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Collaborating to Innovate: Balancing Strategy Dividend and Transactional Efficiencies

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Abstract

When a firm collaborates with its suppliers, it expands its access to external know-how, and thus, can enhance its innovation outcomes. However, such partnerships also expose it to various transactional hazards including knowledge spillovers and opportunism appropriations. The trade-offs are also underscored by whether the collaboration complements the firm's strategic resources and directions deployed to yield a strategy dividend. Recent accounts suggest the verdict on supplier collaborations is noisy. Reports indicate buyer-supplier perceptions of these collaborations do not align on the key issues of governance, strategy, and value generation. We study co-development contracts of a sample of high-tech original equipment manufacturers that collaborated with suppliers from 1985 to 2016 and show that misalignment between a firm's co-development contracts, strategic capabilities, and positioning strategy significantly erodes its innovation outcomes. This suggests that blanket prescriptions for one or the other types of contracts may be misdirected.

Keywords: Governance value analysis; Co-development contracts; Innovation performance; Marketing capabilities, Technological capabilities; Differentiation strategy

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Introduction

When Unilever partners with Novozyme, it is collaborating with one of its major suppliers of enzymes, to fast-track innovation and improve its business performance (Gutierrez et al. 2020). Such Co-Development Collaboration (CDC) is formally defined as "(a collaboration) *that involves combining knowledge, technologies, and other resources across organizational boundaries to create a novel product, service, or solution*" (Oinonen & Jalkala 2015, p. 291). Such partnerships are common, and industry reports indicate up to 85% of firms believe they are effective means of innovation (Tevelson et al. 2013). In many cases, participating in CDCs enables firms to achieve strategic goals such as (a) set new industry standards and reshape the market by developing next-generation, more-advanced, and/or better-performing products (sometimes at lower costs and faster delivery) than those available in the market at that time, (b) pre-empt competitors by getting access to unique resources, (c) overcome economic and technical challenges of developing sophisticated products, and (d) cut product development time and costs. As such, empirical evidence demonstrates that CDCs have significant impact such as enhancing firm innovativeness (Markovic et al. 2020; Wu 2014) and affecting the market value of the partnering firms (Fang, Lee, & Yang 2015; Wu et al. 2015). Based on some industry reports, firms that collaborate regularly with suppliers in innovation activities outperform (e.g., grow more, profit more, reduce operating costs) their peers that do not form CDCs (Gutierrez et al. 2020). This broader impact of these collaborations is aptly captured in the following public statement by Bristol-Myers Squibb: "*As critical drivers of our strategy, external innovation and partnering have brought significant commercial success and pipeline growth. Twelve of our company's twenty blockbuster medicines are derived from collaborations. In addition, more than sixty percent of our current development pipeline is externally sourced bringing significant external innovation to complement our internal capabilities and innovation.*"[1]

The performance-enhancing impact of CDCs is not totally unexpected. Suppliers specialize in cognate technologies, have ongoing relations with other firms, and are often independently engaged in technology development. So, partnering with suppliers expands a firm's access to external know-how, and thus, can shorten learning cycles, accelerate product development, reduce R&D costs, and enhance innovation performance overall (Ozdemir et al. 2017, Li, Wu, & Zhu 2022). However, CDCs also expose the firms to risks of partner opportunism (e.g., knowledge spillovers, misappropriations, and renegotiations), raising the spectre that misaligned partnerships will bleed value (Heide & John 1990; Carson & John 2013; Du 2021). So, the focal firms need to balance the value to be gleaned from the CDCs against the potential transactional hazards that come with them. These trade-offs are sharpened as the firm's strategic resources are increasingly invested in effectively leveraging the collaborations. These are complex issues, and not surprisingly, the verdict on supplier alliances is noisy. Evidence from industry points to as much as 80% of executives being dissatisfied with their outcomes (Tevelson et al. 2013). More specifically, recent data suggest that buyer-supplier perceptions of these collaborations do not align on the key issues of governance, strategy, and value generation (Gutierrez et al. 2020). Unfortunately, this industry interest notwithstanding, the research literature has important limitations in helping managers unpack these key implications for supplier collaborations.

To address these limitations, in our paper, we target several important gaps in the research literature: (a) we study the *full range of governance modes* that dominate the CDC spectrum; (b) we explicitly account for the role of *marketing strategy* in determining outcomes; (c) we account for how different firm-level *functional capabilities* operate together to impact outcomes; (d) we address the *complex*

[1] https://www.bms.com/business-development/existing-partners.html (accessed on Sep. 8, 2023).

interaction between governance, strategy and capabilities with an almost full-fledged test of the *Governance Value Analysis* (GVA) approach; (e) we build a unique database of CDCs from different archival sources and base all our measures and empirical models on this secondary data. We elaborate on these gaps and contributions in the following paragraphs.

Most marketing papers focus on the trade-offs firms face in the dichotomous choice between formal and relational arrangements (e.g., Bouncken, Clauß, & Fredrich 2016; Noordhoff et al. 2011). Yet, as the strategic payoffs and the transaction costs of collaborations pull in different directions, firms face a more granular set of CDC modes. For instance, Boeing and Textron formed a *joint venture*, "Bell-Boeing," to develop and manufacture "V-22 Osprey," a military aircraft. Microsoft, on the other hand, signed a *joint development agreement* with 3com corporation for developing its "OS/2 LAN Manager." In yet another arrangement, Network Equipment Technologies granted Interphase Co. a *license* to use its AATM interface technology in developing ATM adapter cards. The right choice of the CDC form leads to superior firm performance, relative to the wrong choices. With only a few papers addressing the spectrum of formal contracts that dominate practice (*cf.* Mowery, Oxley, & Silverman1996; Oxley 1997), this leaves important sources of potential variation unexplained and limits inferences that practitioners can draw from research results. To address this critical gap, in this paper, we study the implications of the entire spectrum of CDC contracts, from more arms-length agreements and licensing to more integrated Joint Ventures (JVs). We focus on their impact on firm *Innovation Performance (Innov-Perf),* which we define as *the extent to which a firm succeeded in developing and commercializing innovative products as indicated by the quality of its patented inventions and the frequency of its new product announcements*.

The extant literature is also quite limited in its treatment of the firm's marketing strategy despite its critical role in driving the effectiveness of CDCs, as argued by Ghosh & John (1999; 2005). Much of the marketing studies that examine CDC effectiveness, do so independent of the role of firm capabilities and positioning strategy (e.g., Bouncken et al. 2016; Lee 2011). Yet, commitment to a specific market positioning strategy binds a firm to resource deployments that not only draw upon the firm's existing capabilities but in doing so, could also sort between the effectiveness of different CDCs with its suppliers. Drawing inferences without considering such strategy may lead to erroneous inferences about the effectiveness of CDCs. For example, JVs may not be well-suited for a high differentiation-oriented firm with considerable marketing resources at its disposal. However, JVs may be perfectly suited for the same firm if it does not seek high levels of differentiation vis-à-vis its competition. Interestingly, there is indeed disagreement on the efficacy of governance modes among such studies (Sampson 2004a). We hope to address this by explicitly accounting for the firm's positioning strategy in our framework. Relatedly, we use measures of positioning strategy derived from archival data in our paper to build on current results. In this, we borrow from the accounting literature (*cf.* Banker, Mashruwala, & Tripathy 2014) and build on research in marketing that often uses self-reported measures of strategy (e.g., Kaleka & Morgan 2019).[2]

A consideration of the firm's strategy will be incomplete without simultaneously considering the firm's capabilities. Conceptually, the Resource-Based View (RBV) points to different functional capabilities – marketing, technological, and operations – as key to sustainable competitive advantage. Empirically, many marketing studies (e.g., Moorman & Slotegraaf 1999; Narasimhan, Rajiv, & Dutta, 2006) draw on the RBV perspective to investigate the relationship between capabilities and firm performance. However, explicitly considering the effect of functional capabilities on CDC effectiveness is scant in the marketing

[2] We use differentiation strategy to develop our theoretical arguments, controlling for efficiency-focused strategy in the empirical models. This is explained in the later sections.

literature (e.g., Fang et al. 2015; Wu 2014). In this paper, we address this by explicitly investigating the simultaneous impact of functional capabilities along with positioning strategy and CDC governance modes on the firm's innovation performance.

For this, we draw upon the roadmap of the *Governance Value Analysis* (GVA) framework of Ghosh & John (1999; 2005), where they highlight the significance of studying how governance mechanisms that are misaligned with the firm's strategic resources, *and* market positioning strategy, may negatively impact firm performance. We draw upon GVA to hypothesize how the performance of firms participating in CDCs is determined by the fit among the spectrum of contractual arrangements, firm capabilities, and the firm's relevant positioning strategy. The inherent complexity of studying this three-way alignment presents significant empirical difficulties, which has led to only partial tests of GVA in much of the extant literature (*cf.* Nickerson, Hamilton, & Wada 2001). To the best of our knowledge, the full-fledged test of the GVA framework we undertake will be among the first.

Our empirical study uses a database of 202 CDCs that we created from multiple archival sources. We adopt established measures of variables, including factor analyses and stochastic frontier models. Our estimations use generalized linear models, utilizing Gaussian Copula (Park & Gupta 2012) and two-stage residual inclusion methods (Terza, Basu, & Rathouz 2008) to control for potential endogeneity.

Consistent with the postulates of the GVA framework, we find that fit among a firm's positioning strategy, its capabilities, and CDC forms results in superior innovation performance. We also find that the different strategic capabilities interact differently with different CDCs to moderate the latter's effects on a firm's innovation outcomes. In these, we make two key contributions. *First*, we offer a more holistic depiction of the misalignment costs of innovation contracts and how they impact innovation outcomes. We do this in three ways: (a) we generate more granular insights by considering the entire spectrum of CDC contracts; (b) we include marketing and technological capabilities, in our model and control for operational capabilities – to the best of our knowledge, our paper would be the first to illustrate how they operate jointly to impact innovation; (c) we include positioning strategy along with governance and firm capabilities, in a single model, being among the first to study their interlinked mechanisms in the context of innovation collaborations. *Second*, our work highlights the keystone role of a firm's *positioning strategy* in successful innovation. In the process, we offer one of the few direct tests of the *full-fledged* GVA framework, in a new context, and with new data, contributing to the interface of governance and marketing strategy. In the rest of the paper, following a review of the CDC literature, we present our theory, and empirical efforts, and discuss our results.

Literature Review

Firms usually participate in CDCs to share product development costs and risks, acquire new skills, access unique technologies, and accumulate competencies (Ozdemir et al. 2017). Yet, they also risk partner opportunism, knowledge spillover, renegotiations, and hazards of appropriations (Oxley 1997; Du 2021), and thus, suffer from a high failure rate estimated to be as much as 70% (Noordhoff et al. 2011). In fact, that vertical conflicts can negatively impact firm performance has been well documented (Eshghi & Ray 2021). Not surprisingly, keen managerial interest centers on how to effectively design and manage CDCs and there is a large body of scholarly literature in the domain across multiple disciplines. In Table (1), we list a select group of papers in marketing to summarize the general contribution of our paper in that spectrum. As we ground our conceptual model (see Figure 1) on the GVA framework, we postulate that fit among governance, capabilities, and strategy would enhance Innov-Perf by minimizing transaction costs and/or maximizing the created value. Thus, our study contributes to several research domains including innovation collaboration and governance, firm strategy and capabilities, and firm performance as discussed below.

---------- [Table (1) & Figure (1) are about here] ----------

Several marketing papers study the relationship between CDCs and firm performance, including market value (e.g., Boyd & Spekman 2008; Fang et al. 2015), financial performance (e.g., Luo, Rindfleisch, & Tse 2007; Ozdemir et al. 2017), and innovativeness (e.g., Bouncken et al., 2016; Fang 2008; Li et al. 2022). However, the results reveal disagreement on the effectiveness of vertical CDCs. For instance, Yeniyurt et al. (2014) and Luzzini et al. (2015) find that supplier CDCs enhance innovation performance; while Li et al. (2022) conclude upstream collaborations have no direct effect on innovation. Similar mixed results for downstream CDCs also proliferate the literature. For instance, Campbell & Cooper (1999) find that customer alliances have no advantage over in-house development in enhancing product performance. Similarly, Statsenko & Zubielqui (2020) conclude that customer CDCs have no direct impact on innovation performance. In contrast, Fang et al. (2008) find that customer participation enhances the new product development processes. Most of these studies ignore the different CDC governance modes, leaving open the possibility that variation in the results may be resolved with a more granular governance model. Ideas that peg a firm's performance to the governance structure of its CDC are not isolated (Sampson 2004b). Drawing on *Transaction Cost Economics (TCE)*, several non-marketing studies (e.g., Sampson, 2004a) examined the conditions under which a firm would prefer one governance mode over others to form a CDC.

Three governance modes are commonly ascribed to CDCs (*cf.* Mowery et al. 1996; Oxley 1997). (a) *Technology Licensing Contracts (licenses henceforth)*, where one firm (the licensor) gives another firm (the licensee) a license to utilize its technology for development activities in exchange for a fee[3]; (b) *Co-development Agreements (agreements henceforth)*, where partners work jointly on projects of developing new products; and (c) *Joint Ventures (JVs)*, where ownership, in a separately incorporated entity, is shared by partners. However, most papers studying CDCs (e.g., Bouncken et al. 2016; Noordhoff et al. 2011) focus on the trade-off between relational and transactional modes, bypassing the complicated choice of different formal CDC arrangements faced by firms. Yet, other papers study heterogeneity within governance modes. E.g., Carson & Ghosh (2019) and Ghosh & John (2005) consider completeness of contracts, while Heide & John (1990) study "closeness" in inter-firm arrangements in a non-equity participation setting. In contrast, our paper explicitly considers all three governance modes. Our focus on the three "top tier" CDC forms is driven by three main concerns. First, our context of innovation is laden with major strategic significance for the firm. Second, these comprise the spectrum of innovation contracts in practice. Third, these are substantially diverse from each other in practice – e.g., the duration and termination costs of JVs are more than either for agreements or licenses, whereas their decision-making is much less decentralized. We summarize these differences between the three governance modes in Table (2). We believe that not accounting for the granularity of these diverse contractual arrangements in studying CDCs is a critical gap in the literature. This gap leaves a big part of the implications of CDCs unaddressed and limits inferences that can be drawn from research results.

---------- [Table (2) is about here] ----------

[3] In a co-development context, licensing includes collaborative activities such as the licensor assisting the licensee with technical details relevant to training, testing, interoperability etc.

In the context of mixed results in the CDC-performance relationship in the literature, it is also interesting to note the relatively thin focus on the role of firm-level strategic factors. In general, a firm's functional capabilities (i.e., marketing, technological, and operations) are indicated as critical factors of firm performance (Krasnikov & Jayachandran 2008). Yet, only a few marketing studies explicitly consider their moderating effects on the effectiveness of CDCs (Fang et al. 2015 is a notable exception). Even this thin slate of studies focuses on either technological or marketing capabilities (e.g., Lee & Chang 2014), and none account for all three capabilities simultaneously. We believe this leaves key parts of the variation in Innov-Perf unexplained, limiting our inferences. We incorporate both marketing and technological capabilities in our theoretical framework and control for operations capabilities in our empirical model, thereby accounting for all three capabilities simultaneously.

The absence of explicit treatment of the firm's positioning strategy in studies of CDCs is surprising. Strategy defines organizational goals, sketches directions for firms' activities, integrates and motivates efforts, and provides criteria to measure performance (Spyropoulou et al. 2018). In addition, strategy designates which capabilities are needed and how resources should be allocated to create value; and it delineates the value propositions of firms (Jin et al. 2019). Positioning a new product is one of the key strategic decisions that determine the product's performance in a market. In the context of the mixed results in the literature, this is a rather significant gap, which we address in this paper. To this end, Porter's widely studied generic strategy of *product differentiation* (Porter 1980) has had a great impact on studies of firms' product strategy in marketing, since it explicitly addresses one basic pillar of competition related to products themselves. Other strategy frameworks concentrated more on environmental factors (Swink & Hegarty 1998). We focus our investigation specifically on the role of the firm's product differentiation strategy.

Theory and Hypotheses

Firms collaborating to improve their Innov-Perf are forced to reckon with a trade-off: access to external know-how and expertise to improve Innov-Perf, versus bleeding value in transaction costs of misaligned contracts due to risks of knowledge appropriation and other hazards of partner opportunism. At the same time, the firm's strategic orientation is focused on generating a dividend in terms of sustainable competitive advantage and determines how the firm develops and deploys its resources prioritizing between different action alternatives. So, the collaboration decisions cannot be neutral to the firm's strategy (Merchant 2014). The same resources that may be seen as boosting the strategy dividend for the firm could be wasteful in the context of realizing the objectives of supplier collaboration, e.g., the firm's resources that engender high marketing capabilities are useful for sensing and anticipating market dynamics ahead of rivals, and thus suitable for firms focused on offering unique solutions to differentiate themselves in the market. Effective implementation of a high-differentiation strategy calls for flexibility to implement quick and sometimes frequent changes in product design and attributes. Potentially, CDC modes that are laden with higher bureaucracy – as the more integrated JVs (relative to the more arms-length modes of agreements and licensing) – might be less suitable in this case, because they may come in the way of quick adaptations, bleeding the value gained from possessing strong marketing capabilities. Thus, misalignment between the firm's capabilities, its strategy, and governance form would result in inferior innovation outcomes. An emerging literature in marketing studies the role of such *ex-ante* firm differences in vertical governance (Ghosh & John 2005; Carson & Ghosh 2019). In particular, the GVA examines this by proposing that the firm's strategic positioning draws on the bundle of resources it possesses; and that this positioning along with the firm's resources influence organizational structure and governance choices. At the core of this argument are the trade-offs between the strategy dividend derived from its strategy portfolio *vis-*

à-vis the transactional costs of its governance structure, and recognition of the endogenous nature of firm decisions of strategy, resources, and governance (Nickerson, Hamilton, & Wada 2001).

We build our hypotheses on GVA. Figure (1) depicts the conceptual framework driving our hypotheses. Notice that there are four main elements to this framework: (1) innovation outcomes are jointly determined by the OEM's strategy, its capabilities, and governance; (2) governance mode is jointly determined by both the firm's strategy and capabilities; (3) capabilities developed are jointly determined by its strategy and governance modes; (4) innovation performance emerges as a net of strategy dividend and transaction costs.[4] Our ultimate goal is to investigate the full GVA-inspired model of the three-way interactions among strategy, capabilities, and governance. However, we cannot do so without first setting the base models of the simple relationships and two-way interactions. Thus, we follow a sequential approach to develop our theory as discussed below.

Governance Mechanisms & Innovation Performance

Licenses might be seen as the "default" mode because they generate less negotiation and formation costs than agreements and JVs (Sampson 2004b). However, given the special nature of technological transactions, which are centered on the exchange of knowledge, and the associated problems of specifying, observing, and enforcing licenses without elevating the transaction costs of crafting and monitoring; firms opt for crafting incomplete licensing contracts (Helm, Kloyer, & Aust 2020). However, using incomplete contracts increases the risk of opportunism and appropriability hazards. So, firms might preserve licenses to situations where the risk of opportunism is low. In contrast, in a similar situation, forming a JV would normally provide greater protection against partner opportunism (Oxley & Sampson 2004), which could motivate the partners to make specific investments and share valuable knowledge and technological resources (Sampson 2004a). The more intimate exchanges these would foster will assist the partners to more easily acquire and assimilate complementary knowledge from each other (Lane & Lubatkin 1998), ultimately assisting novel inventions. Thus, one would expect that when the opportunism risk is high, establishing a JV will be associated with greater Innov-Perf of an OEM than an agreement or license in a similar situation.

On the other hand, initiating a JV is very costly and normally comes with high bureaucracy, which can frustrate innovative activities (Sampson 2004a). While JVs have been argued to ease coordinated adaptation under uncertainty in some contexts (Noordewier et al. 1990), the uncertainty of developing high-tech products present significantly different adaptation challenges. Parties to the technology collaboration may need to frequently change research directions, face unexpected barriers to developing new products, be forced to seek new technology/ knowledge to solve intractable problems, even abandon developed prototypes to re-prioritize their R&D portfolio etc. In this context, the flexibility required to adapt may not be achieved in JVs (Lee et al. 2009).

In contrast, agreements normally have less negotiation and initiation costs in similar situations, and offer more flexibility to firms because they employ decentralized decision-making processes (Sampson, 2004b) and are easier and less costly to be terminated (Oxley 1999). The risk of opportunism may be reduced with aligned incentives resulting from sharing the outcomes of the agreement and mutual hostages, facilitating unfettered flow of knowledge between partners, greater learning, and enhanced innovation (Lane & Lubatkin 1998). Hence, collaborating through an agreement may then be

[4] Note that positioning strategy is considered exogenous in this framework. In the empirical section, we argue that firms in our sample make relatively longer-term commitments to strategy and are thus not prone to frequent adjustments.

associated with greater Innov-Perf of an OEM than a JV or license even in the presence of high opportunism risks. The competing explanations indicate that governance modes have contingent outcomes, and their aggregate impact is best considered an empirical issue.

Functional Capabilities & Innovation Performance

Marketing, technological, and operations have been identified as the core functional capabilities for a firm's innovation journey as they underlie the processes of developing, manufacturing, and commercializing new products (Danneels 2002). ***Marketing Capabilities (MCAPs)*** denote the ability of a firm to sense and understand customer needs and wants better than rivals (Day 1994), and to deploy its marketing-based resources (e.g., ad expenditures, customer relationship) efficiently to satisfy these requirements ahead of competitors (Zang & Li 2017). MCAPs imply a strong market orientation that is considered a substantial source of innovative ideas (Dutta, Narasimhan, Rajiv 1999). Understanding the market dynamics motivates innovation to exploit them ahead of rivals. MCAPs also enable firms to forecast the potential returns to their investments in innovation projects and thus allocate resources effectively among them (Zang & Li 2017). ***Technological Capabilities (TCAPs)*** mean a firm's ability to deploy its technological resources (e.g., R&D expenditures) in developing new technologies, and its skills in utilizing various technologies in innovating products and processes to satisfy current and emerging customer needs (Moorman & Slotegraaf 1999). TCAPs enhance a firm's ability to evaluate, acquire, and utilize external knowledge and technologies in developing innovative products. Thus, TCAPs are crucial for achieving superior Innov-Perf for firms, especially those operating in high-tech markets where product life cycles are short and new product introductions are rapid. A firm with superior TCAPs can develop and introduce new products more frequently, faster, and cheaper than rivals (Dutta et al. 1999). ***Operations Capabilities (OCAPs)*** indicate a firm's ability to enhance its output through the most efficient use of its production processes, technologies, and coordinating the flow of materials (Krasnikov & Jayachandran 2008). We include more details in Table (3).

---------- [Table (3) is about here] ----------

Capabilities do not have immutable impacts and may interact to boost or dampen firm performance (Feng, Morgan, & Rego 2017; Krasnikov & Jayachandran 2008). So, we model them simultaneously. We focus only on *marketing* and *technological capabilities* which are more directly relevant to the co-development context, incorporating *operations capability* as a control variable in our analyses. Consistent with the explanations above, we expect that each of the *MCAPs and TCAPs will be positively associated with Innov-Perf.*

Governance Mechanisms, Functional Capabilities, & Innovation Performance

Their capabilities are key to the firms' sustainable competitive advantage. In structuring any CDC, key considerations would be leveraging these capabilities to create value from the learning and knowledge sharing in the collaboration and protection from the hazards of misappropriation by the partner. Nevertheless, these capabilities themselves involve unique firm-level resources which now must be fully deployed in order to derive maximum value from the CDCs (Fang, Lee, & Yang 2015). So, while these capabilities may differ in the type of *ex-post* value creation they engender, they present the OEM with significant appropriability concerns. We now discuss how these moderate the outcomes.

Marketing capabilities (MCAPs), governance mechanisms, & Innov-Perf:

Strong MCAPs enable firms to identify opportunities for successful innovation. However, effective exploitation of higher levels of MCAPs involves sharing increasingly unique and proprietary market/customer knowledge and resources, with its partners, which can be opportunistically appropriated in the absence of adequate safeguards. For firms more vulnerable to partner opportunism, a more integrated, hierarchical mechanism, like JVs, offers greater safeguards (Houston & Johnson 2000). So, ceteris paribus, faced with greater appropriability hazards, a high-MCAP firm will be more motivated to engage with its partners and leverage its MCAPs, under a JV arrangement, compared to the more arms-length modes of licenses and agreements (Sampson 2004a). The intense direct interactions with its JV partner, afford the firm better opportunity to learn from the partner (Keil et al. 2008), further improving the odds of successful innovation for firms with stronger MCAPs. Thus:

> *H1: Ceteris paribus, JVs are more strongly associated with higher Innov-Perf for OEMs with strong marketing capabilities as compared to Agreements and Licenses.*

Technological capabilities (TCAPs), governance mechanisms, & Innov-Perf:

Firms with strong TCAPs face very similar types of trading hazards associated with MCAPs because leveraging strong TCAPs could require the firm to exchange increasingly unique and valuable technological knowledge and resources with its suppliers. Consequently, the need for monitoring to prevent opportunistic appropriation of its technological know-how is well recognized (Veugelers 1997). So, ceteris paribus, these greater appropriability hazards would motivate a high-TCAP firm to prefer the better safeguards of a JV arrangement, over the more arms-length modes of licenses and agreements (Sampson 2004a). Further, the better-coordinated adaptations under JVs will also enable easier absorption of knowledge and expertise in the CDC, complementing the higher levels of technology absorption capacity that comes with higher TCAPs (Berchicci 2013). Thus:

> *H2: Ceteris paribus, JVs are more strongly associated with higher Innov-Perf for OEMs with strong technological capabilities as compared to Agreements and Licenses.*

Governance Mechanism, Capabilities, Strategy, & Innovation Performance

Strategy defines organizational goals, sketches directions for firms' activities, integrates and motivates efforts, and provides criteria to measure performance. Firms need to be "superior" at "distinctive capabilities" to attain their strategic goals (Day 1994) – pointing to the need for targeted resources to develop these distinct capabilities. In an inter-firm collaboration, these shared resources are accompanied by the usual appropriability hazards – pointing to the need for organizing efficient transaction arrangements to enhance joint performance. We discuss how the fit among strategy, capabilities, and governance might affect Innov-Perf. In discussing the fit among the three, we take the firm's strategy as given. There are two reasons for this. The first reason is pragmatic. In a model where all three simultaneously impact each other increases the complexity of the reasoning and makes it difficult to glean sharp takeaways. The second reason is more contextual. While GVA does imply simultaneous causation among the three variables, in many cases, as in our sample, firms make relatively longer-term commitments to their strategies, and are thus not prone to frequent revisions. This allows us to anchor our sensemaking on the immutable nature of strategy and explore the interactions.

Differentiation strategy, governance mechanism, capabilities & Innov-Perf:

A high differentiation strategy is mainly centered on idiosyncratic innovations and unique marketing efforts that are difficult to be imitated (Svendsen et al. 2011). We focus only on differentiation since it is the most directly relevant strategic posture in our context of product innovation.[5] Market knowledge is crucial for its successful implementation. Collaborations allow firms to access that knowledge (Keil et al. 2008), and firms with strong MCAPs can effectively use their high market sensing for such purpose (Porter 1980; Day 1994). However, just gathering knowledge is not predictive of a successful strategy. A successful high-differentiation strategy must confront the need for a high level of flexibility to quickly adapt to changing market conditions. This need stems from several sources including frequent changes in competitive product assortments that require the firm to adapt quickly to maintain its differentiation (Harrigan 1988). While a JV facilitates easier knowledge sharing, its relatively higher bureaucracy (compared to the more arms-length arrangements) can come in the way of implementing successful differentiation (Miller 1986). Differentiation requires a focus on "unique" products. While a more flexible control system grants employees more space to be creative to achieve that, highly bureaucratic environments might restrain such creativity. The more decentralized modes, on the other hand, allow the partners greater flexibility to quickly adapt to changes and seize emerging market opportunities (Sampson 2004b). Access to diverse knowledge is also a key to the success of differentiation (Merchant 2014). Engaging in several short-term agreements with multiple suppliers offers greater advantages on this count than committing to longer-term JVs with few partners. So, while a high-MCAP firm may prefer JV to be better suited from the perspective of safeguards, the effectiveness of its differentiation strategy is critically dependent on the firm being able to leverage its superior market sensing and customer understanding without the constraints of JVs. While licenses come with some of the flexibility of arms-length arrangements, they offer lesser opportunities for direct interaction and knowledge sharing than agreements. So, amid the greater flexibility of agreements, high-MCAP firms are naturally able to leverage their stronger information gathering and processing advantages to complement the requirements of successful differentiation. Thus:

> *H3: Ceteris paribus, Agreements are more strongly associated with higher Innov-Perf for high-differentiation-oriented OEMs with strong marketing capabilities as compared to JVs and Licenses.*

Note that, implementing a high-differentiation strategy also entails producing more "specialized" products, which involves a relatively high degree of knowledge specificity (Svendsen et al. 2011; Merchant 2014). At the same time, and despite such need for specificity, for the strategy to be effective in a competitive scenario, the firm needs to maintain flexibility to produce a broad range of such products, as it responds to market changes, and protect its differentiation advantage. So, the firm not only needs to be able to quickly acquire and assimilate external technological knowledge effectively, it must also be able to do so for a dynamic spectrum of diverse technologies as well. High-TCAP firms are able to effectively evaluate, acquire, and utilize such external knowledge to develop novel products more frequently and rapidly (Berchicci 2013). Nevertheless, a high-differentiation strategy imposes an additional and crucial demand for flexibility. Despite their better-safeguarding properties, this makes JVs less suited (compared to more arms-length arrangements like agreements and licenses) to fully leverage the firm's strong TCAP for effective differentiation. Of course, any arms-length transactions come with their expected limitations. With the effectiveness of TCAPs residing in the firm's ability to acquire and assimilate knowledge from the collaboration as it engages in innovation, any opportunistic withholding of information (or misinformation) by the partner, can easily jettison the firm's innovation outcomes, and thus, the effectiveness of its differentiation strategy.

[5] This also helps us achieve some parsimony in our full-fledged GVA analyses without compromising the framework.

This becomes a greater concern as effective differentiation may require the firm making investments in technology that may be very transaction specific, opening it up to even more holdup problems.

So, on one hand, differentiation-oriented high TCAP firms face the prospect of not being able to fully leverage their TCAP in JVs; on the other hand, in the more arms-length modes of agreements and licenses they face significant technology-related transactional hazards despite being able to leverage their TCAPs. If a firm could identify these technology related transaction hazards and proactively address them in well-defined terms, it would mitigate some of the concern. This would require the firm to be well-informed about the technology spectrum, industry trends, having a good grip on possible interdependencies between disparate protocols and also, being able to identify diverse usage of the technology to reduce holdup – all characteristics of a firm with strong TCAPs (McGee et al. 1995). A high-TCAP firm is more likely to effectively specify the terms of its technological exchanges such that they can be verified, monitored, and enforced without being subjected to protracted renegotiations.

This suggests that ceteris paribus, a high-TCAP firm may be better positioned to leverage the flexibility required of a high-differentiation strategy with arms-length CDCs such as licenses and agreements, as well as ride out the associated transaction hazards that come with these forms.

The need of flexibility for effective differentiation, makes licenses a better choice – for high-TCAP firms – over agreements since licenses give the firm greater flexibility in utilizing the licensed technology in all possible projects without being limited to an agreement's identified objectives (Oxley, 1999). That said, licenses may also be more restrictive in knowledge transfers outside of the contracted technology. Since, high-TCAP firms also have strong absorptive capacities, they can still assimilate and integrate diverse external knowledge effectively outside of contracted formal interactions with partners. Thus:

> *H4: Ceteris paribus, Licenses are more strongly associated with higher Innov-Perf for high-differentiation-oriented OEMs with strong technological capabilities as compared to JVs and Agreements.*

Empirical Analyses

Data and Variables

We build our database from several archival sources. From the Thomson Financial SDC Platinum database, we identified an initial sample of 428 dyads of high-tech OEMs that formed CDCs with high-tech suppliers, between 1985 and 2016. From this, we extracted measures for CDC governance and several control variables. Next, for firms in this sample, we consulted their annual reports and searched other databases (Compustat, Thomson one, Factiva, and Mergent online) to collect data on firm-specific strategic factors. Then, we searched the United States Patent and Trademark Office (USPTO) and ABI/Inform databases to collect data on innovation outcomes. After merging, we were left with a final sample of 202 observations. The sample consists of OEMs operating in five high-tech sectors, *viz.* electronics; computer hardware and software; telecommunications; biotech and pharmaceutical; and medical equipment. Approximately 30% of the sample are international, while the majority (about 88%) of the OEMs are US firms. All financial data were standardized to be in millions of US dollars. The average annual revenue of these OEMs is US $20.3 billion with a standard deviation of US $25.7 billion. About 60% of the OEMs had agreements with suppliers, 28% had licenses, and the rest established JVs; and about 56% had prior experience with similar alliances.

Dependent variables:

Innovation performance (Innov-Perf): we measured Innov-Perf using two indicators. (1) P*atent citations* – we counted the number of citations received, from following patents, by each of the patents an OEM filed within one year of establishing the CDC. This indicates the quality of the OEM's inventions. (2) *New Product Announcements (NPAs)* – we counted the number of new product launches announced by each OEM within four years of forming the CDC.[6] This indicates the frequency of an OEM's success in converting its inventions into commercializable products. Our measures of Innov-Perf is similar to earlier studies (*cf.* Hagedoorn & Cloodt, 2003, Zhang et al., 2010). Number of patents is also often used as a measure of innovation outcome. However, since historical patent activity is a component of our TCAP measure we exclude it from our estimations.[7] We summarize these and other measures along with their sources in Table (4).

---------- [Table (4) is about here] ----------

Independent variables:

Governance mechanism: we categorized the CDCs between OEMs and suppliers into three types: Joint ventures, co-development agreements, and technology licensing contracts (Oxley 1997).

Functional capabilities: we followed prior studies to measure firm capabilities using Stochastic Frontier (SF) estimations (Dutta et al.,1999; Narasimhan et al., 2006). Details of our estimation procedures and results are in Web Appendix (A). For *MCAPs*, we used sales revenue as an output, and the inputs are current year advertising expenditures, advertising stock, current year marketing expenditures, stock of marketing expenditures, investments in customer relationships, and installed customer base. For *TCAPs*, we considered patent counts as a technological output and the inputs are patent stock, current R&D expense, and accumulated R&D expenses from previous years. We also measure OCAP, later used as a control variable, estimating a cost function to minimize the cost of goods sold as the output, using three inputs: cost of labor, output, and cost of capital.

Product positioning strategy: for this, we draw inspiration from earlier studies (e.g., Mintzberg 1987; Banker et al. 2014) that draw a difference between intended strategy (i.e., strategy seen as an intended course of action) and realized strategy (i.e., strategy reflected by actual actions resulting from the firm's decisions). While the intended strategy can be captured through perceptual measures of the survey method, the the realized strategy cannot be easily inferred without direct observations of the firm's actions, in particular how it deploys and prioritizes its resources. Since it is the realized strategic actions that have a direct bearing on the firm's realized outcomes, it is important to try and capture that in any empirical test relating strategy to outcomes. Albeit not as direct a measure as observation can be, financial data reported by the firm in its annual reports can help us infer its realized strategy (*cf.* Banker et al. 2014). The idea behind this measurement approach is that a firm would likely dedicate more resources to the activities that are essential to the deployment of its strategy, and these investments would be reflected in its financial statements. At its core, a differentiation-focused strategy is mainly centered on deploying idiosyncratic innovations and unique marketing efforts to create "unique" value for customers that is difficult to be imitated. On the other hand, an efficiency-

[6] Since developing and launching a new product usually takes longer time than filing a patent, we measured the new product announcement indicator within a four-year period to account for this fact. This follows Sampson (2004b) who also utilized the four-year window to measure innovation performance of high-tech companies in a similar context.
[7] We thank the review team for pointing out the challenges that poses for our empirical specifications.

focused strategy emphasizes the efficient use of firm resources to gain competitive advantage. Differentiation is the most directly relevant strategic posture in our context of product innovation. However, as argued by Hambric (1983), who uses similar measures as ours, the two strategic orientations of differentiation and efficiency are not mutually exclusive, and a firm can effectively implement them both simultaneously. Therefore, it is important to examine their joint impact in our model, and we control for efficiency in our analyses.

Following Banker et al.'s (2014) measurement approach, who argue that a firm adopting a differentiation strategy would invest more in R&D and marketing activities, we pose the following ratios as indicators for *differentiation strategy* – "Selling, General, and Administrative (SGA) expenditures/Sales", "R&D expenses/Sales", and "Sales/Cost of Goods Sold (COGS)". Similarly, following their argument that a firm adopting an efficiency strategy would make the most efficient use of its resources to generate revenue and use as few assets as possible per unit of output, we pose the following as indicators for *efficiency strategy* – "Sales/Total assets" and "Sales/Capital expenditures."[8] For each of these five ratios, we took its mean over five years to capture the long-term nature of the strategic orientation of an OEM. An exploratory factor analysis (EFA) of the five ratios confirms the reliability and a confirmatory factor analysis (CFA) attested to the validity of these measures. We then used the factor loadings of each ratio to compute a factor score for each factor. Our measures for the strategies are the respective standardized factor scores (see Web Appendix B for more details).

While we follow Banker et al. (2014) to compute them, these measures have potential limitations. For example, Sales/COGS, may also be seen as part of the efficiency strategy (lowering costs will increase the ratio), and current assets like accounts receivables in Total Assets may be seen as deviating from the spirit of efficiency (accounts receivables are sales but bias the Sales/Total Assets ratio downwards). So, for further validation, we test two alternate measures. For the first, we replace Sales/Total Assets with Sales/P&E (Plant and Equipment); and for the next, we drop Sales/COGS. In both cases, the ratios load as expected on the factors, and our key results remain unchanged. We take this as vindications of the robustness of our measures and results (details in Web Appendix F).

Control variables:

We measure several OEM-specific, supplier-related, and alliance-related variables that might have an impact on Innov-Perf, as controls. Specifically, the *year* in which the CDC was formed; the *high-tech industry* at which the OEM operates, the OEM's *operations capabilities*; the OEM's *nationality*; the OEM's *age* on the date of partnering; whether the OEM had prior *experience* with similar collaborations; the *scope of the CDC* (i.e., whether the CDC was limited to R&D or also included marketing and/or manufacturing as well); whether the CDC was a *domestic* alliance or included cross-border partners; the *supplier's patents* as a proxy of partner innovativeness; and the *market overlap* between partners.

Tables (5) and (6) present the descriptive statistics and correlations between our variables. On average, the computer hardware and software sector achieved the highest average number of patents, citations, and New Product Announcements (NPAs) of 1012, 25610, and 60; respectively. While the biotech sector scored the lowest average patent counts and citations of 52 and 1053; respectively. The medical equipment sector had the lowest average number of NPAs of just 2. However, it formed more JVs

[8] We follow Hambric's (1983) terminology of labeling the second set of ratios as indicators of a firm's efficiency-focus. Banker et al. (2014) uses the same ratios but labeled it "cost leadership". We thank an anonymous reviewer for pointing out the challenges that come with the latter.

(35% of the sector) than the other sectors. While the electronics firms tended to utilize agreements more (70% of the sector) than the others. The biotech sector had the highest percentage of licenses at about 47%. In addition, differentiation strategy was most prominent for biotech firms, while cost-leadership strategy was most prominent for medical equipment firms. We also assessed multicollinearity between our variables by running Variance Inflation Factor (VIF) tests using a log-transformed version of our models. Results are reported in Web Appendix (G).

---------- [Tables (5) & (6) are about here] ----------

Model Specification and Estimation

Our basic approach to estimating our hypothesized effects is to model the impact of governance, capabilities, and strategy, and their interactions on Innov-Perf. We take a stepwise approach to this by estimating the following four equations:

$$\boldsymbol{P_i} = \beta_0 + \beta_1 Gov_i + (\beta_2 : \beta_{11}) Controls_i + \epsilon_{i1} \qquad \textbf{(1)}$$

$$\boldsymbol{P_i} = \gamma_0 + \gamma_1 Mcap_i + \gamma_2 Tcap_i + (\gamma_3 : \gamma_{12}) Controls_i + \epsilon_{i2} \qquad \textbf{(2)}$$

$$\boldsymbol{P_i} = \delta_0 + \delta_1 Gov_i + \delta_2 Mcap_i + \delta_3 Tcap_i + \delta_4 Gov_i * Mcap_i + \delta_5 Gov_i * Tcap_i + (\delta_6 : \delta_{16}) Controls_i + \epsilon_{i3} \textbf{(3)}$$

$$\boldsymbol{P_i} = \theta_0 + \theta_1 Gov_i + \theta_2 Mcap_i + \theta_3 Tcap_i + \theta_4 Diff_i + \theta_5 Gov_i * Mcap_i + \theta_6 Gov_i * Tcap_i + \theta_7 Gov_i * Mcap_i * Diff_i + \theta_8 Gov_i * Tcap_i * Diff_i + +(\theta_9 : \theta_{24}) Controls_i + \epsilon_{i4} \textbf{(4)}$$

where P_i is the innovation performance indicator (i.e., citations and NPAs, and thus, we ran each of these four models twice using one performance indicator each time),[9] Gov_i is the governance mechanism implemented by OEM (i), $Mcap_i$ marketing capabilities of OEM (i), $Tcap_i$ technological capabilities of OEM(i), $Diff_i$ differentiation strategy for OEM(i), $Controls_i$ are control variables, and $\epsilon_{i(.)}$ are the random error terms. The complete list of variables is in Table (4).

Generalized linear model (GLM):

Since our dependent variables are counts, we used the Generalized Linear Models (GLM) for our estimations, assuming a negative binomial distribution (Nelder & Wedderburn, 1972).[10]

Clustered standard errors:

Our sample covered the period 1985-2016 and an OEM may have multiple CDCs with suppliers in that period. Therefore, we estimate our models using the cluster-robust standard errors, which allows errors within individual clusters (i.e., OEMs) to be correlated while keeping errors across clusters independent (Cameron & Trivedi 2010, p. 313).

Endogeneity: Mixed approach - Gaussian copula and two-stage residual inclusion:

[9] We also run seemingly unrelated regressions (SUR) estimating the dependent variables simultaneously. While our results are consistent, we had to use a log-transformed version of the models to implement this, losing several observations with zero counts, neutralizing some of the potential efficiency gains. Web Appendix (H) has more details.
[10] Web Appendix (C) explains our approach for analyzing count data. We used the inbuilt routines in Stata.

There can be several sources of endogeneity in our specifications. Unobserved factors that may determine a firm's innovation outcomes may constrain its choice of marketing strategy. A firm could also adjust its strategy, based on the observed outcomes. These could make strategy potentially endogenous. Nevertheless, a firm's positioning strategy is a long-term commitment towards forming a specific image in the market which is not prone to frequent adjustments (Ghosh & John, 2005). So, the endogeneity in question here is more likely to be pertinent for more temporal tactical adjustments in the firm's marketing mix, which do not impact its core positioning. Further, we estimated positioning strategy using data over the five years *before* the collaboration year, ruling out any potential contemporaneous impact. So, positioning strategy is considered exogenous.

Reverse causality between the regressors and the dependent variable can also be a source of endogeneity. To rule out this, we measure Innov-Perf one year *after* the collaboration, while other regressors including governance and capabilities are measured *in the year* of collaboration.

Nevertheless, it is difficult to rule out all sources of endogeneity, especially for governance and capabilities. Several unobserved variables (e.g., management competency, idiosyncratic local market conditions etc.) could simultaneously impact choice of governance, investment in capabilities, and innovation performance, necessitating endogeneity corrections. Given the different types of these potentially endogenous variables, we used mixed methods (i.e., the Gaussian Copula and Two-Stage Residual Inclusion (2SRI) methods) to correct for such endogeneity.

First, we utilized the instrument-free *Gaussian Copula method* to correct for potential endogeneity in the continuous variables (functional capabilities). Park & Gupta's (2012) semi-parametric Copula method constructs the joint distribution of the endogenous variable and the error term from the individual marginal distributions. While this method assumes that the structural error term is normally distributed, the results have been shown to be robust to other distributions as well (Park and Gupta, 2021).[11] It also requires the distribution of the endogenous variable to be non-normal – our endogenous variables satisfy this condition, as the results of the Shapiro-Wilk normality test confirms that none of the functional capabilities are normally distributed (see Web Appendix D). Following Carson & Ghosh (2019), we estimated Copula terms for each of our endogenous capabilities variables using the following formula, $\mathrm{C}_v = \Phi^{-1}(\mathrm{H}(v))$, where C_v is the *Copula* term for an endogenous variable (v), Φ^{-1} is the inverse normal cumulative distribution function, H is the Kernel cumulative density function, and v is the endogenous regressor. Then, we added these terms as control variables to our models (3) and (4). This Control Function (CF) approach for endogeneity correction follows Rutz & Watson's (2019) recommendations for non-linear models.[12]

Second, we implemented another CF method to correct for potential endogeneity in our categorical variable, governance. We employed the *two-stage residual inclusion* (*2SRI*) method suggested by Terza et al. (2008) and Wooldridge (2015). This method depends on using a valid instrument that is correlated with the endogenous variable, but uncorrelated with the dependent variable. We used two Instrumental Variables (IVs) to estimate the first-stage model: cross-technology transfer and coefficient of variation in OEMs' sizes. *Cross-technology transfer* is a binary variable indicating whether a CDC's deal included an agreement between the partners to exchange technology. Firms committed to

[11] Our estimation uses a negative binomial distribution. While Park and Gupta (2012) assume normal distribution of the error term, their simulations also demonstrate that Gaussian Copula is robust against misspecifications in its true distribution; thus, suggesting robustness of the results in models such as ours.

[12] Wooldridge (2015, p. 420) defines a control function as "a variable that, when added to a regression, renders a policy variable appropriately exogenous."

this are more likely to make specific investments to facilitate the technology transfer process. After assimilating and internalizing the acquired technology, the switching costs would be high and thus each partner would be more likely to avoid opportunistic actions. This might affect the choice of the governance mechanism, but it should have no impact on Innov-Perf of an OEM. *Coefficient of Variation in OEM size* (CV_size) is calculated from their total assets. A firm's size dispersion from rivals might drive the choice of a particular collaboration form. Smaller firms might prefer to form JVs to gain more assets and be competitive in their markets. On the other hand, larger firms might have strong bargaining power that makes market-like contracts more appealing to them. Yet, this size dispersion should not affect Innov-Perf of a firm.

We implement the 2SRI method in three stages. (a) We ran a first-stage multinomial logistic regression model for governance using our two instruments along with all other regressors appearing in the right-hand side of Equation (3) and the Copula terms controlling for endogeneity in functional capabilities. (b) We estimated the predicted probabilities of this model and subtracted the observed values from it to get the residuals. (c) We then added the computed residual as an additional regressor to Equation (3). We repeated the steps for the three-way interaction model in Equation (4). Results of the first-stage multinomial logit models are in Web Appendix (D). After adding Copula terms and CFs, our adjusted models (3) and (4) are:

$$\boldsymbol{P_i} = \omega_0 + \omega_1 Gov_i + \omega_2 Mcap_i + \omega_3 Tcap_i + \omega_4 Gov_i * Mcap_i + \omega_5 Gov_i * Tcap_i + (\omega_6 : \omega_{16})\ Controls_i + \omega_{17} C_{Mcap\ i} + \omega_{18} C_{Tcap\ i} + \omega_{19} C_{Ocap\ i} + \omega_{20} Govhatcap_i + \epsilon_{i5} \quad \textbf{(5)}$$

$$\boldsymbol{P_i} = \eta_0 + \eta_1 Gov_i + \eta_2 Mcap_i + \eta_3 Tcap_i + \eta_4 Diff_i + \eta_5 Gov_i * Mcap_i + \eta_6 Gov_i * Tcap_i + \eta_7 Gov_i * Mcap_i * Diff_i + \eta_8 Gov_i * Tcap_i * Diff_i + (\eta_9 : \eta_{24})\ Controls_i + \eta_{25} C_{Mcap\ i} + \eta_{26} C_{Tcap\ i} + \eta_{27} C_{Ocap\ i} + \eta_{28} Govhatst_i + \epsilon_{i6} \quad \textbf{(6)}\ \#$$

Where $C_{Mcap\ i}$ is the Copula term for marketing capabilities, $C_{Tcap\ i}$ the Copula term for technological capabilities, $C_{Ocap\ i}$ the Copula term for operations capabilities, $Govhatcap_i$ the CF for the two-way model, and $Govhatst_i$ the CF for the three-way model.

Results

We present our estimations and results in four steps. First, we estimate equation (1) for each of Innov-Perf's indicator, including only the governance modes as regressors in addition to the control variables. Second, we estimate equation (2), including only the capabilities as regressors in addition to the control variables. Third, we estimate equations (3) and (5) with the two-way interactions between governance and capabilities added to the model. We estimate both the baseline GLM model (equation 3) without endogeneity corrections, and an adjusted GLM model (equation 5) with the endogeneity corrections. Fourth, we estimate equations (4) and (6) with the three-way interactions included, estimating both the baseline (equation 4) as well as the adjusted GLM (equation 6) that includes the endogeneity corrections. We summarize the results of the first two phases here and present detailed results in the appendix (Web Appendix E). Our results pertaining to the contingent effects are presented in Tables (7) and (8).

Results of direct impact of CDC governance modes and functional capabilities:

In our first estimation we find that the aggregate marginal impacts of all governance modes are significantly positive. Each unit increase in JVs, agreements, and licenses are associated with increase in the number of citations by about 4905, 8076 and 7321, respectively. Agreements are associated with 30% higher New Product Announcements (NPAs) than licenses, and no significant differences between agreements and JVs. In our second estimation we find both MCAP and TCAP are positively associated with Innov-Perf. A 1% increase in MCAPs is associated with a 4.9% and 3.9% increase in citations and NPAs, respectively. Similarly, a 1% increase in TCAPs is associated with a 5.7% and 1.6% increase in citations and NPAs, respectively (detailed results in Web Appendix E).

In Figure (2) – panel (A), we plot the predicted Innov-Perf values based on the estimated coefficients of equation (2) calculated at the means of all other variables. Notice the positive slopes of MCAPs and TCAPs for the two indicators. Citations are higher for firms with high levels of TCAPs, while NPAs seem to be higher for firms with high levels of MCAPs.

---------- [Figure (2) is about here] ----------

Results of two-way Interactions – Capabilities X Governance:

Next, we estimate governance and capabilities simultaneously, and their relationship with Innov-Perf to test H1 and H2 – see Table (7). Our baseline model in panel (d) shows that agreements are associated with higher Innov-Perf than JVs. While there is no support for it in the adjusted model in panel (e). We also find support for the positive relationships between each of MCAPs and TCAPs and Innov-Perf once again in both the baseline and adjusted models. Table (7) also illustrates the two-way interaction effects of governance and capabilities.

The baseline model confirms that JVs are associated with the highest Innov-Perf for firms with strong MCAPs. For example, the baseline model shows that for JVs, a one percent increase in MCAPs is associated with 7.5% more citations and 10.2% more NPAs over that of agreements, and 9.7% more NPAs over that of licenses. While the adjusted model conveys that for JVs, a one percent increase in MCAPs is associated with 9.8% more citations and 9.3% more NPAs over agreements, it also has a more positive, but not significant, relationship over licenses. These results offer *partial* support for *H1* which suggests that for firms with high MCAPs, JVs are associated with higher Innov-Perf than both agreements and licenses. While the baseline model coefficients are largely insignificant for the interactions with TCAPs, after correcting for endogeneity, the adjusted model returns several significant coefficients. In particular, we find that a one percent increase in TCAPs for agreements is associated with 6.4% and 2.9% more citations over JVs and licenses, respectively. Thus, we *reject* H2, with agreements being associated with higher Innov-Perf over both JVs and licenses, for firms with stronger TCAPs. We speculate that in spite the fact that firms with higher technological capabilities may face similar types of trading hazards associated with marketing capabilities, strong technological capabilities of the type alluded in our discussions preceding H4, might enable firms to leverage their superior technological expertise to mitigate such hazards.

---------- [Table (7) is about here] ----------

To illustrate the results, in Figure (2) – panel (B), we plot the predicted number of citations against the capabilities at the mean of other variables, for different governance modes, based on estimations of equation (5). Observe that at high values of MCAPs, JVs generate higher citations than agreements and licenses. In contrast, notice that for firms with higher TCAPs, agreements generate higher citations than other modes.

Results of three-way interactions – Capabilities X Governance X Strategy

Finally, we include the three-way interactions of governance, capabilities, and strategy to test H3 and H4 – see Table (8). Interpretation of the three-way interactions are more involved. In H3, we hypothesized that for differentiation-oriented firms, *agreements would outperform JVs or licenses* at higher levels of MCAPs. The significant coefficients of JV x MCAP x Diff in panel (f) suggest that for JVs, each unit increase in MCAPs and differentiation is associated with 9.3% and 9.1% fewer citations and NPAs, respectively. In contrast, looking at the coefficients for Agreement x MCAP x Diff, under the same conditions, *for agreements*, it is associated with an *increase* of 9.6% in citations (and no significant results for NPAs). In comparison, the coefficient for the License x MCAP x Diff suggests that *for licenses*, the *increase* would be of the order of 7.8% for citations (not significant for NPAs). The corresponding coefficient in the endogeneity-adjusted model suggests, it is only for agreements that differentiation is associated with higher Innov-Perf of 7.8% more citations (no significance for others). We infer that these offer overall strong support for H3.

The results for the three-way interactions involving TCAPs *reject* the hypothesis in H4. In particular, the coefficients for License x TCAP x Diff show, in both the baseline and the endogeneity corrected model, that each unit increase in TCAPs, and differentiation is associated with less Innov-Perf (2.3% and 1.8% fewer citations). So, we speculate that beyond the need for flexibility, a high-differentiation strategy may invoke additional appropriation hazards for high-TCAPs firms. This could result from the need to develop product technologies that are highly specific to achieve differentiation. In arms-length CDCs like licenses, the hold-up problems that accompany innovation of high-TCAP firms may thus be magnified under a high-differentiation strategy. While high-TCAPs firms may effectively identify technologies for better product differentiation, contrary to our expectations, they may not be as effective in managing the significant hold-up problems that may arise here.

The above result offers an interesting foil to the results we observe with regard to H2. Strong TCAPs firms would be better at qualifying partners, their associated technology complement, as well deploy their superior knowledge and technology absorption to achieve higher value creation and lower transaction hazards (Berchicci 2013). Ceteris paribus, this allows the firm to seek the greater efficiencies of bureaucratic costs in more arms-length modes of agreements or licenses compared to JVs (*cf.* Houston & Johnson 2000). However, the superior absorptive capacity that support enhanced organizational learning and knowledge development offers both the ability and the incentive to develop product technologies that may be highly specific and thus open to appropriation hazards, muting the desirability of arms-length CDC modes. This contingent impact is the crux of our paper.

Among interactions not hypothesized, we find that for efficiency-oriented firms, both JVs and agreements are associated with less citations and NPAs at higher levels of MCAPs, and at higher levels of TCAPs, JVs are associated with higher NPAs. While agreements are associated with less NPAs, and JVs are associated with higher citations at higher levels of operations capabilities.

The other results offer deeper insights into our earlier results. While the baseline model, in panel (f), shows that agreements generate higher Innov-Perf than JVs and licenses, the adjusted model shows no significant differences among the impacts of the governance modes. This highlights the contingent efficiency of the governance modes, which is a central plank of our theory.

Both the baseline and the adjusted models confirmed the positive relationships between each of MCAPs and TCAPs and Innov-Perf, however these relationships are insignificant in the adjusted model. The two-way interactions between governance and capabilities are generally consistent with our observations earlier, albeit to a lesser degree. For example, the JV x MCAP coefficient is significant only for citations in the baseline model, such that for JVs, a one percent increase in MCAPs is associated with an increase of 1.3% in citations over that of agreements, the other results being non-significant. While the relevant interaction terms are not significant in the baseline model, the TCAPs interaction terms in the endogeneity-adjusted model show that with increasing TCAPs, agreements are associated with 8.5% more citations than JVs. However, the difference is not significant with respect to licenses.

---------- [Table (8) about here] ----------

To illustrate the three-way interactions, in Figure (2) – panel (C) we plot the predicted Innov-Perf indicator, calculated using the estimated coefficients of equation (6), against the capabilities for each governance mode, once each for high and low values of the firm's positioning strategy (based on a median split of the strategy measures).[13] The predictions are calculated at the mean of the other variables. We only plot some of the significant results. In the first row, notice that both agreements and licenses result in higher citations for high-differentiation-oriented firms with high levels of MCAPs. However, for low-differentiation-oriented firms that is no more the case, and agreements are dominated by JVs. JVs are also associated with higher NPAs for high-efficiency-oriented firms with strong TCAPs. Notice that the advantage of JVs over the other forms does not hold for low-efficiency-oriented firms as agreements dominate at high levels of TCAPs. While these are consistent with our hypothesized effects, the broader point is that the fit of strategy, capabilities, and governance modes enhances the firm's innovation performance; conversely, misalignments bleed value. Thus, to claim any one form, e.g., JVs, would be secularly more effective, would be wrong.

Discussions

At the core of any strategic decision taken by firms are the presumed value generated from the implementation of the decision and the presumed costs to be incurred in the process. To the extent innovation co-developments are seen as contributing to the firm's broader marketing strategy, one dominant managerial concern should be whether any strategy dividend will be sustained by such contracts. The strategy dividend can be whittled away by the transaction costs of misaligned contracts, as well as misaligned sunk costs in functional capabilities. So, "fit" between the firm's strategic positioning, its functional capabilities, *and* the co-development governance modes is critical. To that end, one of the key contributions of our results is that they help calibrate the costs of misalignments and thus offer an evidentiary base to decision making for innovation collaborations with suppliers.

Consider, for example, industry observations that JV partnerships can help firms navigate economic downturns (Bamford et al. 2020). Economic downturns impose a need for cost efficiencies, and JVs can help achieve that through the more integrated equity participation involved. Yet, as our hypotheses and results show, this economic dividend can only be realized when firms have high levels of technological capabilities. We estimate, for firms with similar efficiency orientations, technological capabilities are associated with an increase of 5.2% in new products announcements for JVs, but not for licensing and agreements. On the other hand, estimates show that strong marketing capabilities in the same situation are associated with a 17.9% *decrease* in citations for JVs. Nevertheless, marketing capabilities seem to be more benign for agreements in high differentiation-oriented firms. For such

[13] We use the log of the performance indicators to better capture the differences in our plots.

firms, marketing capabilities are associated with an increase of 7.8% in agreements. Indeed, going back to Porter (1980), while marketing capabilities can be seen as vital for implementing a differentiation strategy, they may be incongruent with cost leadership, an efficiency orientation. Thus, one of our central themes is, the idea of fit in co-developments collaborations comes with underlying notions of misalignment costs which need to be recognized.[14]

In mapping these bases of misalignment, we draw on a more granular spectrum of contractual arrangements in the domain, building on studies like Noordhoff et al. (2011) that studied binary relational versus transactional modes of collaborations. In a similar vein, we also use the spectrum of functional capabilities in our model. While their critical roles in driving firm performance is recognized, they have rarely been studied together in the context of innovation co-developments. In this, we complement studies, such as Fang et al. (2015), that do. An underlying rationale for studying the spectrum of capabilities is the idea that the payoffs from these capabilities are not immutable. Some of these payoffs can be lost at higher levels, further underscoring their misalignment costs. Nevertheless, there are resources vested in these capabilities, and at high levels, firms would be driven to safeguard them by aligning their contracts, balancing safeguarding needs with the value to be gleaned from the collaboration type – JVs for high marketing capabilities and agreements for high technological capabilities.

Perhaps our signature contribution to mapping the bases of misalignment in innovation collaborations is in highlighting the keystone role of the firm's positioning strategy. By itself this should not be surprising, for strategy frames how a firm deploys its resources and focuses its energies. So, a misalignment will naturally manifest in deadweight losses, perhaps one that will emerge over time. What is surprising however, is the near absence of studying the role of strategy in effectiveness of innovation collaborations. So, by considering the firm's positioning strategy, we build a distinct dimension of fit and misalignment, that had been missing in the innovation co-development literature. In this, we borrow from and offer further validation of the governance value approach that frames misalignments as the net of transactional (in)efficiency and the strategy dividend (Ghosh & John 1999). As the empirical results bear out, this is for good measure – misalignment between contracts, capabilities, and strategy significantly erodes innovation outcomes.

Managerial Implications

We offer three key managerial takeaways. *First*, our findings identify the appropriate co-development arrangements for superior innovation performance, given existing firm capabilities and positioning strategy. This minimizes misalignment costs while easing the process of generating and sharing value. So, as firms focus on motivating partners to share know-how and expertise and facilitating efficient knowledge transfers, they must also pay attention to protecting the firm's valuable knowledge and skills from opportunistic appropriation and ensure effective use of its deployed resources, for better innovation outcomes. *Second*, our results provide guidance for building the "right" functional capability to yield the most benefit from innovation collaborations. For instance, we suggest that a firm needs to invest in building marketing capabilities if it is driven by high differentiation and considering more arms-length arrangements such as agreements with suppliers. In contrast, our results suggest firms driven by efficiency considerations are better off developing their technological capabilities when considering a joint venture. *Third*, our results warn against blindly copying the practices of other firms,

[14] We focus on the three "top level" CDC forms, but note that microstructures within each form can also vary (e.g. Heide and John 1990 and Oxley 1999 study variations within agreements and JVs), and map to varying misalignment costs.

regardless of the appearance of "industry best practices". Particularly, we find that considering the firm's positioning strategy along with its capabilities is crucial to designing effective contracts. Thus, blanket prescriptions for one or the other types of contracts (e.g., joint ventures during downturns) may be misdirected.

Limitations and Further Research

Perhaps one of the key substantive limitations of our study is it maps variations across the spectrum of formal contracting but does not consider the relational modes of collaborations. We call for future research in this area given the long history of studies on the role of relational governance for collaboration outcomes (Poppo & Zenger 2002). Future studies should also investigate frameworks that differentiate between different innovation outcomes (e.g., patents, citations, NPAs) – our framework does not have that level of granularity. Similarly, we call for studying other conceptualizations of strategies, beyond the generic strategy of product differentiation that we study. We believe that will help map a greater spectrum of misalignment costs. A key data limitation is that we only consider OEM-side data. While we control for supplier innovativeness and market overlap between partners, more research with dyadic data will be worthwhile, allowing for investigating the role of suppliers' capabilities and how that may complement the focal firm's capabilities in identifying the "right" CDC form for better mutual outcomes. Another key data limitation of our study is that our analyses lack key transaction attributes. We use proxies for some attributes (e.g., use cross-technology transfer as a proxy for asset specificity in the first stage of the governance model, and control for the year of collaboration to capture some of the economic uncertainty), but lack more explicit measures. We call for future research with more granular transaction-level data such as: (a) the specific assets invested by each partner to facilitate the exchange and deployment of knowledge and technologies, (b) the technological uncertainty pertaining to the acquired technologies and their related problems of *ex-ante* considerations of value and performance, and (c) the previous ties between the collaboration's partners. We also hope future research will improve upon our estimations, in particular in finding efficient ways of using non-linear simultaneous equations with multiple innovation outcomes, for models with a mix of count, categorical, and continuous variables.

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Table (1): Selected Marketing Studies on Product Co-development Collaborations and Performance.

Study- Journal	Research objective(s)	Theoretical lens	Empirical context/ Methods	Key findings
Bouncken et al. (2016) – IMM*	Examine the effect of singular (transactional or relational) vs. plural (transactional and relational) governance on product innovation in coopetition alliances.	Research on interfirm governance.	The European Medical device industry/ Survey.	Utilizing singular transactional governance can hurt product innovativeness in vertical alliances with high levels of coopetition. In contrast, a singular relational governance would enhance innovation performance in these partnerships. Moreover, complementing relational governance with transactional governance might improve innovation even more.
Chakravarty et al. (2020) - JM	Study the impact of network (direct and indirect) asymmetry between the focal firm and its partner on the focal firm's abnormal returns and idiosyncratic risk with highlighting the moderating role of innovation quality and total interdependence between the partners.	Prior studies on alliances and interfirm relationships.	The biopharmaceutical industry/ Archival method.	Direct tie asymmetry has an inverted U-shaped relationship with the abnormal returns of the firm. Whereas each of direct and indirect tie asymmetry has a U-shaped relationship with its risk. These curvilinear relationships are flattened by the firm's innovation quality and total interdependence between the focal firm and its partner.
Fang (2008) - JM	Investigate the effect of customer participation on new product outcomes with moderating each of downstream customer network connectivity, and new product development process interdependence and complexity.	Social network theory.	General machinery, electrical & electronic machinery, and transportation equipment industries/ Survey.	Customer participation as an information source increases new product speed to market when downstream customer network connectivity is high. While customer participation as a codeveloper enhances speed to market (but hurt innovativeness) when process interdependence is low.
Fang et al. (2008) - JAMS	Explore the impact of customer participation in new product development processes on creating and appropriating value of the new product.	The institutional arrangements, dependence, and equity perspectives.	Machinery and transportation equipment industries/ Survey	Customer participation has a positive impact on both information sharing and coordination effectiveness and thus improves NPD processes. It also increases the level of specific assets invested by both the customer and supplier.
Fang et al. (2015) - JM	Study the impact of collaboration timing on the market value of the partnering firms with moderating each of governance mechanism, technological capabilities, and market competitiveness.	Transaction Cost Economic.	The biotech and pharmaceutical industries/ Event study	Equity governance positively (negatively) moderates the impact of early-stage co-development on abnormal returns of the upstream (downstream) partner. Whereas technological capabilities of the upstream (downstream) partner negatively (positively) moderates the impact of early-stage co-development on its abnormal returns.
Harmancioglu et al. (2019) - JAMS	Examine the short- and long-term effects of forming an international co-development alliance on the market value of a firm.	TCE	Various industries/ Event study	International co-development alliances increase the abnormal returns of a firm in the short run, but this positive effect decreases overtime.
Lee (2011) - JM	Investigate how the alignment of contract terms of technological partnerships might impact the outcomes of collaborations to a firm.	Interfirm relationships literature.	Pharmaceutical industry/ Archival method	Firms that utilize more scale/nonequity (link/nonequity) terms in their knowledge-creating (knowledge-appropriating) relationship portfolio experience a higher number of radical new products.

Study- Journal	Research objective(s)	Theoretical lens	Empirical context/ Methods	Key findings
Li et al. (2022) - IMM	Study the impact of black-box supplier involvement on the supplier's contribution to a buyer's innovation through the relationship benefits perceived by the supplier.	The stimulus-organism-response theory & the motivation-opportunity-ability framework.	Chinese companies/ Survey	The black-box supplier involvement impacts the supplier's contribution to innovation only when the supplier perceive relationship benefits from the collaboration.
Markovic et al. (2020) - IMM	Compare the impact of collaborating with competitors to partnering with suppliers on firm innovation.	The knowledge-based view.	Spanish firms in various industries/ Survey.	Both suppliers and competitors contribute almost equally to enhancing service innovation. However, if a firm embraces product innovation, collaborating with competitors, as compared to suppliers, generates higher service innovation.
Noordhoff et al. (2011) - JM	Examine the positive and negative sides of embedded ties between partners in B2B innovation partnerships	Research on joint innovation activities.	Dutch industries/ Survey.	Embedded ties per se have no impact on supplier innovation. However, when they interact with customer innovation knowledge, they would have positive or negative effects conditional on certain relational and governance variables.
Rindfleisch & Moorman (2001) - JM	Investigate the roles of relational embeddedness and knowledge redundancy in facilitating/hindering the acquisition and utilization of information in new product alliances.	Social network theory.	U.S companies /Survey.	Vertical alliances have higher (lower) levels of relational embeddedness (knowledge redundancy) than horizontal alliances. In addition, relational embeddedness facilitates both the acquisition and utilization of information in alliances, while knowledge redundancy hinders information acquisition but improves information utilization.
Sivakumar et al. (2011) - JAMS	Study the impact of alliance expertise (alliance experience and partners diversity) and governance modes (horizontal vs. vertical and JVs vs. others) on global innovation generation and financial performance the focal firm.	TCE & the resource-based view.	U.S. pharmaceutical Companies/ Archival method.	Alliance experience (partner diversity) has positive (negative) impact on global innovation generation. JVs, as compared to other governance modes, are associated with more global innovation generation. Global innovation generation has an inverted U-shaped relationship with financial performance.
Wuyts et al. (2004) - JM	Examine the effect of the characteristics (i.e., technological diversity and repeated partnering) of a portfolio of R&D collaborations on radical and incremental innovation, and firm profitability.	Research on interfirm cooperation.	The pharmaceutical industry/ Archival method.	Technological diversity has a positive impact on both radical and incremental innovation, but it hurts profitability. While repeated partnering enhances radical innovation, has no significant impact on incremental innovation, and has an inverted U-shaped impact on profitability.
This study	Investigate supplier collaboration effectiveness by examining how an OEM's innovation performance is determined by the fit among its positioning strategy, functional capabilities, and the collaboration form it chooses to govern its partnership with suppliers.	Governance Value Analysis.	High-tech Companies/ Archival method.	Misalignment among the spectrum of contractual arrangements, functional capabilities, and the OEM's relevant positioning strategy is associated with less patent citations and new product announcements.

* IMM: Industrial Marketing Management JM: Journal of Marketing JAMS: Journal of The Academy of Marketing Science

Table (2): Benefits and Costs of Formal Governance Mechanisms of CDCs.

Governance	Definition	Advantages/ Major Benefits	Disadvantages/ Major Costs
Equity Joint Ventures *(JVs)*	A form of interfirm collaboration in which two or more firms agree to jointly create and own a separate legal entity to carry out a common goal. It is a "quasi-hierarchical" form of partnership.	▪ Attenuate opportunism through incentives alignment (Oxley, 1999; Houston & Johnson, 2000) ▪ Intensive interaction and higher coordination (Sampson, 2004b). ▪ Facilitate mutual knowledge flow (Keil et al., 2008). ▪ Increase partners' motives to share knowledge and technological resources and to make specific investments (Sampson, 2004a). ▪ Low monitoring costs (Oxley, 1999).	▪ Relatively very high formation costs (Sampson, 2004a). ▪ High bureaucracy level (Sampson, 2004a). ▪ Longer decision-making process (Sampson, 2004b). ▪ High termination costs and complicated process (Oxley, 1999). ▪ Lower power incentives to partners (Oxley, 1999).
Joint Development Agreements *(Agreements)*	A form of interfirm collaboration in which two or more firms agree to combine their resources to achieve the desired goal without establishing an independent entity.	▪ Attenuate opportunism through mutual hostage (Oxley, 1997). ▪ Facilitate mutual knowledge flow (Oxley, 1997). ▪ Coordination and interaction between partners (Lane & Lubatkin, 1998). ▪ Decentralized decision-making process (Sampson, 2004b).	▪ Relatively high formation and negotiation costs (Sampson, 2004a). ▪ Higher risk of opportunism than JVs (Oxley, 1997).
Technology Licensing Contracts *(Licenses)*	A form of interfirm collaboration in which one firm (i.e., the licensor) gives another firm (i.e., the licensee) the right to utilize its technology in return for a sum of money and/or royalty fees.	▪ Relatively low formation and negotiation costs (Sampson, 2004a). ▪ Lower termination costs (Hagedroon & Hesen, 2007). ▪ High-powered incentives to partners (Oxley, 1999). ▪ Decentralized decision-making process (Sampson, 2004b). ▪ Licensor knowledge and expertise.	▪ Difficult to adequately specify the value of the technology *ex-ante* (Oxley, 1997). ▪ High opportunism risk (Oxley, 1997). ▪ High monitoring and adaptation costs (Oxley, 1999). ▪ Limited interaction/ passive learning (Lane & Lubatkin, 1998).

Table (3): Definitions and Construct Details of Functional Capabilities:

Capability	Definition	Operationalization	Measure	Impact on Innovation	Sample References
Marketing	The ability of a firm to sense and understand customer needs and wants better than rivals, and to deploy its marketing-based resources (e.g., ad expenditures and customer relationships) efficiently to satisfy these requirements ahead of competitors.	An OEM's ability to convert its marketing resources into sales revenue.	A stochastic frontier model for: Sales= f (ad stock, stock of marketing exp., investments in customer relationships, customer installed base).	- Strong market orientation (MO), a substantial source of innovative ideas. - Continuous sensing of market trends, opportunities, threats, and emerging technologies motivate innovation. - Help identify the potential needs of new markets and direct innovation to satisfy them. - Enable forecasting potential returns to investments of innovation projects and thus allocate resources effectively among them.	Dutta et al. (1999); Day (1994); Krasnikov & Jayachandran (2008); Mariadoss et al. (2011); Nath et al. (2010); and Zang & Li (2017).
Technological	The ability of a firm to deploy its technological resources (e.g., R&D expenditures) in innovating new products and processes.	An OEM's ability to convert its technological resources into innovation.	A stochastic frontier model for: Technological output= f (Tech. base, cumulative R&D exp.)	- Enable firms to utilize various technologies to innovate new products and processes. - Important source of absorptive capacity that helps firms to identify and evaluate knowledge and technologies from external sources & acquire, assimilate, and integrate these external resources into their internal innovation processes	Dutta et al. (1999); Moorman & Slotegraaf, (1999); Narasimhan et al. (2006); Saboo et al. (2017); Sarkees et al., (2014); and Zhou & Wu, (2010).
Operations	The ability of a firm to integrate and coordinate a complex set of activities to enhance its output through the most efficient use of its production processes, technologies, and flow of knowledge and materials.	An OEM's efficiency in generating outputs with minimum costs.	A stochastic frontier model for: Cost of production = f (output, cost of capital, labor cost)	- Cost-reduction systems such as TQM, and six sigma help in significantly cutting product development time, freeing-up valuable resources, and generating returns to be reinvested in innovating new products. - Early supplier involvement bring in new knowledge supporting the innovation activities. - Commitment to continuous improvement means that employees are trained to think critically to solve problems and to utilize diverse tools and techniques to improve their performance, creating an organizational culture of innovation	Dutta et al. (1999); Lizarelli et al. (2021); Nath et al. (2010); Saboo et al. (2017); Sarkees & Hulland (2009); and Tan et al. (2007)

Table (4): Measurements of Research Variables.

Variable	Abbreviation/ Symbol	Measurement/ Indicators	Reference(s)	Data Sources
Innovation performance	Innov-Perf/ P_i	Patent *citations* & new product announcement (*NPAs*).	Hagedoorn & Cloodt, (2003); Zhang et al. (2010)	USPTO & ABI/Inform
Governance mechanism	Gov_i	A categorical variable valued 0 if the CDC was a *JV*, 1 if it was an *Agreement*, and 2 if it was a *License*.	Oxley (1997)	SDC Platinum.
Marketing capabilities	$Mcap_i$	A stochastic frontier (SF) model for: Sales= f (ad stock, stock of marketing exp., investments in customer relationships, installed base).	Dutta et al. (1999); Narasimhan et al. (2006)	Compustat, Thomson one, Factiva, Mergent online, & annual reports of OEMs.
Technological capabilities	$Tcap_i$	An SF model for: Technological output= f (technological base, cumulative R&D exp.)		
Differentiation strategy	$Diff_i$	A factor score of: (SGA exp./Sales); (R&D exp./Sales); & (Sales/COGS) ratios.	Banker et al. (2014).	
Efficiency strategy	Eff_i	A factor score of: (Sales/Capital exp.); & (Sales/Total Assets) ratios.		
Control Variables:	$Controls_i$			SDC Platinum
Collaboration year	$year_t$	A categorical variable of five levels that sorted years into five eras.	Bouncken et al. (2020)	
High-tech industry	ind_i	A categorical variable for the five high-tech sectors.	Bouncken et al. (2020)	
OEM's nationality	$usoem_i$	A dummy variable of whether the headquarter of an OEM is in US.	Lee (2011)	
Prior experience	$exper_i$	A dummy variable of whether an OEM had formed CDCs before the focal one.	Oxley (1997); Sampson (2005)	
Scope of CDC	$scope_i$	A dummy variable of whether a CDC was limited to R&D activities, or it included additional activities like marketing and/or manufacturing.	Sampson (2004b); Cui & O'Connor (2012)	
Domestic CDC	dom_i	A dummy variable of whether a CDC's partners have same nationality.	Sampson (2004b)	
OEM's age	age_i	The number of years between an OEM's foundation date and its CDC's formation date.	Bouncken et al., (2016)	SDC Platinum, Compustat, Thomson one, Factiva, & or Mergent online.
Market overlap	$sameind_i$	A dummy variable of whether an OEM and its supplier operated in the same industry.	Oxley (1997); Li et al., (2010)	
Operations capabilities	$Ocap_i$	An SF model for: Cost of production = f (output, cost of capital, labor cost)	Dutta et al. (1999); Narasimhan et al. (2006)	
Supplier's patents	$suppat_i$	A count variable of the total number of patents of an OEM's supplier.	Sampson (2007)	USPTO database
Gaussian Copula terms:	Copula	Variables generated using an instrument-free method to correct for potential endogeneity in continuous variables.	Park & Gupta (2012)	Generated using our observed variables
Copula for MCAP	$C_{Mcap\ i}$	$C_{Mcap\ i} = \Phi^{-1}(\mathrm{H}(MCAP))$		
Copula for TCAP	$C_{Tcap\ i}$	$C_{Tcap\ i} = \Phi^{-1}(\mathrm{H}(TCAP))$		
Copula for OCAP	$C_{Ocap\ i}$	$C_{Ocap\ i} = \Phi^{-1}(\mathrm{H}(OCAP))$		
Control function:	CF	A first-stage residual used to correct for potential endogeneity in categorical variables.	Terza et al., (2008); Wooldridge (2015)	Calculated based on multinomial logit estimation
Control function for equation 3	$Govhatcap_i$	Residual of a multinomial logit model of governance on all the other regressors of equation (3).		
Control function for equation 4	$Govhatst_i$	Residual of a multinomial logit model of governance on all the other regressors of equation (4).		

Table (5): Correlation Matrix and Descriptive Statistics.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**
(1) Patents	1.00																	
(2) Citations	.53*	1.00																
(3) NPAs	.02	.07	1.00															
(4) Governance	.04	.05	.00	1.00														
(5) Mktg Cap.	.09	.15*	.16*	-.05	1.00													
(6) Tech. Cap.	.16*	.26*	.11	.16*	-.09	1.00												
(7) Differentiat.	-.06	-.07	-.06	.18*	-.03	.00	1.00											
(8) Efficiency	-.05	-.19*	.08	.00	-.30*	.08	-.19*	1.00										
(9) Years	.24*	.10	.07	-.17*	-.08	-.18*	.09	.15*	1.00									
(10) Industry	-.02	-.10	-.05	.02	-.05	-.07	.19*	.23*	.10	1.00								
(11) Oper. Cap.	-.03	.00	-.09	-.08	-.03	-.21*	.16*	-.26*	-.10	-.07	1.00							
(12) US_OEM	-.04	.02	.09	.10	-.02	.01	.12	-.04	-.10	.14	-.16*	1.00						
(13) Experience	.26*	.49*	.43*	.08	.13	.15*	-.07	-.22*	-.02	-.12	.08	.03	1.00					
(14) Scope	-.01	.02	.08	.09	-.11	.04	.11	.13	-.05	.10	.11	-.03	-.12	1.00				
(15) Domestic	-.05	.00	.06	.24*	.01	.00	.12*	-.09	-.21*	.08	.00	.34*	.12	-.03	1.00			
(16) OEM_Age	.34*	.48*	-.14*	-.09	.15*	.10	-.24*	-.08	.11	.04	.13	-.26*	.21*	.05	-.08	1.00		
(17) Overlap	.01	.10	-.07	-.17*	.04	-.15*	.08	-.01	.25*	.01	.02	.05	-.10	.01	-.11	.04	1.00	
(18) Sup. Patent	.07	.11	.03	.00	.02	.11	-.05	-.01	.17*	-.09	-.14*	-.06	.08	.02	-.20*	.04	.15*	1.00
No. Obs.	202	202	202	202	202	189	202	202	202	202	202	202	202	202	202	202	202	202
Mean	564.6	18378.2	38.5	1.2	83.8	81.4	0	0	2.11	2.79	77.1	.89	.56	.61	.70	50.61	.46	133.7
Std. Dev.	1119.6	26391.7	57.3	0.61	10.2	15.7	1	1	.82	1.17	14.3	.32	.50	.49	.46	30.14	.50	333
Min	0	0	0	0	0	0	-1.01	-1.00	1	1	0	0	0	0	0	6	0	0
Max	8976	158418	285	2	100	100	8.63	6.36	5	5	100	1	1	1	1	109	1	1917

Significant at 95%

Table (6): Sample Characteristics by the High-Tech Sector.

(a) Patent and New Product Activity by Sector:

Sector	Obs.	Patents				Citations				NPAs			
		Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
1. Electronics	**41**	441.19	485.08	0	1911	15220.09	21353.17	0	114131	22.02	29.80	0	160
2. Telecomm.	**20**	471.55	583.19	0	1512	18157.95	22506.69	0	67193	31.90	37.42	1	140
3. Computr h&s/ware	**102**	1011.58	2431.10	0	21125	25610.24	30788.47	0	158418	60.09	69.48	0	285
4. Biotech & Pharm	**19**	52.05	80.46	0	306	1052.89	1472.32	0	5091	3.16	3.45	0	12
5. Medical equip	**20**	160.90	280.98	0	948	4648.75	7746.84	0	23768	2	1.95	0	5

(b) Governance Mechanisms and Strategy by Sector:

Sector	Obs.	*Governance Mechanisms*						*Strategy*							
		JVs		Agreements		Licenses		Differentiation				Efficiency			
		n	%	n	%	n	%	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
1. Electronics	**41**	6	14.6	29	70.7	6	14.6	-.39	0.36	-.91	.44	-.2	.66	-.96	2.55
2. Telecomm.	**20**	1	5	11	55	8	40	-.20	0.41	-.67	.70	.02	.93	-.67	2.94
3. Computr h&s/ware	**102**	5	4.9	69	67.6	28	27.5	.02	0.49	-1.01	2.12	-.12	.89	-.97	6.19
4. Biotech & Pharm	**19**	4	21	6	31.6	9	47.4	1.52	2.43	-.17	8.63	.09	.67	-1.00	1.85
5. Medical equip	**20**	7	35	7	35	6	30	-.51	0.51	-1.01	1.04	.88	1.77	-.77	6.36

(c) Capabilities by Sector:

Sector	MCAPs					TCAPs					OCAPs				
	Obs.	Mean	S.D.	Min.	Max.	Obs.	Mean	S.D.	Min.	Max.	Obs.	Mean	S.D.	Min.	Max.
1. Electronics	41	84.54	6.72	63.95	93.64	**39**	81.78	17.68	0	95.35	**41**	77.76	11.46	53.93	94.00
2. Telecomm.	20	80.57	20.51	0	95.63	**17**	80.79	13.96	51.16	99.92	**20**	75.63	19.63	1.95	92.73
3. Computr h&s/ware	102	84.89	6.14	62.03	95.43	**99**	82.81	12.45	8.97	100	**102**	78.23	11.59	0	100
4. Biotech & Pharm	19	82.65	9.27	53.84	100	**16**	75.19	23.97	2.57	98.81	**19**	77.88	11.19	50.87	96.32
5. Medical equip	20	81.26	16.85	21.40	96.08	**18**	78.46	19.36	25.16	99.66	**20**	71.19	25.18	8.54	95.09

Table (7): The Two-Way Interaction between Governance Modes & Firm Capabilities.

	(d) Baseline GLM		(e) Adjusted GLM	
	Dependent Variables		Dependent Variables	
	(1d)	(2d)	(1e)	(2e)
	Citations	**NPAs**	**Citations**	**NPAs**
JV		*Reference Category*		
Agreement	6.696**	12.037***	6.58	8.251
	(2.823)	(3.939)	(4.526)	(5.204)
License	5.273*	11.975***	3.842	7.031
	(3.17)	(4.586)	(5.426)	(5.973)
Marketing Cap. (MCAP)	.104***	.128***	.14***	.11*
	(.032)	(.043)	(.051)	(.059)
Technological Cap. (TCAP)	.05***	.032***	.048***	.046**
	(.006)	(.008)	(.013)	(.018)
JV X MCAP		*Reference Category*		
Agreement X MCAP	-.075**	-.102**	-.098***	-.093*
	(.032)	(.044)	(.036)	(.053)
License X MCAP	-.047	-.097**	-.066	-.078
	(.034)	(.048)	(.044)	(.058)
JV X TCAP		*Reference Category*		
Agreement X TCAP	.017	-.03	.064***	.003
	(.021)	(.019)	(.02)	(.017)
License X TCAP	.005	-.022*	.035***	-.005
	(.015)	(.013)	(.013)	(.015)
Controls:		*Results are in Web Appendix (E)*		
CF & Copula Terms:				
GOV_hat_CAP			1.662*	1.28
			(.938)	(1.053)
Copula_MCAP			-.227	.072
			(.272)	(.197)
Copula_TCAP			-.451**	-.544**
			(.219)	(.246)
_cons	-6.627***	-12.33***	-16.286***	-14.063***
	(2.19)	(4.073)	(4.541)	(5.237)
Obs.	189	189	187	187
Chi2	1772.866	612.074	1628.718	939.410
Prob > chi2	0.000	0.000	0.000	0.000
Akaike crit. (AIC)	3801.623	1605.713	3762.948	1592.409

Standard errors are in parentheses *** p<.01, ** p<.05, * p<.1*

Table (8): The Three-Way Interaction of Governance, Firm Capabilities, & Strategy.

	(f) Baseline GLM		**(g) Adjusted GLM**	
	Dependent Variables		Dependent Variables	
	(1f) **Citations**	(2f) **NPAs**	(1g) **Citations**	(2g) **NPAs**
JV		*Reference Category*		
Agreement	17.279**	7.139	6.583	-7.785
	(6.905)	(8.492)	(8.334)	(8.921)
License	10.65	3.434	.086	-10.621
	(7.714)	(8.619)	(9.173)	(9.007)
Marketing Cap. (MCAP)	.167***	.045	.127	-.049
	(.051)	(.069)	(.079)	(.089)
Technological Cap. (TCAP)	.065***	.041**	.037	.048
	(.017)	(.019)	(.031)	(.033)
Differentiation (Diff)	-2.893	1.773	-3.283	.505
	(3.797)	(2.743)	(3.66)	(3.187)
JV X MCAP		*Reference Category*		
Agreement X MCAP	-.133**	-.016	-.073	.075
	(.055)	(.067)	(.062)	(.076)
License X MCAP	-.095	-.001	-.004	.093
	(.058)	(.072)	(.069)	(.076)
JV X TCAP		*Reference Category*		
Agreement X TCAP	.001	-.036	.085***	.023
	(.024)	(.024)	(.032)	(.023)
License X TCAP	.004	-.022	.061**	.016
	(.033)	(.02)	(.031)	(.02)
Three-Way Interactions:				
JV X MCAP X Diff	-.093*	-.091*	-.068	-.056
	(.056)	(.05)	(.052)	(.045)
Agreement X MCAP X Diff	.096**	.014	.078**	.024
	(.038)	(.032)	(.034)	(.04)
License X MCAP X Diff	.078*	.018	.061	.035
	(.041)	(.035)	(.041)	(.041)
JV X TCAP X Diff	.04	.021	-.023	-.002
	(.034)	(.023)	(.048)	(.04)
Agreement X TCAP X Diff	-.014	.023	-.029	.022
	(.036)	(.023)	(.034)	(.019)
License X TCAP X Diff	-.023***	-.009	-.018**	-.005
	(.009)	(.007)	(.008)	(.007)
Controls:		*Results are in Web Appendix (E)*		
CF & Copula Terms:				
GOV_hat_ST			.366	1.186
			(1.148)	(1.173)
Copula_MCAP			-.271	.028
			(.389)	(.284)
Copula_TCAP			-.551**	-.79**
			(.278)	(.331)
_cons	-15.274**	-7.032	-17.722**	1.152
	(6.456)	(8.75)	(8.921)	(9.49)
Obs.	189	189	187	187
Chi2	4109.49	1266.35	5380.13	2495.15
Prob > chi2	0.000	0.000	0.000	0.000
Akaike crit. (AIC)	3794.89	1621.53	3757.65	1607.44

*Standard errors are in parentheses *** p<.01, ** p<.05, * p<.1*

Figure (1): Conceptual Framework for Innovation Performance.

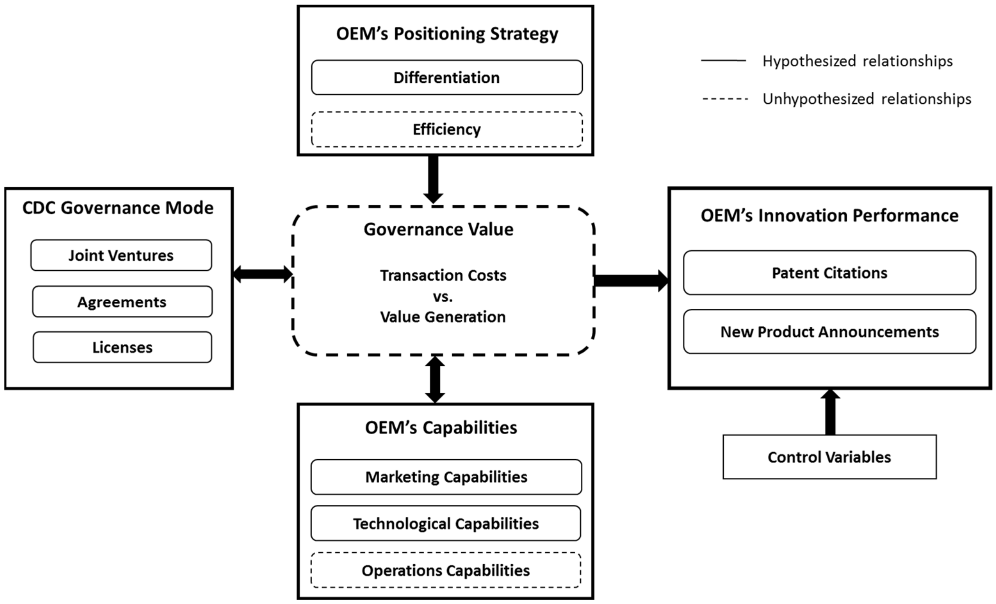
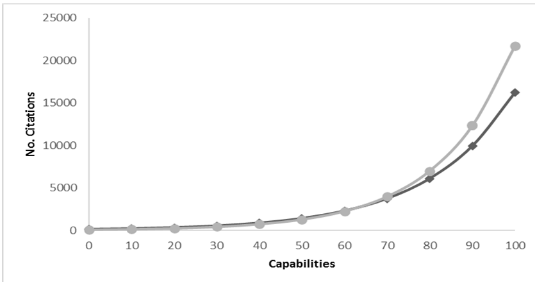


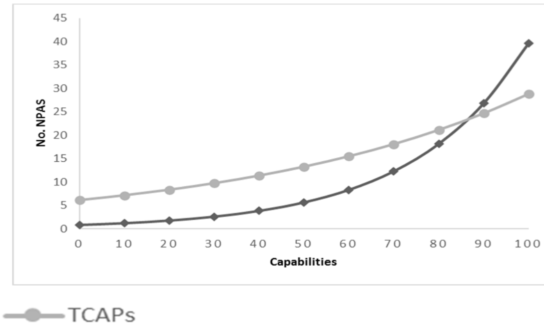
Figure (2): Sample Effects on Innovation Performance.

(A): The Relationship between Capabilities and Innovation Performance

Citations

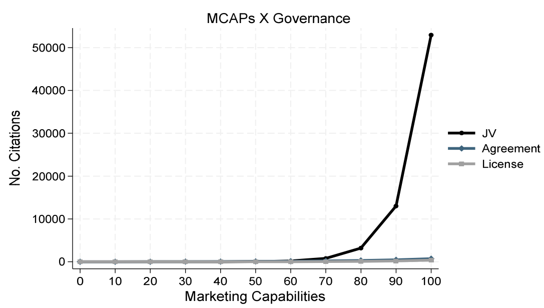


NPAs

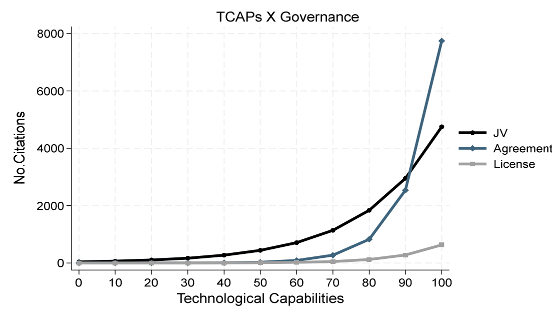


(B): Sample Two-way Interactions

MCAP X Governance

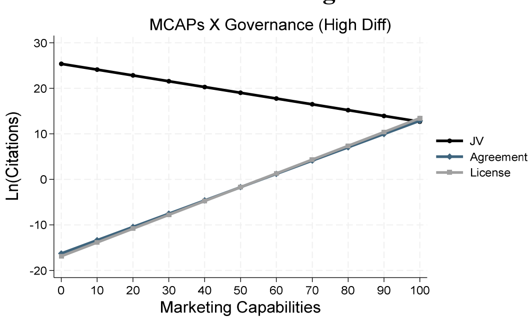


TCAP X Governance

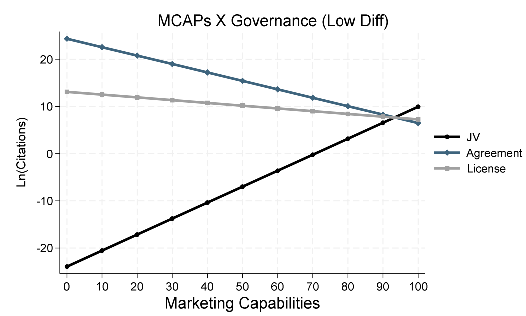


(C): Sample Three-way Interactions

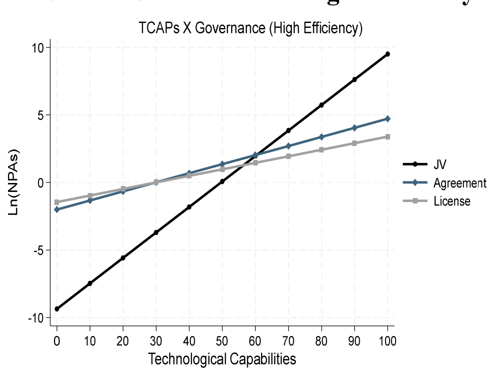
MCAP X Governance X High Differentiation



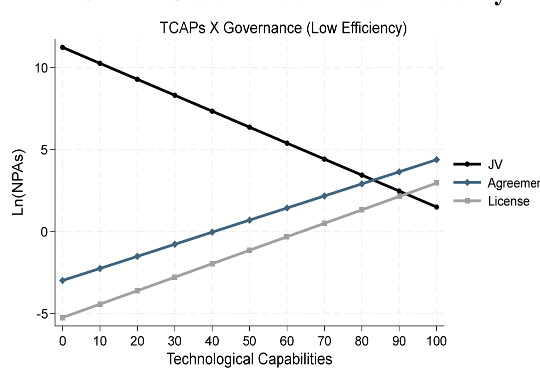
MCAP X Governance X Low Differentiation



TCAP X Governance X High Efficiency



TCAP X Governance X Low Efficiency



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