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Cui Bono? The Selective Revealing of Knowledge and its Implications for Innovative Activity

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CUI BONO? THE SELECTIVE REVEALING OF KNOWLEDGE AND ITS IMPLICATIONS FOR INNOVATIVE ACTIVITY

ABSTRACT

Current theories of how organizations harness knowledge for innovative activity cannot convincingly explain emergent practices whereby firms selectively reveal knowledge to their advantage. We conceive selective revealing as a strategic mechanism to re-shape the collaborative behavior of other actors in the innovation ecosystem. We propose that selective revealing may provide a more effective alternative to known collaboration mechanisms in particular under conditions of high partner uncertainty, high coordination costs, and unwilling potential collaborators. We specify conditions when firms are more likely to reveal knowledge and highlight some boundary conditions for competitor reciprocity. We elaborate upon strategies that allow firms to exhibit managerial agency in selective revealing, and discuss its implications for theories of innovation and management practice.

Keywords: Selective revealing, collaboration, innovation, induced isomorphism, absorptive capacity, knowledge.

He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me.

Thomas Jefferson, letter to Isaac McPherson, 13 August 1813
http://press-pubs.uchicago.edu/founders/documents/a1_8_8s12.html

The control over valuable resources is one of the most potent sources of competitive advantage that organizations can possess (e.g., Barney, 1991; Dierickx & Cool, 1989; Pfeffer & Salancik, 1978; Teece, 1986). Organizations that control resources enjoy higher rates of survival, and exert influence over other organizations in need of these resources. These weaker organizations, in turn, will strive to get access to these resources or substitute them by applying strategies such as partnerships, alliances, joint ventures, mergers and acquisitions, board interlocks, or political action (e.g., Bresser & Harl, 1986; Hillman & Hitt, 1999; Jacobs, 1974; Kale & Singh, 2009; Oliver, 1990; Podolny & Page, 1998). Accordingly, organization theory predicts that firms strive to be autonomous whenever they can, and engage in collaboration whenever they must to access resources and overcome environmental uncertainty (Cook, 1977; Galaskiewicz, 1985).

In the context of innovative activity, the two most crucial resources that organizations will try to attain ownership of and access to are technologies and markets (e.g., Barney, 1991; Cook, 1977; Dierickx & Cool, 1989; Grant, 1996; Gulati & Singh, 1998). Firms in control of these resources should be able to generate higher rents from innovation. Consequently, they are also encouraged to isolate and protect these resources from other organizations through a series of appropriation mechanisms to ensure and sustain their favorable competitive position (e.g., Teece, 1986; Winter, 1987). For example, with regards to knowledge as the resource in question, Cassiman and Veugelers (2002) suggest that organizations should strive to maximize incoming, while minimizing outgoing knowledge spillovers.

Recent empirical anomalies appear to challenge this view. For example, Yang et al. (2010) find that coincidental, involuntary spillovers of knowledge by a firm may actually

increase the possibility that it receives valuable knowledge in the future. Other studies go even further, indicating the value-accretive potential of strategies in which knowledge is *purposefully* and *strategically* disclosed to the environment. Following such “selective revealing” strategies (Harhoff, 1996; Harhoff et al., 2003; Henkel, 2006), firms consciously select some of their internally developed knowledge and make it accessible to outside actors, often for free and without contractual requirements. ‘Open source software’ (von Hippel & von Krogh, 2003), in which companies disclose the blue prints of their software products to the general public who are further allowed to modify and redistribute the software for free and without contact the original authors, represents a recent and particularly salient example. Notably, the use of selective revealing has already been documented in the 19th century. For example, Allen (1983) discusses the example of information-sharing amongst competitors in the English blast furnaces industry after 1850. While the application of selective revealing strategies today remains relatively rare (CED, 2006), the rising prominence of selective revealing in consumer goods, information technology, pharmaceuticals, defense, or the built environment (see also Table 2) poses a challenge for theories of innovation. In particular, explanations of why firms choose to enact this behavior, how it may be value-accretive, the boundary conditions under which they operate, and how selective revealing can be embedded in larger innovation strategies, are scarce. Whereas recent advances acknowledge the deterrence-potential of selective revealing (Clarkson & Toh, 2010; Polidoro & Toh, 2011), there is limited research on the collaborative aspects of selective revealing (Fosfuri & Rønde, 2004; Henkel, 2005).

At the heart of our argument lies a novel appreciation of selective revealing as a strategic mechanism to improve the firm’s technological and market conditions. In particular, firms that are parts of larger innovation ecosystems—defined as “the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution”

(Adner, 2006: 98)—are dependent on the behavior of other actors to achieve positive returns to innovation (see also e.g. Adner, 2012; Pisano & Teece, 2007). We maintain that by revealing some of its own knowledge—either in the form of problems or solutions (von Hippel, 1988)—a focal firm can initiate collaborative relationships with other actors to re-shape its competitive environment and improve its access to technologies and markets. In contrast to prevailing approaches to collaboration, these selective revealing strategies may also succeed under adverse conditions of high partner uncertainty, high coordination costs, and when known partners are unwilling to collaborate—conditions under which (contractual) collaboration has previously been shown to be difficult to initiate (e.g., Ahuja, 2000; Casciaro & Piskorski, 2005; Emerson, 1962; Gargiulo, 1993; Jacobs, 1974). In addition, even if revealed knowledge is merely taken in, but not reciprocated, by external actors producing knowledge in the firm’s innovation ecosystem (hereafter, externals), indirect benefits of selective revealing could already outweigh the costs for the focal firm. Specifically, if externals take in the revealed knowledge, because of the cumulative and path-dependent nature of knowledge (Nelson & Winter, 1982), future knowledge production by these externals and the spillovers they produce will be of higher value to the focal firm. In short, we argue that selective revealing holds the potential to re-shape both the active, deliberate as well as the passive, unknowing collaborative behavior of externals in the firm’s innovation ecosystem.

Next, to understand when firms would act on the opportunity to reveal selectively, we analyze drivers of the value of selective revealing to the focal firm. We show how factors internal and external to the firm influence its decision to selectively reveal, and highlight the particular importance of modularity of resources, existing capabilities, and substitutive threats.

Finally, we discuss how firms may embed selective revealing in innovation strategies. When considering the revealing of problems and solutions in conjunction with organizational

goals of extending an existing technological paradigm or creating new paradigms (Dosi, 1982; Garud & Rappa, 1994; Garud & Karnøe, 2001), we derive four archetypes of selective revealing: issue-spreading, agenda-shaping, product-enhancing, and niche-creating.

In doing so, our analysis allows us to make several contributions to the management literature. First, we add to ongoing discussions on inter-organizational relations (Dollinger, 1990; Gulati et al., 2000; Oliver, 1990), showing how the strategic disclosure of knowledge not only allows the focal firm to forge new ties to external actors and form coalitions, but potentially to create entirely new knowledge networks. Second, we link our insights to institutional theory (DiMaggio & Powell, 1983; Phillips et al., 2000) and resource-dependence theory (Casciaro & Piskorski, 2005; Pfeffer & Salancik, 1978) by highlighting how selective revealing implies a subtle form of competitor manipulation, and thus represents an exercise of power. To explain this mechanism, we introduce the notion of induced isomorphism—deliberate strategic action to induce other actors to become more similar to the focal firm, in particular with respect to the production of knowledge. Finally, we contribute to conversations on the organization of innovative activity by discussing extensions to the concepts of absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002) and open innovation (Chesbrough, 2003).

WHY? THE BENEFITS OF SELECTIVE REVEALING

Definition and Representation of Selective Revealing in Extant Literature

At its core, innovation is a path-dependent, cumulative activity that involves multiple actors (Grant, 1996; Kogut & Zander, 1992; Nelson & Winter, 1982). Each actor privately invests in R&D to expand their knowledge base so as to be able to create new or improved products, processes, and services. At the same time, knowledge may “spill over” to competitors, in the sense that competitors, to the disadvantage to the focal firm, gain access to private knowledge. In order to be receptive to spillovers, firms build their absorptive capacity—an

ability to recognize the value of externally produced spillovers, assimilate them, and apply them inside the firm. Thus, the concept of absorptive capacity helps explain why investment in R&D, even when its benefits cannot be fully appropriated by the focal firm, is sensible because it improves the firm's ability to learn from its environment and use this knowledge to increase innovative activity (e.g., Cohen & Levinthal, 1990). In line with recent empirical insights by Yang et al. (2010) as well as conceptual work by Agarwal and colleagues (2007, 2010), the above may be represented as a dynamic model in which outgoing spillovers, modified and enhanced by different actors along the way, may eventually return to the focal firm. This stylistic representation, shown in Figure 1, provides an intuitive basis to explain the logic behind why firms would selectively reveal knowledge.

INSERT FIGURE 1 ABOUT HERE

Following Henkel (2006), we define selective revealing as the voluntary, purposeful, and irrevocable disclosure of specifically selected resources, usually knowledge-based, that the firm could have otherwise kept proprietary so that it becomes available to a large share or even all of the general public, including the competition of the firm. Despite its contradiction with established literature emphasizing the protection of knowledge produced in-house, work in this stream has shown that selective revealing may positively affect a company's innovation and business performance (Stam, 2009; West, 2003), by allowing for outsourcing-like cost cutting (Lakhani & von Hippel, 2003), increasing the diffusion of products leading to beneficial externalities (Varian & Shapiro, 1999), and changing the competitive behavior of others. Focusing on this latter point, both Pacheco-de-Almeida and Zemsky (2011) and Clarkson and Toh (2010) separately show that disclosing internal technology resources may deter rivals from investing in similar ones. Polidoro and Theeke (2011) find that firms publish research results to influence their market positioning, in particular in the face of similar efforts by rivals and under

substitutive threats. Finally, Farrell and Gallini (1988) show that even technology monopolists may gain from selectively revealing their knowledge to rivals when consumers face high adoption cost and are afraid of lock-in.

Thus far, however, the literature has not fully acknowledged the use of selective revealing as a strategic tool and falls short of comprehensively explaining the purposeful design and use of strategies embodying selective revealing. For example, while Yang et al. (2010) find that involuntary knowledge disclosure by firms may be beneficial over time, they fall short of conceptualizing spillovers as purposeful, but assume that they occur by chance and suggest that their “results should not be interpreted as a prescription for encouraging spillovers” (p. 386). Relatedly, Polidoro and Toh (2011) find that firms choose not to fend off imitators when the threat of substitution is high, particularly in the early stages of development of a technology and when the underlying knowledge is new – raising the question of whether active revealing could allow a further leveraging of these benefits (also see Agarwal et al., 2007, 2010).

Building on these important insights, we propose that selective revealing can best be understood as a strategy aiming at shaping the collaborative behavior of others in the context of innovative activity. Specifically, the two most crucial resources needed for innovative success are knowledge embodied in technology, processes, and routines underlying the firms’ products and services and access to the respective product markets (Grant, 1996; Gulati & Singh, 1998; Kogut & Zander, 1992). In turn, a firm can be expected to initiate collaborative relationships with other parties if it either *lacks technological know-how* to complete its competitive offering, or to increase its potential profits from its products and services by *establishing or improving market access and position*. Accordingly, a focal firm will primarily reveal knowledge selectively in the hope that it will lead others to modify their behavior in a way that the focal firm improves its access to the technologies or markets required for innovative success. Notably,

such a response should not be considered improbable. Externals may decide to reciprocate for a variety of reasons, such as the pure enjoyment of problem-solving (Lakhani & Wolf, 2005), status incentives (Jeppesen & Lakhani, 2010), reciprocity (Bonaccorsi & Rossi, 2006), and, of course, downstream financial profit (Henkel, 2006)—irrespective of whether the reciprocated knowledge is irrelevant (Allen, 1983) or relevant (Henkel, 2005; Spencer, 2003) to competition.

At the same time, selective revealing dictates that the firm makes available some of its resources. Thus, the resources owned at a point in time determine what it can offer to entice others to collaborate. Following von Hippel's distinction (1988), we suggest that the resources the organization should be most inclined to share are problem-related (or need-related) and solution-related knowledge. In the case of problem-revealing, the company purposefully discloses to its environment current or anticipated future technological problems for which it seeks others' support. For example, firms such as HP and Intel regularly reveal knowledge about problems they are facing internally and future research trajectories they intend to explore in open calls for research (Alexy et al., 2009; MacCormack & Herman, 2004). Arguments presented under the labels of crowdsourcing and broadcast search advocating the inclusion of large numbers of externals in the solution of technical problems by disclosing these publicly or through intermediaries would also be encompassed by this definition (e.g., Afuah & Tucci, 2012; Jeppesen & Lakhani, 2010).

In contrast, solution-revealing occurs when the focal firm voluntarily and strategically discloses to its environment knowledge on how to solve a certain problem, as for example embodied in a patent, publication, product, or product component addressing a certain need or providing a certain function, to encourage imitation and diffusion. For example, an upstream firm may be willing to share some of the results of its R&D to increase downstream demand for related products (e.g., Harhoff, 1996). Similarly, firms might be willing to contribute upstream

knowledge and IP to joint knowledge production efforts in order to attract more parties to join in quasi-collusive collaboration efforts to ensure the firms' downstream competitiveness (Alexy & Reitzig, 2011). For example, in 2005, IBM made publicly available 500 valuable patents to the open source community. Followed by several other firms including Nokia and NEC, this decision was motivated not by altruism, but by a desire to sustain and support collective efforts to create and appropriate value from open source software.

Next, we will look at how selective revealing may be used to entice externals to display active collaborate behavior in situations in which other collaboration mechanisms known from the literature rarely apply. Subsequently, we examine how selective revealing may re-shape externals' generation of knowledge and spillovers so that both are of greater value to the focal firm, even if externals merely use the revealed knowledge, but do not collaborate. Our intent is to explain (1) how selective revealing may cause externals to collaborate intentionally and directly, as well as (2) unknowingly and indirectly with the focal firm.

Direct Benefits: Selective Revealing as Novel Pathway to Collaboration

A large body of literature exists arguing that firms will try to establish relationships with others when they lack critical resources or are faced with environmental uncertainty (e.g., Casciaro & Piskorski, 2005; Hillman et al., 2009; Pfeffer & Salancik, 1978). In the context of innovation, scholars have emphasized an increasing disposition to strategically engage in collaborative relationships to overcome such issues (e.g., Arora et al., 2001; Chesbrough, 2003; Phelps et al., 2012; Powell et al., 1996). In a nutshell, this literature argues that organizations do not prefer to collaborate, but sometimes, they simply have to—either because technologies and markets crucial to innovative success are (perceived to be) controlled by others, or because of specialization on certain elements of the value chain as is for example common in innovation ecosystems (Adner, 2006; Cook, 1977; Van de Ven & Walker, 1984). Accordingly, firms

attempt to strategically design relationships with other actors (Bresser & Harl, 1986; Gulati et al., 2000; Oliver, 1988, 1990) to secure access to these crucial resources and establish (relatively) predictable environments (Adner, 2012; Cook, 1977).

Forms of and issues with traditional forms of collaboration. A variety of formats for collaboration that organizations may choose has been proposed by different literatures with selective revealing hitherto missing as an option (for recent reviews, see, e.g., Casciaro & Piskorski, 2005; Hillman et al., 2009; Parmigiani & Rivera-Santos, 2011; Phelps et al., 2012). Prevalent arrangements – alliances, consortia, joint ventures, or acquisitions – usually all occur under the shadow of a contract (so as to minimize unwanted spillovers or moral hazard). At the same time, it is clear that firms cannot always successfully use these mechanisms (Ahuja, 2000). We identify three core reasons for when this may be the case from extant literature and then maintain that these may be overcome by applying strategies involving selective revealing.

First, firms will often need to go beyond currently accessible partners to get access to the technologies and markets they need for innovative success. However, in a context of *high partnering uncertainty*, firms may simply be unaware of who the right partner would be, or face prohibitively high search cost identifying them (Gulati, 1998; Gulati & Gargiulo, 1999; Jacobs, 1974). Notably, this problem may be bi-directional—externals that would be willing to collaborate may simply not be aware of the focal firm's issue.

Second, even if firms knew the right partners, traditional methods of cooperating suggested by the literature may simply be *too costly to establish or coordinate* (Dollinger, 1990; Gargiulo, 1993; Gulati & Singh, 1998; Henkel & Baldwin, 2011). While the logic of how this may apply to acquisitions or joint ventures is intuitive, a brief elaboration is required for alliances. Importantly, coordination costs associated with the formation and management of alliances can reasonably be assumed to increase non-linearly. Thus, if firms require multiple

partners to bring a technology to the market successfully – for example, if they would need to form a coalition to legitimize a certain technology (Dodgson et al., 2007; Garud & Rappa, 1994) – it is likely that the costs associated with the creation of a plethora of bilateral alliances would substantially decrease the value of this option. Also, the fuzzy boundaries of knowledge and the paradox of disclosure pose difficult challenges when assembling partnerships (Arrow, 1962).

While consortia may present a way to mitigate some of these concerns, they have been shown to be much less effective when potential collaborators are competitors in product markets (Branstetter & Sakakibara, 2002), leading to the third issue: even under the condition that the firm is aware of a limited and accessible set of collaboration partners, these may be *unwilling to collaborate*. Most notably, in a situation in which an external party controls access to the technology and/or market desired and the focal firm has little or no bargaining power, incentives to collaborate for the supposed partner are limited, suggesting that a collaborative tie should be unlikely to form (Casciaro & Piskorski, 2005). Regarding collaboration by competitors of similar resource endowment in consortia, Branstetter and Sakakibara (2002) summarize a debate in the industrial organization literature stating that efficiency gains from such endeavors may well be eaten up in subsequent market competition.

These issues should be particularly salient in innovation-related contexts, where technological uncertainty and incomplete appropriability increase the salience of high partner uncertainty, high coordination costs, and potential partners' unwillingness to collaborate. Finally, these three problems might also be interlinked. For example, a focal firm might already be in a collaborative relationship with another firm, and hope to extend this relationship to gain access to a resource or market to foster another innovation. However, for competitive reasons, the partner firm might be unwilling to comply (the third issue), forcing the focal firm into a novel search for alternative partners (the first issue) and subsequent contracting (the second issue).

We suggest that selective revealing may be an appropriate strategic move that allows firms to partially overcome these impediments to attain access to technologies and markets.

Overcoming partnering uncertainty. To address the problem of unawareness of partners, the voluntary disclosure of knowledge is a clear signal of the intent to collaborate with externals; a non-trivial precursor of actual collaboration (Kogut & Zander, 1996). By selectively revealing, the firm is reducing the pre-existing information asymmetry about (1) whether or not it is looking for a collaboration partner and (2) which attributes these partners should hold, thereby encouraging fitting external actors to respond to the signal (see Spence, 1973). In doing so, selective revealing provides a solution to the basic nested problem of establishing common ground (“I know that you know that I know that you know...”) that needs to be solved for collaboration to emerge (Puranam et al., 2009). Thus, selective revealing will often represent an open invitation to externals to collaborate (even if the firm knows exactly who the potential collaborators might be). This is clear for both problem-revealing (e.g., through crowdsourcing) as well as solution-revealing (as shown e.g. in the earlier IBM-patents example).

In addition, selective revealing may drastically reduce the search cost for external actors by allowing firms to cast a wider net in their quest for collaboration partners. This does not only hold for the potential number of externals that may be reached, but also with respect to their scope. Specifically, the open invitation given through selective revealing may be received by externals active outside the space in which the organization traditionally searches for collaboration partners which may be particularly effective in supporting the focal firms’ innovative efforts (Afuah & Tucci, 2012; Jeppesen & Lakhani, 2010). For example, Afuah and Tucci (2012) describe how problem-revealing in the form of crowdsourcing may allow firms to drastically expand the limits of local search. With respect to solution-revealing, Jeppesen and Molin (2003) articulate how software firms instigated the development of extensions to their

products by voluntarily and strategically disclosing parts of their products. We thus posit

Proposition 1a: The higher the level of partnering uncertainty perceived by an organization needing to collaborate, the more likely it will consider selective revealing over other mechanisms to induce collaborative behavior.

Overcoming coordination costs. Selective revealing can significantly reduce or even eliminate contracting costs as potential partners self-select to accept the open offer to collaborate, and mandates neither formalized nor contractual collaboration to achieve the focal firm's goals (Spencer, 2003). Notably, selective revealing in itself only encompasses fixed setup costs that can be discounted over a potentially limitless number of collaborations. Unsuccessful contracting is largely eliminated since costly bilateral negotiations are replaced by the matching process of offer and self-selection. In fact, a substantial reduction of coordination costs is a necessary condition to benefit from the expansion of the scope of partner search described above. This does not mean that no contracting exists; however, it is usually delayed till after it is clear that the collaboration can be successful. For example, companies in many sectors engage in problem-revealing by publicly disclosing them on their website (Alexy et al., 2012). In such scenarios, companies may often not need to negotiate at all with externals since these may submit their ideas for free due to motivations other than financial reimbursement (e.g., Lakhani & Wolf, 2005; Lerner & Tirole, 2002). However, if negotiations have to take place, the revealing firm may, compared to other modes of collaboration, know better whether external suggestions may actually solve its problem (Lakhani et al., 2007) and possibly also have higher bargaining power due to the increased scope of search and resulting availability of alternate solutions.

At the same time, selective revealing positively impacts the “three Cs of collaborative activity”—complementarity, compatibility, and commitment (Kale & Singh, 2009). Externals who self-select to respond to the organizational selective revealing endeavor will also signal information about themselves. First, externals should only self-select into collaboration if they

hold complementarity knowledge and use compatible processes. Because selective revealing creates transparency about the revealing firm's goals regarding the collaboration (i.e., the expected contribution of joining parties), externals will only decide to partake in the exchange if it is perceived as beneficial (Emerson, 1962; Jacobs, 1974). Notably, however, even free-riding may generate indirect benefits to the revealing firm. Furthermore, the second party self-selecting into the relationship should develop even higher degrees of complementarity and compatibility to the focal firm by internalizing the selectively revealed knowledge.¹

Second, the specific action that represents the externals' self-selection decision may be interpreted as a signal of commitment. In many cases, the focal firm will be able to observe the response of the external. From that, the focal firm may evaluate the external's level of commitment by looking at factors such as the level of resource commitment or its reversibility. Third, the same method may allow the focal firm to judge the capabilities of externals. Consider again the earlier HP-Intel example. Following the open call, university researchers will self-select into responding, generating two key benefits. First, the firm receives, for free, a large number of proposals depicting the current level of progress of research in the problem area and the possible range of approaches to solving the problem. Second, it can handpick, and fund or hire those individuals whose suggestions they deem most economically or strategically viable to begin the joint exploration of identifying problem solutions—that is, those with the highest levels of complementarity, compatibility, and commitment.

Finally, the irrevocability of selective revealing instigates trust, as problems of moral hazard are minimized (Farrell & Gallini, 1988; Gulati & Sytch, 2007; Kale & Singh, 2009). In doing so, trust may eventually become an enabler for more intense, and higher-value information

¹ We elaborate on these important points (“indirect benefits” and “higher complementarity and compatibility”) in the section titled “Indirect Benefits: Selective Revealing as Pathway to Re-Shape External Knowledge.”

exchange between the parties (e.g., Gulati, 1998). Notably, this would also suggest that selective revealing could instigate subsequent more in-depth relationships between firms (such as joint ventures or alliances). Consider again the above solution-revealing example of IBM disclosing 500 patents. Not only did this lead to several other firms following suit, it also paved the way for IBM to come together with other firms to jointly invest into the creation of a dedicated venture tasked to protect these firms' selective revealing efforts against non-practicing entities such as patent trolls. Summarizing, we posit:

Proposition 1b: The higher the level of coordination costs perceived by the organization needing to collaborate, the more likely the organization will consider selective revealing over other mechanisms to induce collaborative behavior.

Overcoming unwillingness to collaborate. Selective revealing offers two options to address the issue of powerful actors unwilling to collaborate. Generally, the most compelling mechanisms to reduce dependence on a powerful actor are the identification of alternate sources of supply and the formation of a coalition (Cook, 1977; Jacobs, 1974). Formally, how to achieve the first goal follows the argument of how selective revealing widens the search for partners. Regarding the second goal, selective revealing might not only represent an invitation to *collaborate with* the focal firm but also one to *collude against* another firm or even a network of firms. Following Polidoro and Toh (2011), firms decrease their efforts at deterring imitation when faced with a threat of substitution. However, the substitutive threat not only applies to the focal firm in question, but to all firms following the same technological trajectory (Dosi, 1982), that is, to all potential imitators. As these firms face similar incentive structures with regards to which technology trajectory they want to see emerge victorious, but have different idiosyncratic resource endowments for their commercialization, selective revealing by one actor may thus initiate reciprocal actions by others facing the same competitive issues. It is clear how this logic applies to the IBM-patents example, which has as its “targets” competitors such as Microsoft as

well as non-practicing entities. Yet, this strategy is clearly not limited to software. For example, as part of its “Merck Gene Index”, Merck discloses all human gene sequences into a public database. The goal of this initiative is clear (Pisano & Teece, 2007), namely to entice similar others to join Merck in preventing an upstream input to pharmaceutical products being monopolized by actors specializing in this space. We thus propose:

Proposition 1c: The higher the level of unwillingness to collaborate perceived by an organization needing to collaborate, the more likely the organization will consider selective revealing over other mechanisms to induce collaborative behavior.

Indirect Benefits: Selective Revealing as Pathway to Re-Shape External Knowledge

At the same time that selective revealing may influence the intentional collaborative behavior of externals, we further argue that it may also have a subtle, yet important impact on how these externals generate knowledge that may lead to them *unintentionally exhibiting collaborative behavior*. Importantly, we maintain further that this effect should be present irrespective of whether or not externals reciprocate with collaborative behavior, just as long as they merely *use* the knowledge that the focal firm has released. Put differently, the cost of revealing might already be outweighed by indirect benefits of selective revealing, which *always* accrue if the selectively revealed knowledge is taken in. These benefits originate from changes to how users of the selectively revealed knowledge generate knowledge themselves and the voluntary and involuntary spillovers (Winter, 1987) they produce.² In the following section, we will focus our arguments on situations in which the selectively revealed knowledge is only used by externals who then free-ride and do not give back knowledge actively in return. If they did, then all effects described in the following should be present to an even stronger degree.

² Notably, further benefits may exist for the revealing firm. For example, von Hippel and von Krogh (2003) maintain that revealing in itself brings benefits such as learning, which may outweigh its total cost. Furthermore, we point to the literature discussed above on the deterrence effect of revealing.

Why should selective revealing have an impact on the knowledge and in particular the spillovers that organizations taking in the revealed knowledge produce? To be able to answer this question, we first need to look at what constitutes the value of an externally-held knowledge, namely whether or not it objectively addresses a need of the firm (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998), that is, its *content compatibility*, and whether or not it exhibits *structural compatibility* to the firm's existing body of knowledge, that is, an overlap in its categorization of knowledge (for example, according to certain scientific disciplines) and the language used to describe it (e.g., Dyer & Singh, 1998; Grant, 1996; Lane & Lubatkin, 1998). In turn, content compatibility represents the objective maximum value of externals' knowledge (and of the spillovers they produce voluntarily or involuntarily), and structural compatibility predicts the costs of absorption. Thus, selective revealing by the focal firm will produce indirect benefits if it can influence others in such a way that their production of knowledge and spillovers generated in this process are of improved structural or content compatibility.

Effects on content compatibility. When firms engage in problem-revealing, as argued above, this is likely to facilitate the development of solutions by others. Even when externals should be unwilling to freely share their solutions with the focal firm as voluntary spillovers, their involuntary spillovers will exhibit increased content compatibility, because externals will still be basing their production of knowledge on the needs of the focal firm. Thus, the mere use of the released problem-related knowledge by a sufficiently large number of externals, even if these do not actively reciprocate, may create externalities leading to the focal firm seeing its original problem sufficiently lessened or even solved entirely.

This logic similarly applies to solution-revealing. Here, the non-reciprocated use of the released solution is identical to the choice of an imitation strategy by externals, or free-riding. However, even free riding may often be strictly beneficial to the focal firm. For example,

Pacheco-de-Almeida and Zemsky (2011) show how competitors switching from innovation to imitation strategies may convey time-related advantages to the focal firm. And in case externals choose to employ the revealed knowledge as an ingredient to their own innovative activity, this means they become more closely aligned with the technological path of the focal firm. Thus, future spillovers by externals taking in the revealed knowledge will have higher content compatibility to the focal firm. More importantly, however, these externals will also partake (to some degree) in the focal firm's technological path, so that they become potential supporter to a focal firm's attempt to create or displace technological standards or dominant designs, and legitimize new technologies or markets. This is consistent with scholars who argue that in the face of a substitutive threat, firms should change their evaluation of strategies encouraging imitation (Polidoro & Theeke, 2011; Polidoro & Toh, 2011). Thus, we propose:

Proposition 2a: The more the focal firm seeks to influence the content compatibility of externals' knowledge, the more likely it will consider engaging in selective revealing.

Effects on structural compatibility. The use of selectively revealed knowledge should further affect the structural compatibility of future knowledge production by these externals. In short, when taking in the revealed knowledge, the external has to bear the cost of translation. Externals that want to work on a disclosed problem will need to assimilate this problem to match their own language and structure for knowledge. Should they intend to solve it, they will further have to produce an output that is structurally compatible to the problem originally revealed (Jeppesen & Lakhani, 2010) for which they would need to adjust their knowledge production processes (Grant, 1996; van den Bosch et al., 1999). In turn, this may permanently increase the structural compatibility of their knowledge production to the focal firm (Cohen & Levinthal, 1990; Grant, 1996; Gulati & Gargiulo, 1999; van den Bosch et al., 1999).

The argument for solution-revealing is analogous: the revealed knowledge taken in becomes an input to the external's own R&D and is assimilated and adapted. However, in this

absorption process, it is likely that the knowledge will retain some of its original language and structure. Through its own absorption process, the external firm will familiarize itself with the original structure and language of the voluntary spillover and keep some of it as its own (e.g., Dyer & Singh, 1998; Lane & Lubatkin, 1998), in particular when re-using the external knowledge with little to no modification (Fleming, 2001; Kogut & Zander, 1992) or when external knowledge is generally preferred to internal knowledge (Menon & Pfeffer, 2003). Eventually, as shown by Yang et al. (2010), this increased structural compatibility will lead to a rise in the focal firm's ability to profit from incoming spillovers. We thus posit:

Proposition 2b: The more the focal firm seeks to influence the structural compatibility of externals' knowledge, the more likely it will consider engaging in selective revealing.

Inter-temporal effects. Over time, the greater a number of externals who have committed to a certain trajectory – including its content, structure, and language – in a given knowledge domain, the more beneficial it is for other actors to also convert to this trajectory and facilitate efficient cooperation (Grant, 1996; Kogut & Zander, 1992) necessitated by increased interconnectedness and mutual dependence (Gulati & Sytch, 2007). *Ceteris paribus*, this may cause the establishment of norms about the focus, structure, and language of knowledge production (Kogut & Zander, 1996)—as for example articulated in a dominant design (Spencer, 2003)—*potentially even if no firm is actively colluding with the selectively revealing actor.*

In short, we argue that as soon as externals choose to use the knowledge revealed by the focal firm (and all the more so should they decide to reciprocate by actively showing collaborative behavior), the focal firm may achieve benefits from externals developing higher levels of structural and content compatibility. Through selective revealing the focal firm may try to induce externals to align their technological trajectories and knowledge production processes so that they become more similar to that of the focal firm in the sense of higher structural and content compatibility. While some externals may of course see right through such strategic

efforts (Dollinger, 1990; Oliver, 1988, 1990)—yet may still decide to use the selectively revealed knowledge and possibly even reciprocate—at the same time it will cause others to *unknowingly* become more isomorphic to the firm in their knowledge generation.

In turn, this induced isomorphic behavior and the resulting higher structural and content compatibility should render future collaboration with the focal firm an increasingly attractive option to these externals. For example, as a response to problem-revealing, firms that have a related technology may decide to adapt it to match the signal, thus interpreting it as information about a potential market. Similarly, complementors having to choose between competing platforms should strongly prefer an open one as it decreases uncertainty with regards to the outcome of contracting and future access. Finally, firms struggling with high technological uncertainty should be more likely to model their explorative efforts on the problems of others (see DiMaggio & Powell, 1983) and thus also use free intermediate solutions to then extend these as needed. Notably, in all of these cases, uncertainty reduction will be higher if the external permanently aligns itself to the revealing firm, which is likely to continue to supply further uncertainty-reducing knowledge. Permanent alignment may be the outcome of subsequent interactions, even in the absence of trust, which is only developed subsequently (Van de Ven & Walker, 1984). Further, each transaction increases mutual dependence on each other and thus increases the likelihood and value of future collaboration (Gulati & Sytch, 2007). We propose:

Proposition 2c: The more the focal firm seeks to induce isomorphism, the more likely it will consider engaging in selective revealing.

WHEN? BOUNDARY CONDITIONS OF SELECTIVE REVEALING

Of course, we are not trying to argue that selective revealing is universally beneficial to all firms in any given competitive situation. Rather, managers will need to make boundedly-rational evaluations of whether anticipated benefits of selective revealing outweigh its potential costs (Henkel, 2004). In fact, even if the above-mentioned benefits render selective revealing a strategic alternative worth *considering*, this needs to be separated from the decision of whether the organization *should actually reveal*. Such a decision needs to factor in the costs that the focal firm needs to bear to initiate selective revealing and the risks of unwanted outcomes. Here, three forms of risk seem to be particularly crucial. First, by revealing, the organization may accidentally disclose resources beyond what it wanted to or should have released (Harhoff et al., 2003), potentially culminating in loss of control over current and future product development (Chesbrough & Teece, 1996). Second, it might struggle to manage the increased complexity of its innovative activities that now transcend the boundary of the firm in a way that runs counter to the traditional emphasis on the value and protection of intellectual property generated in-house (Alexy et al., 2009). And finally, the organization may fail to attract externals to even use the revealed knowledge. These risks may, of course, be mitigated. Specifically, organizations can decide which resources to reveal, after taking into account their competitive position, capabilities, and internal processes to ensure that it may reap possible benefits of selective revealing. Moreover, factors external to the organization need to be taken into account.

Internal Drivers of the Selective Revealing Decision

Whether or not to reveal a specific resource is a question of trade-offs. While the organization must not reveal valueless resources (since these would most likely neither be used nor reciprocated by externals), it will try to abstain from disclosing resources that are of high competitive relevance (e.g., Polidoro & Toh, 2011). For example, firms will hesitate to disclose

tacit or complex knowledge as it can be kept secret easily, thus promising high returns from excludability and inimitability (Rivkin, 2000; Teece, 1986; Winter, 1987). However, should the firm decide to release such high-value resources nonetheless, this may substantially increase the likelihood of them being picked up by other parties, which may ultimately overcompensate for the initial cost of giving up exclusivity. Accordingly, such trade-offs will need to be evaluated for each selective revealing decision, limiting the scope for generalization.

Looking at the organization's resource base more broadly, modularity should increase the likelihood of the organization deciding to engage in selective revealing (Henkel & Baldwin, 2011). If the firm's resource base is modular, that means it can release some parts of it without having to disclose others it wants to keep proprietary. Still the released knowledge will have content and structural compatibility with what the firm keeps in house, so that both direct and indirect benefits of selective revealing are attainable. For example, an organization that has its knowledge based modularized along the layers of industry architecture (Jacobides, 2006) may be able to reveal knowledge only on one layer of the industry architecture and at the same time retain relatively secure revenue streams originating from activities on other layers (West, 2003). Furthermore, such modularity may increase the likelihood that externals exist that are interested in the knowledge the firm reveals, yet are not direct competitors on the product market. In turn, this should increase the likelihood that these externals use and reciprocate the revealed knowledge to engage in collaborative research (Branstetter & Sakakibara, 2002) or even collusion (Alexy & Reitzig, 2011; Dollinger, 1990). Accordingly, we propose:

Proposition 3a: The degree of modularity of the organization's resource base will increase its propensity to engage in selective revealing.

Furthermore, we expect an organization to engage in selective revealing if it perceives that it is fit to benefit from it. Here, the assessment of fit includes an evaluation of all steps of the selective revealing process: first, are we good at disclosing knowledge—can we present it in a

format so that others can successfully use and possibly build on it? Specifically, the organization will need to de-contextualize its problems and solutions enough so that they are accessible to externals, yet not too much so as to ensure that subsequent related knowledge generated by externals will be valuable to the firm. Emergent research (Baer et al., 2012; von Krogh et al., 2012) shows this is indeed a non-trivial process. Second, the firm will need to be ready to reap external knowledge. As a minimum, sufficient absorptive capacity is a prerequisite to be able to gain from the contributions of others to the selective revealing effort, but specific internal organizational practices may be required (Foss et al., 2011). On a larger scale, the organization may have to adjust its processes for value creation and capture—tied together to form its business model—should it look to profit from its selective revealing endeavor (e.g., Chesbrough, 2006; Chesbrough & Appleyard, 2007). In addition, in particular if the organization seeks to induce long-term relationships with externals, it will need to ensure that its internal routines and culture are up for this task (e.g., Alexy et al., 2009). Organizations that have not internalized these respective capabilities will more likely shy away from selective revealing, as they would otherwise need to bear the considerable burden of establishing them. Accordingly, we posit:

Proposition 3b: Existing firm capabilities in extracting value from external knowledge will increase its propensity to engage in selective revealing.

External Drivers of the Selective Revealing Decision

Two kinds of external considerations will matter in particular to firms considering selective revealing, (1) the firms' competitive environment and (2) the perceived likelihood of externals using or reciprocating the revealed knowledge. Below, we take each in turn.

First, competitive dynamics have the potential to affect the urgency to selectively reveal and thus increase firm's tolerance to disclose valuable knowledge. In particular, selective revealing may be a reaction to a severe threat to a firm's competitive position. Here, as alluded to before, the perceived threat of substitution (Polidoro & Toh, 2011) should strictly positively

affect the firm's willingness to engage in selective revealing. Especially if knowledge is path-dependent and learning is cumulative (Scotchmer, 1996), organizations should be willing to defend their paths against others, while hoping to be able to fend off imitators through lead time (Clarkson & Toh, 2010). Thus, in particular when multiple technological trajectories proposed by different organizations are competing against each other, selective revealing might become a compelling option since some externals may be enticed to support the focal firm (Alexy et al., 2009), possibly tipping a standard race in the favor of the focal firm (Varian & Shapiro, 1999).

At the extreme end of such efforts lies what is described in literature on open source software. Here, companies engaged in solution-revealing in order to prevent being squeezed out of a market entirely by a (to-be) monopolist. Specifically, firms such as Netscape—which found itself overwhelmed by Microsoft in the “browser wars” of the 1990s—felt that they would be better off competing on open products and standards rather than await certain competitive annihilation, and thus revealed essential parts of their product portfolio to the public. While of course a gamble, these companies expected higher odds of survival from taking a chance on whether selective revealing dynamics unfolded rather than by following traditional forms of product-market competition on proprietary IP (Henkel, 2004). We thus posit:

Proposition 4: The perceived strength of a substitutive threat to the organization's resource base will increase its propensity to engage in selective revealing.

Beyond substitute threats, a brief look at the existing literature on collaboration shows an extensive list of elements of competition which should also affect selective revealing in that they increase or decrease the costs, urgency, or likelihood of success of selective revealing. These include existing collaborative networks and their structure which can be reactivated for the selective revealing effort (Gulati & Gargiulo, 1999) and predict the firm's reach (Schilling & Phelps, 2007) and its influence on other actors (Galaskiewicz et al., 2006; Powell et al., 1996). Further, regarding the ecosystem surrounding the firm, the number of players and their level of

diversity determine limit what knowledge the firm may possibly attain (e.g., Gulati & Sytch, 2007; Mowery et al., 1996; Van de Ven & Walker, 1984). Modularity of these ecosystems at large (Baldwin & Clark, 2000), as expressed by layered architectures (Pisano & Teece, 2007) or fragmented markets (Dollinger, 1990; Jacobs, 1974) may also increase the chance of selectively revealed knowledge being used and reciprocated. Finally, the existence of institutions and social norms supporting collaboration will also positively affect the performance of selective revealing strategies, such as include intellectual property regimes (Teece, 1986), a culture facilitative of trust-building (Kale & Singh, 2009), and the general existence of an appropriate legal framework governing and supporting knowledge production and sharing (Fosfuri & Rønde, 2004). Whereas each of these competitive factors could potentially affect selective revealing, we have restricted our propositions to those where there is a preponderance of evidence to build theory. Our intention is not to diminish the importance of other plausible drivers, but to be parsimonious in our selection from a multitude of potential influences.

HOW? ARCHETYPES OF SELECTIVE REVEALING STRATEGIES

Finally, we address the question of how selective revealing may be embedded in innovation strategies. To do so, we build on our distinction of problem and solution-revealing which respectively focus on improving access to technologies and markets. In addition, we consider the innovation goals of the organization in light of the existence of technological paradigms (Abernathy & Utterback, 1978; Dosi, 1982; Garud & Rappa, 1994; Garud & Karnøe, 2001), which strongly resonates with our discussion of the benefits and drivers of revealing, and also matters tremendously in the context of innovation ecosystems (e.g., Adner, 2012).

Following both Garud & Rappa (1994) and Powell et al. (1996), a technological paradigm is best understood as a socially constructed frame of reference that informs organizations of what a technology can and cannot do, how it should be physically embodied,

and how it can be evaluated by all players in the field. Early on, a technological trajectory is solely sustained by the beliefs of the people exploring it and huge uncertainties exist on all dimensions. In addition, multiple trajectories will be competing at the same time to address the same market need until the emergence of a socially accepted evaluation system that selects a dominant design. Conversely, once a technological path is established, relative certainty exists over technology and markets (Abernathy & Utterback, 1978; Dosi, 1982; Garud & Rappa, 1994). Yet, because of the cumulative nature of knowledge, organizations will find themselves locked into a certain path (Garud & Rappa, 1994; Nelson & Winter, 1982). Accordingly, when the innovative activity of organizations aims at *extending existing paths*, we would expect that the need for collaborative behavior will mainly originate from problems of technological specialization or the wish to expand into different market segments. Conversely, organizations intending to *create new paths* will need to shape their technological and market environment to eliminate from an uncertain future as many unfavorable possible future trajectories as possible.

Combining the two dimensions results in the matrix depicted in Table 1. In the following section, we explain the resulting four archetypes of selective revealing and how they allow firms to access technologies and markets; examples of practices embedded these strategies from several industries are shown in Table 2. Our examples highlight the plurality of revealing strategies. These strategies are often conducted through a variety of organizational structures, including, for example, research consortia, open source software and crowdsourcing. Rather than seeking to explain the specific organizational structure that enables selective revealing, we focus on the rationale behind the decision of the firm to reveal knowledge. Thus, while we present a variety of examples of selective revealing, at its core, our argument is indifferent to the specific mechanism or strategy chosen to selectively disclose knowledge.

INSERT TABLES 1 AND 2 ABOUT HERE

Issue-spreading

Issue-spreading, the selective revealing of technology-related knowledge to extend existing paths, may have two effects on the firm's environment. Both of these build on the fact that issue-spreading directly embodies a need of the focal firm that others may be able to satisfy in a way that is mutually beneficial. First, external actors may be encouraged to submit to the focal firm their existing knowledge to address the specific problem. Alternatively, the revealed knowledge may act as a trigger for new development activity since the focal firm is signaling downstream demand. The crowdsourcing examples given earlier in this paper clearly illustrate this point. Here, the focal firm directly signals current problems it is unable to solve on its own to its environment in the hope of finding externals with related, yet sufficiently distinct knowledge, able to tackle the issue at hand.

Second, issue-spreading can be interpreted as an invitation to collude on extending existing technology paths. Under the condition that R&D is either too costly for one firm to bear or when R&D is not a differentiation factor, the focal firm can reasonably hope for other actors facing similar technological problems to accept this invitation, thereby enabling or supporting collective strategies (Bresser & Harl, 1986; Dollinger, 1990). An example of issue-spreading can be seen in the GreenTouch initiative, a new consortium of leading IT companies that have come together try to increase the environmental performance of networks. Although often competitors, GreenTouch members have sought to outline the architecture, specifications, and roadmap required to improve network energy efficiency by a factor of 1,000 over 2010 standards by 2015. Issue-spreading allows these firms to indicate their commitment to this technological path, make interdependencies publicly visible, attract new participants and complementors, and ease the coordination of R&D investment decisions.

Agenda-shaping

Theories of power make clear that the ability to shape discourses serves as a source of power (e.g., Lukes, 2005), also in collaborative relationships (e.g., Phillips et al., 2000). By influencing what is being talked about and how, actors may steer the social construction of technology paths in a direction more suitable to their needs. Extending this argument to our context, we suggest that problem-revealing may allow the focal firm to *shape the development agenda* for new paths it intends to create, so as to entice externals to coordinate or align around the production of solutions fitting to the focal firm's intended trajectory and its gaps. Thus, a firm will communicate those issues they consider relevant for the creation of its most preferred pathway, and try to set in motion a legitimate discourse around it and connect other actors to this discourse to facilitate collaborative behavior (Hardy et al., 2005; Phillips et al., 2000).

Such communication to the environment may for example occur through open research calls. Even more basic, simply making the focus of R&D activity known to the public through the company website may spur the development of related activity and their submission to the firm from its environment. Most famously, agenda-shaping is incorporated in the so-called DARPA model, which has been executed successfully by the U.S. Department of Defense for decades, and which has also been transferred to several Silicon Valley companies, as clearly shown by the examples of Intel and HP given earlier.

Product-enhancing

Through solution-revealing, the focal firm releases knowledge embodied for example in products, components, or patents, to make it available to external actors. Externals using the revealed knowledge may begin to provide improvements and extensions to the revealed knowledge itself, and by extension also to related knowledge the firm has kept in-house. In turn, this active encouragement of imitation should precipitate both greater convergence toward the focal firm's technological trajectory as well as the generation of complements and second-

generation innovation built on and around the revealed knowledge (e.g., Harhoff et al., 2003; Henkel, 2005). Second, as the fear of lock-in by a monopolistic supplier decreases through the release of the spillover in voluntary form (Farrell & Gallini, 1988), higher levels of use of the revealed knowledge, also among consumers, is more likely. For example, Google's decision to make its mobile operating system Android open source has created confidence among consumers and mobile operators that this platform will be built upon by other firms, helping to increase its chances of adoption. Taken together, these two mechanisms suggest a high likelihood of network externalities, which may ultimately result in other firms permanently joining the focal firm's knowledge trajectory (Spencer, 2003). Eventually, the effects of solution-revealing may culminate in inducing norms of reciprocity and create networks of knowledge production with the focal firm at the center (Varian & Shapiro, 1999).

By engaging in *product-enhancing*, the extension of current paths through solution-revealing, the firm has the opportunity to improve its competitive position in current markets or advance into new ones, even if strong competitors exist. Product-enhancing might be particularly appealing to firms in control of non-dominant technology platforms. For example, IBM opened up the core of its Eclipse software development tool to the public, including the source code of the software (West, 2003). Doing so increased its diffusion among end users and led to many commercial firms abandoning efforts at developing similar tools, instead focusing on adapting Eclipse to their respective needs. As many of these actors made their adaptations open to the public again at no cost, the functional scope of Eclipse and its compatibility with other platforms was extended substantially beyond IBM's initial contribution. This led to a further boost in diffusion, rendering Eclipse the de-facto standard software development tool on all platforms, including those controlled by IBM's fiercest rivals Microsoft and Sun in which IBM previously had hardly been able to establish a foothold. In turn, IBM was able to create a bustling ecosystem

around its platform producing upgrades and extensions to its program, and a substantially increased installed base to which it could sell complementary offerings.

Niche-creating

Niche-creating is the use of solution-revealing to shape and establish novel knowledge paths. Following the mechanisms laid out in the preceding section, collaboration with relevant others through solution-revealing and the assembly of a critical mass may allow for the creation of new institutional rules and resources (Phillips et al., 2000). Put differently, the strategic release of solution-related knowledge may entice existing actors as well as new entrants to converge towards the focal firm's technological trajectory and participate in the social construction process necessary to eventually legitimize this newly created path on the market.

Specifically, niche-creating assists the firm in trying to convince other industry stakeholders that its preferred technology trajectory is both viable and legitimate, and should be preferred over alternative solutions if these exist (Garud & Rappa, 1994). By encouraging others to use the revealed knowledge, the firm may be able to influence its environment to converge (or at least shift) towards the focal firm's preferred trajectory (Garud et al., 2002). As these externals' future paths become more aligned to that of the focal firm, niche-creating will increasingly allow the firm to impact how other industry stakeholders think about the evolution of the technology, guiding them towards the firm's preferred path. In doing so, niche-creating ultimately may enable the firm to shape relevant discourses and create entirely new markets that are closely aligned to their focal interest (Garud et al., 2002; Phillips et al., 2000).

As a poignant example of niche-creating, Dodgson, Gann, and Salter (2007) describe the case of the engineering consultancy Arup, which had developed a novel technological solution to use elevators in case of fire emergencies. However, since established norms were strictly contradictory to this technological advancement, Arup needed to convince industry stakeholders

of the viability of this technology. Arup revealed its solution knowledge to its competitors and other externals to increase the number of actors interested in establishing this market, including the regulators of new building designs. Ultimately, this strategy allowed them to create and legitimate ‘fire engineering,’ a new niche in the built environment in which they became recognized as the primary authority, since everyone was in concordance with Arup’s technology trajectory. Finally, since Arup was strategic about which pieces of knowledge they revealed, they continued to command a technological lead over other industry players.

DISCUSSION AND IMPLICATIONS

We proposed a model of selective revealing as a deliberate, strategic action to improve conditions for innovation (Figure 2). We suggest that selective revealing is a novel mechanism to shape the collaborative behavior of externals. First, selective revealing may initiate active collaboration even under conditions of high partner uncertainty, high search costs, and when known partners are unwilling to collaborate. Second, it may cause passive and possibly unknowing collaboration by externals even when these are merely free riding on the selectively revealed knowledge by making future involuntary knowledge spillover more valuable to the focal firm and induce the external to become isomorphic. We further outline internal and external factors that should positively impact the firm’s propensity to engage in selective revealing, and point out the role of modularity, existing capabilities, and substitutive threats in this context. Finally, we specify four forms of selective revealing depending on whether the firm aims to improve its access to technologies (through problem-revealing) or markets (through solution-revealing) and whether it aims to extend existing paths or create new ones: issue-spreading, agenda-shaping, product-enhancing, and niche-creating.

 INSERT FIGURE 2 ABOUT HERE

Selective Revealing and Collaboration

Our work provides three insights for management theory. First, we highlight the nature of selective revealing as a previously undocumented, theoretically-relevant mechanism to initiate collaborative behavior. We extend the possibility for strategic action in reshaping environmental dependencies to situations in which the strategy and organization theory literature would consider the actor largely unable to establish access to critical resources through collaboration: high partner uncertainty, high coordination costs, and unusable known collaboration options (e.g., Bresser & Harl, 1986; Cook, 1977; Dollinger, 1990; Jacobs, 1974). We show how even under these circumstances, actors can positively influence environmental contingencies through selective revealing to create alternative source of supply, rally allies, and mitigate uncertainty.

Our argument points to a dynamic element of network creation spurred by selective revealing. Current related theory is scarce on explaining the emergence of collaborative mechanisms such as strategic alliances beyond the argument of multiplex relations, that is, currently existing relationships on another dimension that will be leveraged to form the desired alliance (e.g., Ahuja et al., 2009; Gulati & Gargiulo, 1999; Hallen, 2008). While existing relationships will still matter in our model, they are clearly not necessary for collaboration to emerge from selective revealing. Thus, we would argue that selective revealing represents a novel mechanism explaining the emergence of knowledge networks and collective strategies, in which, in contrast to much extant literature (e.g., Kilduff & Brass, 2010), there is a clear role played by managerial agency. This argument further expands on Hillman et al.'s (2009) question of whether organizations progress through a sequence of strategies aimed at lowering their dependence on their environment – we would predict that, in innovative activity selective revealing may often precede more resource-intensive forms of collaborative engagement.

An important issue that remains to be addressed is what forms of networks will emerge from selective revealing, how these will impact the benefits and management of selective

revealing, and how these networks may be governed. One could imagine a star network with the focal firm in control of a (now semi-open) platform at the center. Such a strategic choice is clearly of high value to the revealing firm, but may be less attractive to potential contributors. Similarly, in a more fully connected network, the party originally revealing knowledge may be relegated to becoming a simple node. The fact that IBM has chosen this option for Eclipse (now governed by an independent foundation) suggests that selective revealing aimed at establishing a truly collective strategy against dominant competitors may require a decrease in the centrality of the revealing firm.³ We strongly encourage empirical research to better understand these points.

Selective Revealing and Power

Our model further allows us to reinvigorate the link between knowledge exchange and isomorphism to provide a stronger integration of theories explaining collaborative behavior with institutional and resource dependence. Regarding the former, the direct goal of problem and solution-revealing is to influence external actors' behavior so that it is more beneficial to the focal firm; its indirect benefits reside in fostering the adaption of the language and structure of externals' knowledge production so that it better matches the focal firm. As the relationship between the revealing party and the user of its knowledge is established, this link automatically and concomitantly forces the using party to engage in behavior similar and thus beneficial to the focal firm. In short, the focal firm is employing selective revealing to subtly exercise *power* over others to purposefully initiate isomorphic behavior. This *induced isomorphism* shares similarities with other forms of isomorphism (DiMaggio & Powell, 1983), in particular coercive isomorphism, which results from pressure or persuasion from environmental sources. Yet, the

³ UK-based semiconductor company ARM represents an interesting example for the opposite case, in which a firm reveals in a dominant position. ARM, which holds over 90% of its core market of smartphone microprocessors, has decided to open *part* of its platform for the development of RISC chips to create an ecosystem of specialized suppliers and design firms. As this ecosystem has evolved, ARM's solutions have become the foundation for semiconductor manufacturers, device developers, designers, and suppliers develop chips that purposefully build on ARM's central offering for the development of new generations of high-mobility, low-power-usage devices.

use and reciprocation of selectively revealed knowledge by external actors is not a coerced decision, as its provision is an open “[invitation] to join in collusion” (DiMaggio & Powell, 1983: p. 150)—an open offer to an indiscriminate number of externals which all of these are free to reject. Nonetheless, its acceptance will mandate at least some isomorphic behavior. Induced isomorphism also shares aspects of mimetic isomorphism; we have explained how some externals will react positively to the focal firm’s knowledge disclosures because they will reduce uncertainty. Finally, the ultimate goal of induced isomorphism is to create normative pressures by establishing dominant standards and designs. Once enough firms have converged to the focal firm’s trajectory, normative isomorphism may lead to the focal firm emerging as the central organization in a larger knowledge network or ecosystem, and stimulating bandwagon effects that will strongly and primarily benefit the focal firm.

From the vantage point of resource-dependence theory, our argument implies that an action born out of a dependence on access to resources held by others may in fact be recast to become a source of control. This logic is particularly appealing when looking at the potential of selective revealing to act as a less expensive mechanism to generate alternate source of supply, and to instigate collective action in the face of power imbalance and low mutual dependence. In this situation, the high-power actor is likely to be able to withhold the desired resource (Casciaro & Piskorski, 2005) if the low-power actor cannot establish a relationship with a third party constraining the high-power actor (Gargiulo, 1993). If that is not the case, low-power organizations can try to engage in unilateral constraint absorption the effects of which, however, the high-power firm can often successfully nullify (Casciaro & Piskorski, 2005). For example, a strategic alliance by the low-power actor, if perceived threatening, may simply be countered by a strategic alliance (with the same partner, or a rival) by the high-power actor (Gimeno, 2004). We would argue that selective revealing invokes different power dynamic mechanisms: because of

its wider reach and lower coordination cost, the low-power actor should find it *easier* to create alternative sources of supply and supportive coalitions than with other documented mechanisms. In addition, a swift and comprehensive competitive response by the high-power actor to a newly-open competitor, especially if openness is exhibited in the core product market of the high-power actor, is difficult to imagine, for example because of varying levels of organizational fit to selective revealing strategies. We are unaware of studies on this subject, and would thus strongly encourage empirical work to uncover the competitive dynamics underlying these processes.

Selective Revealing and Innovation

We contribute to a rich innovation literature by providing a theoretical argument extending selective revealing beyond its known use as a deterrence mechanism (Clarkson & Toh, 2010; Polidoro & Toh, 2011) to a facilitator of collaboration—one that is particularly helpful in, but not limited to, adverse conditions. Second, our discussion of the indirect benefits of selective revealing has made clear that it can instigate a process in which incoming spillovers become more valuable without the firm changing anything about its knowledge production process. In doing so, our arguments formalize and extend a recent contribution (Yang et al., 2010) to the literature on absorptive capacity (Cohen & Levinthal, 1990; Todorova & Durisin, 2007; Zahra & George, 2002) indicating that outgoing spillovers might over time be beneficial to a firm.

To this discussion, we contribute by conceptualizing the voluntary disclosure of knowledge as a conscious strategy aimed at shaping the knowledge and spillovers others produce. Outputs of the focal firm's knowledge production process are purposefully disclosed so that they may be picked up by actors in the firm's environment. In turn, externals' using these disclosed outputs purposefully or unknowingly transform their knowledge production and spillovers, making them more valuable to the focal firm. Importantly, since the anticipated benefits of selective revealing lie in the future and depend on the activities of other actors, the

value of such strategies can only be appreciated by including such inter-temporal dynamics, which are currently not present in the absorptive capacity literature (e.g., Cohen & Levinthal, 1990; Lane et al., 2006; Todorova & Durisin, 2007; van den Bosch et al., 1999; Volberda et al., 2010).

Finally, innovation scholars may benefit from our classification of selective revealing strategies based on what resources companies reveal and what innovation goals they seek to fulfill. For example, it may be used to inform ongoing debates on open innovation and the increasing importance of innovation conducted by non-corporate actors (Baldwin & von Hippel, 2011; Chesbrough, 2003; Dahlander & Gann, 2010). We are hopeful that scholars active in these debates will enrich our conceptual framework with empirical data, so as to also clarify the boundary conditions of our argument. For example, much still needs to be learned about the relative effectiveness of problem and solution revealing, as well as the factors that lead externals to reciprocate in the firm's interest.

Future Directions

Selective revealing is gaining recognition as an important strategic tool in hyper-competitive industries. In terms of theory, selective revealing practices may confound established management theories that predict firm's behavior and innovation outcomes. By perceiving selective revealing as a mechanism to re-shape the collaborative behavior of others, it opens new avenues to enrich strategy and organization theory, and its attendant implications for innovation and performance. Substantial empirical effort is needed to operationalize the drivers, contingencies, and outcomes of selective revealing discussed in this article in order to guide emergent practice as well as to provide extensions of the model presented.

Additionally, our argument raises questions about the right degree of influence firms may want to exert, as too similar an environment may not present the firm with sufficiently original

knowledge spillovers. Thus, research could try to interrelate (changes in) the position of the revealing firm in the network, the network structure, and the emergent homogeneity of knowledge to firm performance as revealing dynamics unfold over time. We could also imagine selective revealing leading to value-destructive dynamics following the logic of patent races. In a similar vein, one might imagine firms using selective revealing as a bluff. Specifically, a firm may disclose knowledge they consider a dead end, hoping that externals commit substantial resources to find that out for themselves and giving the focal firm the opportunity to achieve lead time in an area it considers crucial. Further systematic evidence is likely to enrich our knowledge of the false signals and competitive gaming even within selective revealing strategies.

When knowledge is to be revealed, an essential issue lies in how to structure and present the selective revealed knowledge so as to maximize direct and indirect benefits (Baer et al., 2012; von Krogh et al., 2012). This would open an avenue to connect our reasoning to the problem-based view of the firm (Nickerson & Zenger, 2004). Also, there is a question of how selective revealing relates to the concept of disruptive innovation and the issue of overcoming inertial forces favoring the extension of known technological trajectories (e.g., Christensen, 1997). Selective revealing may present an opportunity to incumbents to disrupt themselves—however, at the same time it may enable competitors to initiate and coordinate the development and diffusion of disruptive innovations.⁴ Finally, from a theoretical perspective, our argument largely focused on knowledge as selectively revealed resource. However, we see promise in extending it to other non-rivalrous resources, and in identifying conditions under which it could also apply when the revealed resource is rivalrous.

Managerial Implications

⁴ We are indebted to an anonymous reviewer for bringing this possible extension of our work to our attention, as well as suggesting the intriguing idea of selective revealing as a bluff.

From the perspective of managers charged with creating and implementing corporate and innovation strategy, our argument is a clear call toward making selective revealing a standard tool in the competitive toolbox. Specifically, we point out *why*, *when*, and *how* managers can reasonably hope to benefit from selective revealing to solve problems, shape technologies, improve market positioning, or even build create new niches. In addition, we provide insight to firms in whose environment selective revealing takes place, and encourage firms to study potential idiosyncratic advantages from reciprocating even if they know that such action might also be beneficial to somebody else. Finally, our argument can act as a note of caution to managers in currently dominant strategic positions, for whom the threat of being attacked through selectively revealing may loom large. In turn, even these firms may find that under certain conditions, they may stand to benefit from selectively opening their resources to others to preempt being outmaneuvered by a coalition assembled via a selective revealing strategy.

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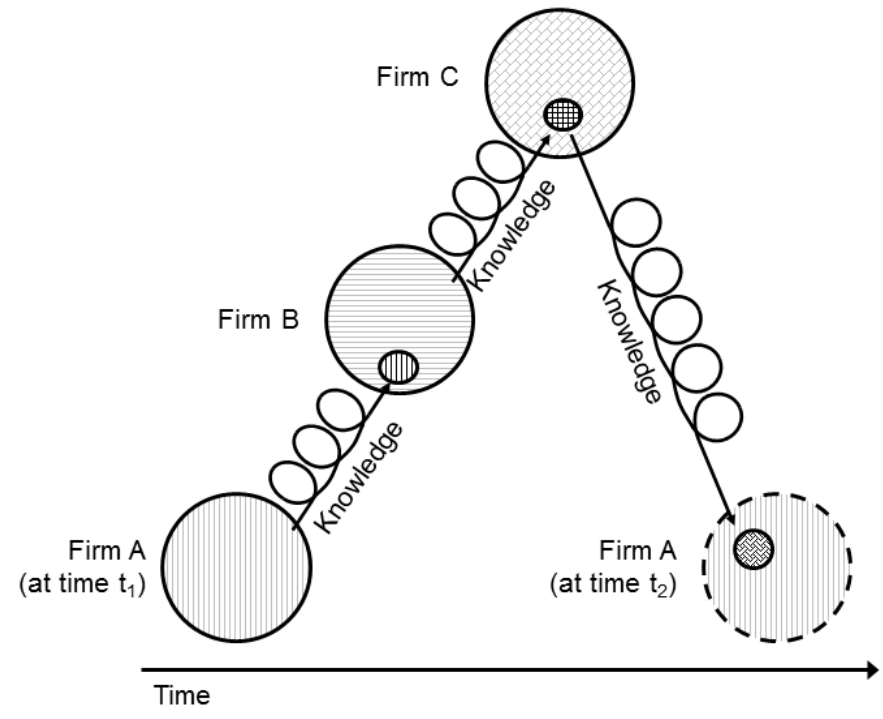
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FIGURES AND TABLES

FIGURE 1

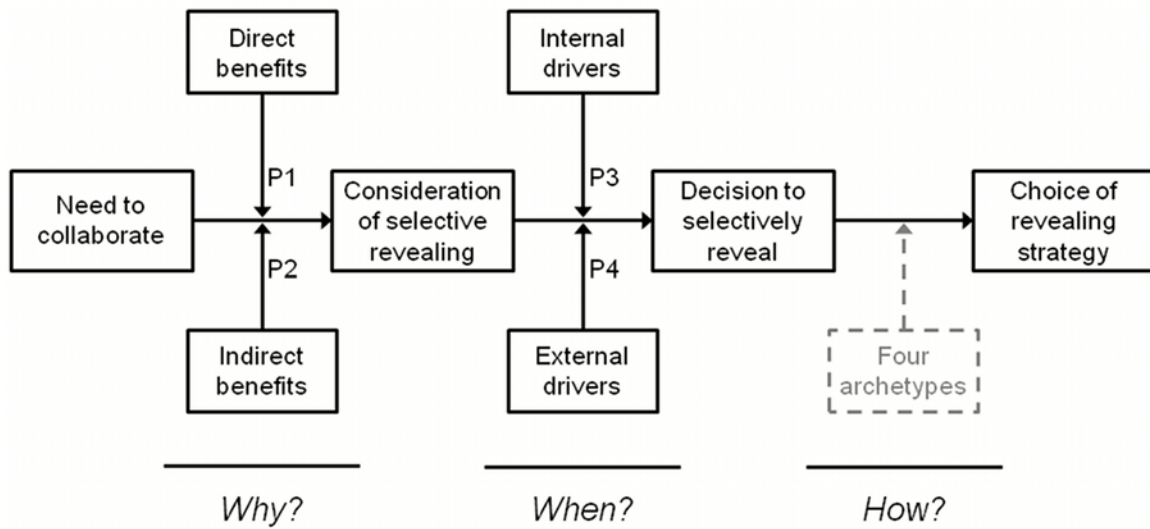
Innovation as an Iterative, Multi-agent System Involving Spillovers



Note: The small circle represents the spillover that is being “passed on.” The shading of both the large and the small circles symbolizes the varying structure of the respective knowledge.

FIGURE 2

A Process Model of the Selective Revealing



Note: Elements shaded in gray represent relationships that are discussed in the paper but for which we refrain from presenting propositions.

TABLE 1**Selective Revealing Strategies**

		Mode of Revealing	
		<i>Problem-revealing</i>	<i>Solution-revealing</i>
Goal	<i>Path-creation</i>	Issue-spreading (Broadcast search)	Product-enhancing (Open source software)
	<i>Path-extension</i>	Agenda-shaping (Open research calls)	Niche-creating (Academic publishing)

Note: Exemplar practices embedding selective revealing are given in parentheses.

TABLE 2**Selective Revealing Strategies: Examples of Successful Implementation from the Academic Literature**

Strategy	Definition	Studies	Study contexts
<i>Issue-spreading</i>	Encourage others to participate in shared problem solving and/or to make complementary investments	Füller (2010); Jeppesen & Lakhani (2010)	Firms on InnoCentive*, consumer goods, IT
<i>Agenda-shaping</i>	Highlight firm's future demands so others can privately invest in and/or actively assist focal firm in developing solutions and complimentary offerings	MacCormack & Herman (2004); Alexy et al. (2009)	Defense industry, IT, pharma, consumer goods
<i>Product-enhancing</i>	Facilitate wide use of revealed knowledge to increase value of complementary assets and likelihood of reciprocal behavior	Allen (1983); von Hippel (1988); West (2003)	User innovation in all sectors, engineering, IT
<i>Niche-creating</i>	Build critical mass supporting firm's technology trajectory to attain buy-in from crucial actors in ecosystem	(Garud et al., 2002), Dodgson et al. (2007)	Built environment, IT

* As Lakhani et al. (2007) explain, the problems posted on InnoCentive usually mainly stem from the life sciences, chemistry, or the applied sciences. Accordingly, the firms posting them would all be included in Scotchmer's (1996) definition of cumulative industries.