $\frac{\partial^2 A_S}{\partial \lambda \partial \rho_S}$.

□

Europe Campus
Boulevard de Constance
77305 Fontainebleau Cedex, France
Tel: +33 (0)1 60 72 40 00
Fax: +33 (0)1 60 74 55 00/01

Asia Campus
1 Ayer Rajah Avenue, Singapore 138676
Tel: +65 67 99 53 88
Fax: +65 67 99 53 99

Abu Dhabi Campus
Muroor Road - Street No 4
P.O. Box 48049
Abu Dhabi, United Arab Emirates
Tel: +971 2 651 5200
Fax: +971 2 443 9461

www.insead.edu

INSEAD

The Business School
for the World®