PRODUCT DEVELOPMENT COLLABORATIONS AND INNOVATION

PRODUCT DEVELOPMENT COLLABORATIONS: IMPLICATIONS FOR MARKETING STRATEGY AND INNOVATION

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A Thesis Submitted to the School of Graduate Studies in Partial Fulfilment of the Requirements for the Degree Doctor of Philosophy in Business Administration

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Lay Abstract

Many firms establish Product Development Collaborations (PDCs) with suppliers to innovate new products. Although PDCs have numerous advantages, they are ladened by various contractual hazards and risks. This raises concerns of many executives about their effectiveness. In this dissertation, I systematically review the existing marketing studies on the PDC topic. Then, building on my review, I empirically investigate several marketing strategy factors that impact a PDC's effectiveness in terms of enhancing the innovation performance of focal firms.

Drawing on several theories, building and using a unique dataset, and utilizing multiple research and econometric techniques, I conduct two empirical studies to examine the impact of four strategic considerations (i.e., functional capabilities, international PDCs, PDC governance mechanisms, and positioning strategy) and their interactions on innovation performance of high-tech firms in PDCs.

My results reveal various interesting and important relationships and interactions that advance our understating of PDCs, their relation to marketing strategy, and provide important managerial implications to practitioners.

Abstract

High-tech firms are no longer able to rely exclusively on their internal knowledge and technologies to respond effectively to current market dynamics. Instead, they frequently collaborate with external entities to access new technologies and share the costs and risks of the innovation process. However, the effectiveness of such collaborations is questioned by many executives. Yet, as these Product Development Collaborations (PDCs) become crucial for a firm's growth and success in current times, executives and academics alike are paying growing attention to them. In marketing, PDC is an active research topic since 1999. However, the body of marketing knowledge on the PDC is scattered across several studies over an extended period of more than two decades. In addition, the extant marketing studies report results that are inconsistent on some PDC issues and have overlooked others. In particular, marketing strategy considerations, in terms of firm's strategic capabilities and objectives, have received somewhat of a short shrift in the literature.

My dissertation contributes to our marketing literature with (a) a systematic review study that synthesizes the current state of marketing knowledge on the topic, identifies the research lacunas, and sets a future research agenda; and (b) two theory-driven empirical studies that provide new insights and novel implications to enrich our understanding of PDCs, their relation to the firm's marketing strategy, and provide clear guidance to practitioners on how to benefit most from their supplier collaborations.

Grounding on several theories, creating and using a unique dataset, and utilizing multiple research and econometric techniques, my dissertation empirically addresses the following two general research questions:

RQ1. Can their functional (marketing, technological, and operations) capabilities lead firms into competency traps and hurt their innovation performance? How? Do international PDCs outperform domestic PDCs in combating the competency trap effect? When?

RQ2. What is the appropriate PDC governance mechanism (joint ventures, agreements, or licenses) that would enhance innovation performance? How do governance and capabilities simultaneously impact innovation performance? How does the firm’s product positioning strategy (differentiation versus cost-leadership) interact with governance and capabilities to affect innovation outcomes?

Acknowledgments

"All Praise be to Allah, Lord of the Worlds, the Most Compassionate, the Most Merciful"

(The Qur'an 1: 2 and 3)

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List of Abbreviations

Abbreviation	Definition
2SRI	Two-Stage Residual Inclusion
Agreement	Joint development agreement
PDC	Product Development Collaboration
CF	Control Function
CFA	Confirmatory Factor Analysis
EFA	Exploratory Factor Analysis
GVA	Governance Value Analysis
IMM	Industrial Marketing Management
Innov-Perf	Innovation Performance
JAMS	Journal of the Academy of Marketing Science
JM	Journal of Marketing
JMR	Journal of Marketing Research
JV	Joint Venture
License	Technology licensing contract
MCAP	Marketing Capabilities
MS	Marketing Science
NPA	New Product Announcement
NPD	New Product Development
OCAP	Operations Capabilities

Abbreviation	**Definition**
OEM	Original Equipment Manufacturer
R&D	Research and Development
RBV	Resource-Based View of the Firm
SF	Stochastic Frontier Models
TCAP	Technological Capabilities
TCE	Transaction Cost Economics

1. Introduction

Scientific discoveries and technological breakthroughs drive unpredictable and rapid changes in customer lifestyles, wants, preferences, as well as market structures. To cope with these dynamics and sustain competitive advantage, a firm needs to develop innovative solutions that add value to its customers. Not surprisingly, the rapid pace of technological changes, characterizing current times, makes a firm's success hinged on effective innovation. In fact, the Boston Consulting Group's (BCG) annual survey of 1,500 global senior executives indicates the same. The BCG's study reveals that about 90% of firms consider innovation as a gate to business growth and success and that the focus of executives on innovation is increasing over years. For instance, about 80% of the executives in 2015 placed innovation in the top three priorities of their businesses compared to only 66% of the executives in 2005 (Ringel, Taylor, & Zablit, 2015).

Intriguingly, the 2021 BCG's report highlights the significant role of the COVID-19 pandemic in accelerating the focus of companies on innovation. For instance, the number of executives who reported innovation as one of their three top business priorities has increased by 10% in 2021. The pandemic has also motivated firms to cut innovation time. For example, Pfizer, in collaboration with BioNTech, developed and commercialized the COVID-19 vaccine, which usually takes more than a decade, in less than one year (Manly et al., 2021). Yet, the BCG also reports that the dissatisfaction rate, among executives, regarding the financial returns on innovation investments is higher than 50%, and only eight firms maintained their existence in the list of *"the 50 most innovative companies in the world"* over years till 2020 (Ringel et al., 2020). Clearly, effective innovation is not guaranteed, and firms struggle to find the magic sauce of success.

Innovation is a "*collaborative and iterative process*" that entails inputs and adjustments from both sides of the supply chain: the upstream supplier and the downstream customer (Gilson, Sabel, & Scoti, 2009). Thus, it is not surprising to see an increase in the number of firms forming Product Development Collaborations (PDC) with suppliers. PDCs are defined as *"formalized collaborative arrangements among two or more organizations to jointly acquire and utilize information and know-how related to the research and development (R&D) of new product (or process) innovations"* (Rindfleisch & Moorman, 2001, p. 1). Although a PDC represents a specific transaction between a firm and its partner(s), it has a strategic nature that allows it to impact the firm's overall performance. Previous studies empirically demonstrated that PDCs have significant firm-level implications such as enhancing firm innovativeness (Estrada et al., 2016; Knudsen, 2007; Markovic et al., 2020; Wu, 2014; Yami & Nemeh, 2014) and affecting the market value of partnering firms (Fang et al., 2015; Wu et al., 2015).

In addition to this academic evidence, several examples from my dataset also offer clear support to the notion that most of these collaborations are prominent arrangements that firms establish for strategic reasons such as (a) *setting new industry standards and reshaping 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. For example, Zycad Corp signed a joint development agreement with Rohm Co Ltd to develop the world's largest Field Programmable Gate Array (FPGA) that would contain 100,000 gates and would be only a quarter the size of equivalent gate arrays. In another arrangement, Life Technologies formed a JV with Oriental Co. to develop a "highly concentrated liquid culture medium capable of speeding cell growth by a factor of 20% to 30%." Likewise, Grumman formed a JV with TRW to develop Follow-on Early Warning Systems (FEWS) that are more capable and less costly than available systems. Another example is the collaboration between Synopsys and LSI Logic to develop “a next-generation submicron digital system” that would allow users “to reduce design iterations and improve design performance”. Furthermore, Intel Corp partnered with Schumacher to develop TRANS-LC, a new "ozone-friendly" chemical to be used in computer chip manufacturing. "TRANS-LC provides the industry with an ozone-friendly alternative to TCA at a similar cost. TRANS-LC is less expensive to set up and maintain than the other industry source for chlorine, HCL, and is of higher purity." (b) *defeating competitors by getting access to unique resources*. For example, Sharp entered into a joint development agreement with Intel to access Intel’s technology which places it ahead of its rivals in Japan. In a similar transaction, HP Co. partnered with Intel to co-develop “next-generation technologies for the end-of-the-decade workstation, servers and computer related products.” By combining their resources, the partnering firms “will share development costs and direct one well-financed team to do battle with their most serious threat, the so-called PowerPC chip backed by IBM, Motorola Inc, and Apple computer inc.”; (c) *overcoming economic and technical challenges of developing sophisticated products*, for example, the collaboration of IBM with STMicroelectronics helped it to overcome the semiconductor industry's technical and economic challenges of developing advanced technologies and enhanced its ability to deliver products faster to the market and offer greater technology advantage to customers; (d) *maintaining their market lead*. For example, Vital Signs partnered with Respironics to develop an improved single-use anesthesia face mask that allowed Vital Signs to maintain the highest market share in the sales of anesthesia face masks; and (e) *cut development time and costs*. For example, Unisys Corp collaborated with Motorola Inc. to get access to the latter’s technologies so it would develop products faster and "save hundreds of millions of dollars over the next few years."

Further, a recent industry study by McKinsey and Company (Gutierrez et al., 2020) reported that firms that collaborate with suppliers in innovation activities outperform (e.g., grow more, profit more, and incur lower operating costs than) those that do not. Previous studies (e.g., Lai, Chen, & Yang, 2012; Lawson et al., 2009; Rosell & Lakemond, 2012; Sun, Yau, & Suen, 2010; Tessarolo, 2007) demonstrate several benefits of involving suppliers early in product development projects. Suppliers may (a) contribute with complementary knowledge and technical skills that are valuable to enhance and accelerate the development process, (b) support product design, identify potential technical problems, and incorporate changes in product specifications, (c) share development costs and risks with the focal firm, (d) control quality problems and provide early insights into new technologies, and (e) assist in decreasing the lead time and improving on-time delivery of the new product. Hence, more and more firms are collaborating with suppliers to develop new products (Yeniyurt, Henke, & Yalcinkaya, 2014).

Nonetheless, the dissatisfaction among executives, regarding the outcomes of these collaborations, could be as high as 80% in some industries (Tevelson et al., 2013). In fact, these arrangements are associated with a high failure rate that is estimated to be 70% (Noordhoff et al., 2011). They also expose firms to partner opportunism and unintended knowledge spillover (Oxley, 1997). Notwithstanding, as they become one of the strategic business decisions that drive firm competitiveness in a market (Howells, James, & Malik, 2003), executives are greatly concerned about how to effectively structure and manage them.

To help executives in their endeavors, many researchers across various disciplines are studying PDCs from different perspectives. Marketing scholars are among those who pay growing attention to this topic since the late 1990s. However, our marketing literature on the PDC topic suffers from two primary issues. *First*, the literature is fragmented across several studies over an extended period of more than two decades. Surprisingly, none of the previous marketing studies – as far as I know – has attempted to compile our marketing knowledge on the topic to draw a conclusion on what has already been done, what needs further consideration, and what is yet to be investigated. In this dissertation, I first aim at filling this gap in the literature with my second chapter in which I review and synthesize the current state of marketing knowledge on PDC and recommend a research agenda for future studies. *Second*, as my systematic review of the literature reveals, the extant marketing studies uncovered inconsistent results on some research questions and understudied others. Therefore, I also attempt to empirically address some of these limitations in chapters three and four of this dissertation. These two empirical studies will contribute to the marketing literature with new insights that will enrich our understanding of the PDC topic and provide clear guidance to practitioners on how to benefit most from their collaborations.

To this end, I present my systematic review of the marketing PDC literature in *chapter two*. I used the Web of Science and Google Scholar platforms to collect nearly a comprehensive list of all articles published in five top marketing journals between 1999 and August 2022. Particularly, my review covers 91 articles published in the *Journal of Marketing*, *Journal of Marketing Research*, *Marketing Science*, *Journal of the Academy of Marketing Science*, and *Industrial Marketing Management*. At the beginning of the chapter, I use bibliometric and descriptive techniques to analyze the articles, demonstrate the trend of the publications on the topic over years, identify the most influential studies, show a network of the academic sources cited in the articles, and depict the relationships between the keywords frequently used in the articles. I then move to scrutinize the substantive subject of the review: the product development collaborations. After I define these collaborations and highlight their benefits and costs/risks to firms, I discuss the different PDC types and how marketing studies approached them. Following this, I spotlight one of the most intensively studied research questions: PDC effectiveness. I show the disagreement in the literature regarding the impact of PDCs on firm performance. I also discuss the different firm-specific and alliance-related factors that affect the success of such collaborations. Before I conclude the chapter by setting a future-research agenda, I review the different theoretical lenses that marketing scholars drew upon in their studies including the transaction cost economics, resource-based view, dynamic capabilities, and social network theories.

In *chapter three*, I empirically investigate the competency trap phenomenon and highlight the role of PDCs in combating this phenomenon. The competency trap is a well-known phenomenon in the literature. Yet, the empirical work investigating it is scant, and – to the best of my knowledge – no previous study examined the competency trap effect of strong functional capabilities in a PDC context. To this end, I build on the Resource-Based View (RBV) of the firm and dynamic capabilities perspective to investigate the downside effects of strong functional capabilities (marketing, technological, and operations) on innovation performance[1] of firms forming PDCs. I first argue that, based on the benefits and costs of strong functional capabilities, there is a curvilinear (an inverted U-shaped) relationship between each of the three

[1] I define Innovation performance as the extent to which a firm succeeded in developing and delivering innovative products as indicated by its patent counts, patent citations, and new product announcements.

functional capabilities and innovation performance. I also postulate that a functional (e.g., marketing) capability would moderate the relationship between another strong functional (e.g., technological) capability and innovation performance. I finally posit that participating in a PDC is a dynamic capability that positively moderates the relationship between strong functional capabilities and innovation performance, and I differentiate between the moderating effect of international versus domestic PDCs.

To conduct the empirical study, I utilized the archival method to collect a sample of industrial firms, operating in several high-tech industries (e.g., telecommunications, electronics, biotechnology, and software), that formed dyadic PDCs with suppliers between 1985 and 2016. To test my empirical models, I built a unique dataset consisting of a final sample of 202 observations. I retrieved data from several databases including the Securities Data Company (SDC), Compustat, LexisNexis, Mergent online, Thomson one, United States Patent and Trademark Office (USPTO), ABI/Inform databases, besides consulting the annual financial reports of firms. I use stochastic frontier models to estimate functional capabilities. I run negative binomial generalized linear models to test the hypotheses, utilizing the Two-Stage Residual Inclusion (Terza, Basu, & Rathouz, 2008) method to control for potential endogeneity in the models.

The results demonstrate the competency trap effect of strong functional capabilities on the innovation performance of firms in PDCs. They also indicate that capabilities interact differently with each other to affect innovation performance. For example, marketing capabilities would interact positively with strong technological capabilities, but its interaction with strong operations capabilities is negatively associated with innovation performance. Moreover, the findings reveal that collaborating with international, as compared to domestic, partners is associated with (a) higher innovation performance for firms with strong marketing or operations capabilities, and (b) lower innovation performance for firms that possess strong technological capabilities.

After I uncover the negative effect of strong functional capabilities on innovation performance and explain how collaborating with international versus domestic partners impact PDC effectiveness, I conduct my second empirical study in *chapter four*. In this study, I investigate the principal role of another firm-specific strategic factor, namely product positioning strategy[2], in enhancing the effectiveness of a firm's collaborations. Surprisingly, positioning strategy is notably absent from previous PDC studies despite its critical value to firm performance according to the Governance Value Analysis (GVA) framework. Thus, grounding on the GVA and its parent Transaction Cost Economics (TCE) approaches, I argue that the "fit" between a firm's positioning strategy (product differentiation versus cost-leadership), its functional (marketing, technological, and operations) capabilities, and the governance mechanism of its PDC (joint venture, co-development agreement, or technology licensing contract) would enhance its innovation performance. In the process, I demonstrate the costs associated with misaligning the three factors (strategy, capabilities, and governance) in a form of less innovation performance.

The empirical analysis uses the same context and dataset as in chapter three. I run stochastic frontier models to estimate functional capabilities and use exploratory and confirmatory factor analyses to measure positioning strategy. I also run negative binomial

[2] I define product positioning strategy as a firm's choice to differentiate its product in the market mainly based on either (a) unique features other than price (i.e., product differentiation strategy), or (b) low price (i.e., cost-leadership strategy).

generalized linear models to test the hypotheses. In this study, I utilize a mixed technique of the Gaussian Copula (Park & Gupta, 2012) and Two-Stage Residual Inclusion (Terza et al., 2008) methods to control for potential endogeneity in the empirical models. The results reveal that the three functional capabilities interact differently with different PDC governance mechanisms to impact innovation performance. Consistent with the postulates of the GVA approach, the findings also demonstrate that fit among a firm's positioning strategy, its functional capabilities, and its chosen PDC governance mechanism yields superior innovation performance.

Overall, my dissertation investigates a special form of interfirm strategic alliances (i.e., product development collaboration) that is particularly important for firm survival and success in the current time of economic downturns in wake of the COVID-19 pandemic (Bamford, Baynham, & Ernst, 2020). PDC is also critical to firm performance because it targets innovation, one of the top business priorities for many firms. The studies in this dissertation and their findings contribute to the extant marketing literature and provide new insights to practitioners in several ways.

To the academic community, it offers the first systematic review – as far as I know – of the marketing studies on the PDC topic. In doing so, it provides interested marketing scholars and forthcoming researchers with a comprehensive resource to refer to for an integrated body of knowledge on PDCs and potential research problems to investigate. Also, it advances research in the marketing discipline by uncovering novel relationships and new interactions between variables that are overlooked in the marketing literature. For example, I demonstrate that the relationship between functional capabilities and innovation performance is more complex than previously depicted in marketing studies. I also explain that the three-way interaction between positioning strategy, functional capabilities, and governance is critical for a PDC's effectiveness.

Moreover, this dissertation contributes to the progress of our research methods by presenting to the marketing community a new technique for measuring firm strategy using financial data.

To firm managers, the results of my empirical research offer new insights and guidelines to help them in forming effective PDCs. For instance, the findings reveal that investing too much in reinforcing existing firm capabilities might hurt innovation performance because of the organizational inertia that would turn a core capability into core rigidity. The results also indicate that one way to avoid falling into a competency trap of strong functional capabilities is to form supplier PDCs and carefully choose between international and domestic partners that align with the functional capability that a firm possesses. Moreover, I provide a clear guideline to practitioners on how to structure effective PDCs that would enhance firm innovation performance. My findings identify the appropriate portfolio of PDC governance mechanisms given existing firm capabilities and positioning strategy. Further, my studies convey a warning message to managers against blindly copying the practices of other firms, regardless of the appearance of “industry best practices”. Particularly, the results demonstrate that considering a firm’s positioning strategy along with its functional capabilities is crucial to structure effective PDCs. Thus, blanket prescriptions for one or the other forms of PDCs (e.g., joint ventures during downturns) may be misdirected.

2. Product Development Collaborations in the Marketing Literature

2.1. Introduction:

Our modern economy witnesses a technological revolution that is greatly impacting how companies operate, compete, respond to customers, and succeed. Companies nowadays are not only facing fierce global competition, but they are also operating in a dynamic environment where product life cycles are short as customer preferences keep changing rapidly and product technical complexity increases. These current market forces are pushing companies toward innovation to flexibly and speedily develop new products to satisfy customers' unpredicted changing wants and to survive market competition (Jakobsen, 2020).

However, New Product Development (NPD) is a costly, risky, and complex process. First, it is costly because it requires massive investments in Research and Development (R&D) activities (Carlson, Frankwick, & Cumiskey, 2011). Second, it is risky because of the high failure rate of development endeavors. For instance, about 86% to 90% of new-product concepts fail to reach the market and about 40% of new products fail at the launch stage (Cooper, 2019). Finally, the NPD process is complex as it is an iterative process (Corswant & Tunälv, 2002) that involves advanced technologies, heterogeneous resources, and diverse skills (Liu, Rindt, & Hart, 2020).

Under these circumstances that surround the NPD endeavors, firms are no longer able to rely exclusively on their internal capacities. Instead, many firms are increasingly collaborating with other entities to share product development costs and risks, acquire new skills, access unique technologies, and accumulate competencies (Ozdemir, Kandemir, & Eng, 2017; Perks, 2000). However, Product Development Collaborations (PDCs) are prone to fail as some estimate their failure rate to be 70% (Noordhoff et al., 2011; Sivadas & Dwyer, 2000). In addition, they raise risks of opportunism, appropriability hazards, and knowledge spillover (Du, 2021; Oxley, 1997).

Because of their strategic importance to firms (despite their risks), executives are greatly concerned about how to effectively structure and manage PDCs (Buyukozkan & Arsenyan, 2012). As these arrangements become one of the strategic business decisions that affect firm competitiveness in the market (Howells et al., 2003), many academics in various disciplines are sustaining their research efforts to analyze them from different angles to guide executives in making well-informed decisions.

Since "product" is one of the four elements of the marketing mix, it is no wonder that marketing is one of these disciplines that are paying growing attention to the topic. Marketing scholars over more than two decades investigated different types of PDCs to address diverse research questions. Thus, our marketing literature is quite rich with studies on the topic of innovation collaborations[3]. However, the body of knowledge on this topic is scattered across numerous studies published over several years in different journals. Each of these studies adopted a distinct perspective to examine a specific aspect of these arrangements, contributing to the whole body with new insight and implications that need to be synthesized to offer an integrated view of the topic.

Moreover, as these partnerships are strategic to firm growth and innovation in current times (Greco, Grimaldi, & Cricelli, 2020), this topic is an active research area that asks for

[3] Please note that I use innovation collaboration and product Development Collaboration (PDC) interchangeably in this dissertation. I also use collaboration, partnership, and alliance interchangeably.

further studies to address the emerging aspects of these alliances. Therefore, a systematic review of the extant marketing studies is much needed now to spotlight the current state of knowledge in marketing about product development collaborations, highlight the current research lacunas, and draw paths for future work.

To this end, we are reviewing nearly a comprehensive list of the marketing studies published on this topic between 1999 and August 2022[4]. Our review builds on 91 papers published in five top marketing journals to synthesize the current marketing knowledge on the topic, identify the research gaps, and set a research agenda for future research.

The rest of this paper is organized as follows. First, we start with descriptive and bibliometric analyses to outline the studies under review. Second, we highlight the concept of product development collaborations, why they are important, and what their problems are. Third, we review the different PDC types as they are discussed in the marketing literature. Fourth, we illustrate the "inconsistent" impact of these alliances on firm performance in light of empirical marketing studies. Fifth, we discuss the different factors that might affect the success of these partnerships. Sixth, we highlight the post-formation dynamics in PDCs by discussing the different causes and types of alliance termination. Next, we elaborate on the theoretical lenses adopted frequently by marketing scholars in examining these arrangements. Finally, we wrap up our discussion with a conclusion and an agenda for future research.

[4] The first marketing study we located on the topic was published in 1999. We completed our search in August 2022.

2.2. Overview of the Marketing PDC Literature: Descriptive and Bibliometric Analyses:

Since the late 1990s, marketing scholars started to investigate the PDC topic. We aimed at reviewing all the studies published on the subject in the top marketing journals[5]. We searched the Web of Science and Google Scholar platforms using the keywords of product codevelopment, R&D, research and development, technological, development, codevelopment, or innovation collaboration, alliance, partnership, or network. We looked up *five top marketing journals*, namely: Journal of Marketing (JM), Journal of Marketing Research (JMR), Marketing Science (MS), Journal of the Academy of Marketing Science (JAMS), and Industrial Marketing Management (IMM). Our search spans the period from 1999 to August 2022. Our efforts yielded a quite large list of 91 articles authored by 221 researchers and earned 6,069 total citations. Table (2.1) summarizes the main information about the articles under review. Appendix (A) presents the main themes of these studies.

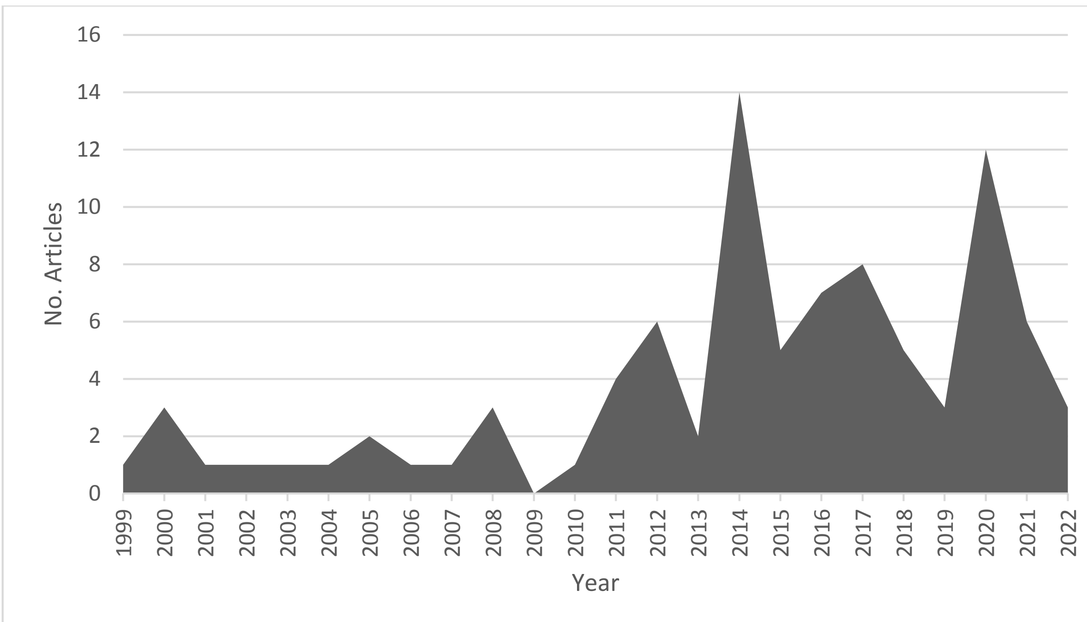
Table (2.1): Descriptive Summary of the Reviewed Articles:

Description	**Results**
Timespan	January 1999 -August 2022
Journals	5 (IMM, JM, JAMS, JMR, MS)
Documents	91
Annual Growth Rate %	4.89
Total citations	6,069
Citations without self-citations	5,878
Average citations per document	66.08
References	5,592
Authors	221
Single-authored documents	11
Co-Authors per document	2.73
International co-authorships %	34.07

[5] Despite being keen not to miss any qualified article, we acknowledge that mistakes are not impossible. If a qualified study is not present in our list, we assure that is an unintended mistake.

Campbell & Cooper (1999) is the first marketing paper on the topic. It investigates the impact of collaborations with customers (compared to in-house development) on product performance. Since then, many marketing studies examined this special type of strategic alliance over more than two decades as shown in Figure (2.1).

Panel (a): Trend of Marketing PDC Articles over the Years



Panel (b): Journal Contribution per Year

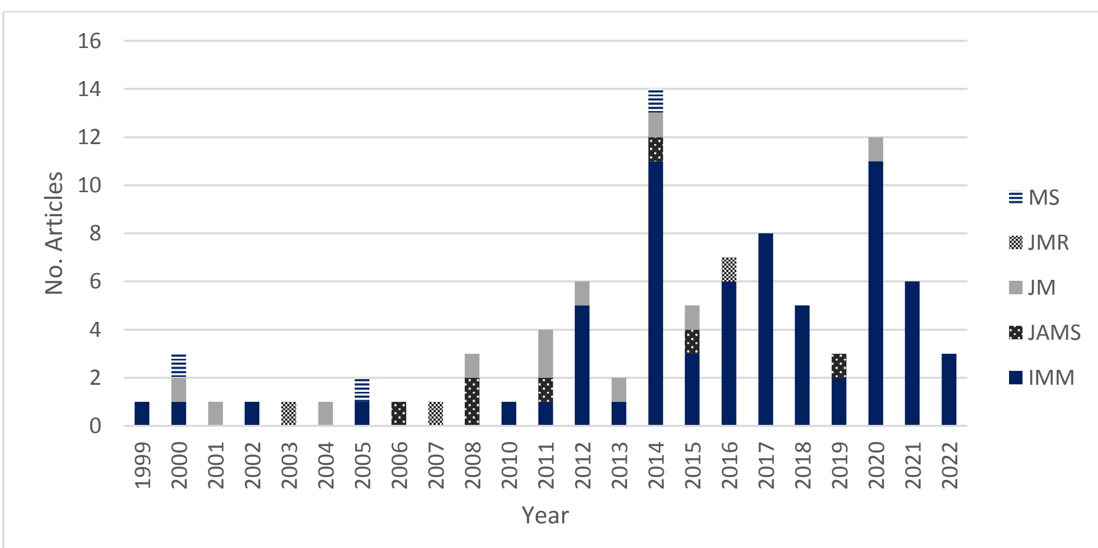
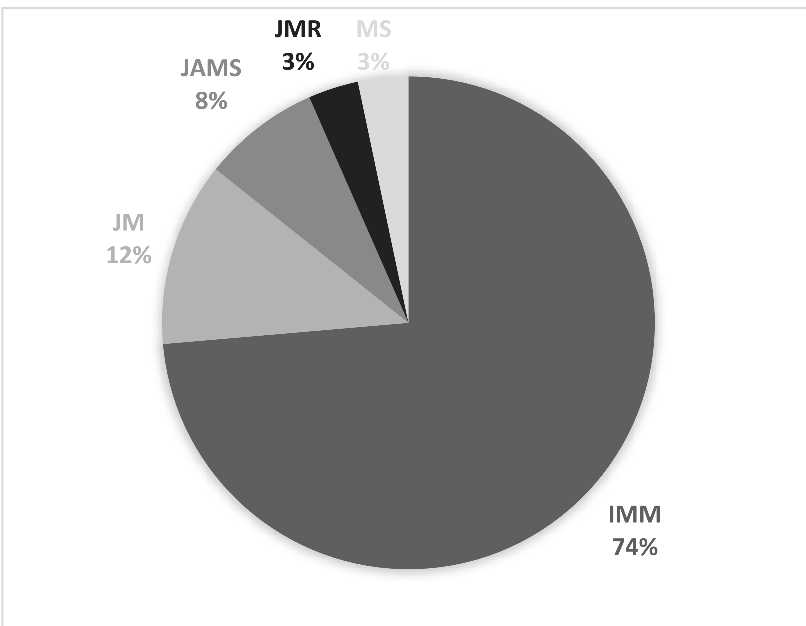


Figure (2.1): Marketing PDC Publications per Year

The contribution of the five investigated journals to the PDC literature varies significantly as illustrated in Panel (a) of Figure (2.2). The lion-share contribution comes from IMM with 67 articles, followed by 11 articles in JM, 7 in JAMS, and 3 in each of JMR and MS. One interesting observation, demonstrated in Panel (b) of Figure (2.2), is that while all five journals show increasing interest in the topic over years, PDC articles published in IMM grow dramatically since 2011. Notwithstanding, the three most influential articles (i.e., Fang, 2008; Rindfleisch & Moorman, 2001; Sivadas & Dwyer, 2000) are published in JM with far more citations than all the others as demonstrated in Figure (2.3).

Panel (a): Percent of Articles per Journal



Panel (b): Trend of Journal Contributions

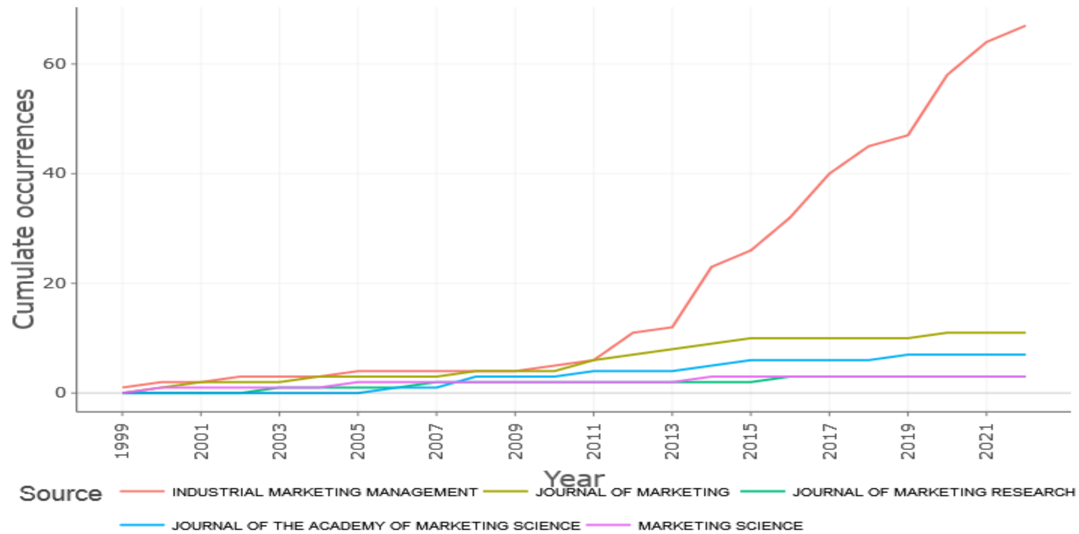


Figure (2.2): Journal Contribution to PDC Literature

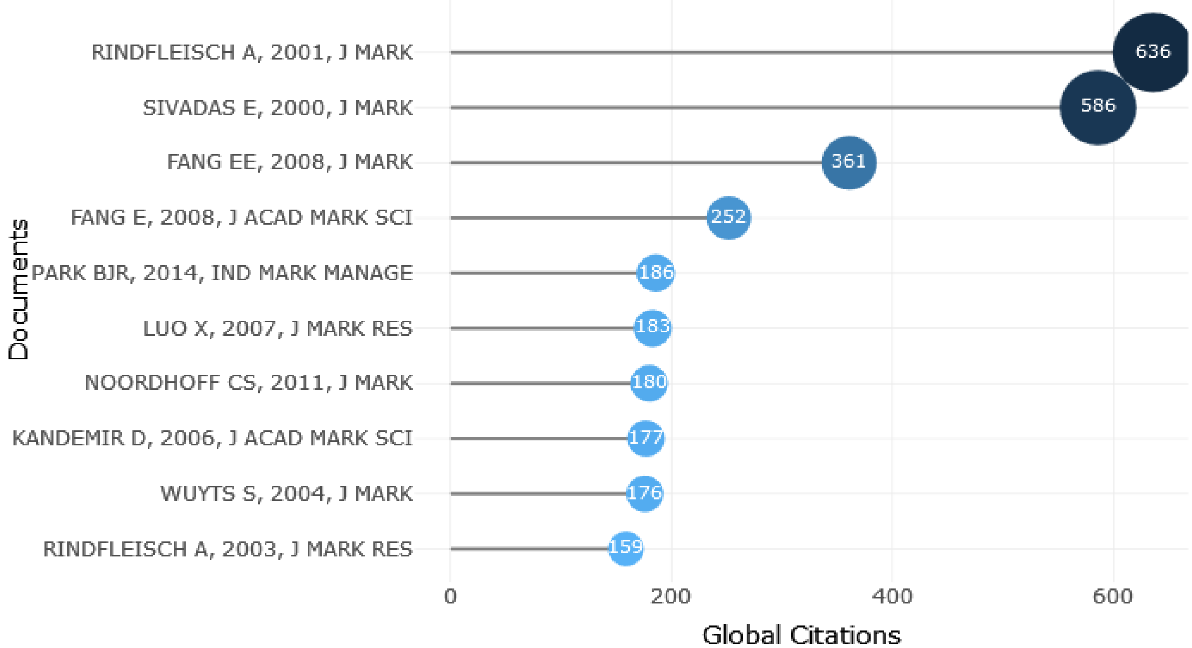


Figure (2.3): The Most Influential Articles

On the other hand, the investigated articles cited many academic sources that can be clustered into two groups as shown in Figure (2.4). One cluster is dominated by the Strategic Management Journal, the Journal of Marketing, the Academy of Management Review, and the Journal of Product Innovation Management. The other is led by Industrial Marketing Management, Research policy, Technovation, and the Journal of Management Studies.

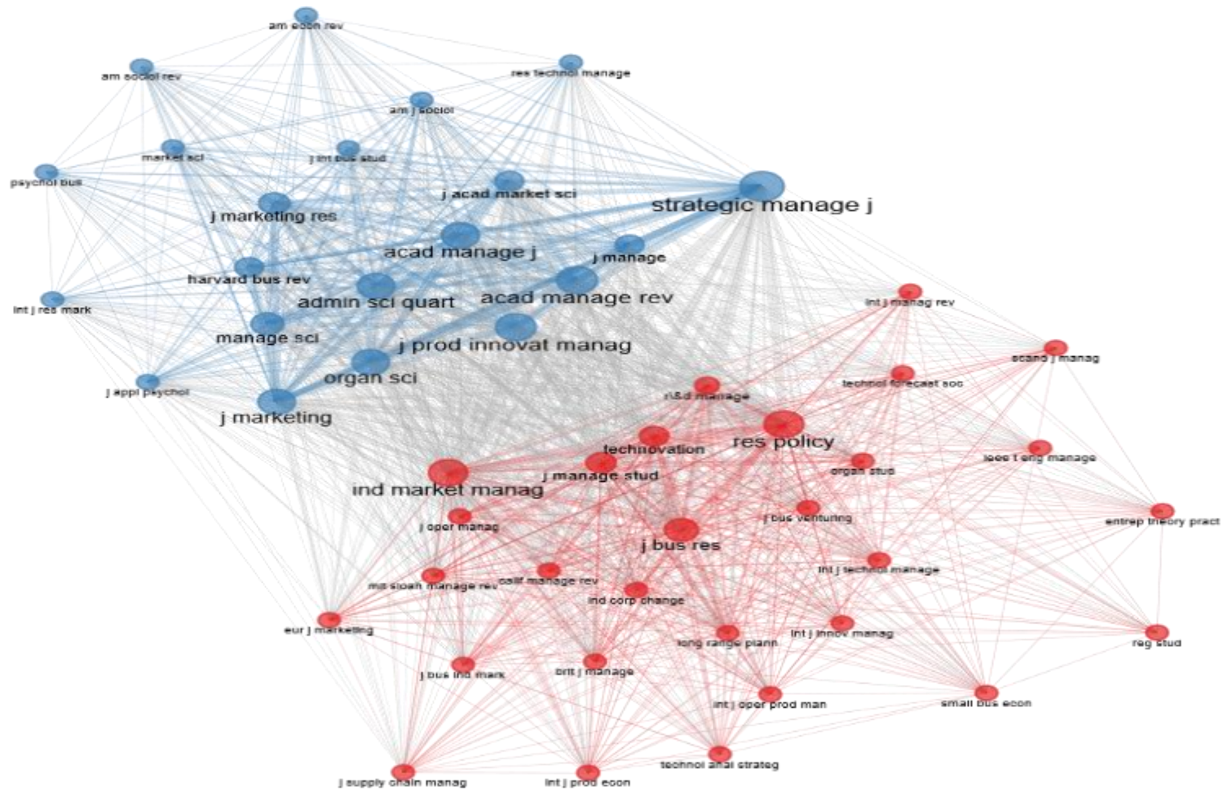


Figure (2.4): Sources Co-Citation Network

The marketing scholars investigated different types of PDCs (e.g., vertical, horizontal, and networks) to address diverse research questions such as collaboration effectiveness (e.g., Estrada, Faems, & Faria, 2016; Ozdemir et al., 2017; Xu et al., 2021), resource allocation in these partnerships (e.g., Perks & Moxey, 2011; Purchase, Olaru, & Denize, 2014), alliance governance-related issues (e.g., Bouncken, Clauß, & Fredrich, 2016; Fang, Lee, & Yang, 2015; Sivakumar, Roy, & Zhu, 2011), alliance portfolio diversity (e.g., Cui & O'Connor, 2012; Greco et al., 2020), partners motivation to participate in focal firms' innovation projects (e.g., Smals & Smits, 2012; Yeniyurt, Henke, & Yalcinkaya, 2014), value creation within these arrangements (e.g., Bouncken et al., 2020; Reypens, Lievens, & Blazevic, 2016), effective management of such collaborations (e.g., Rampersad, Quester, & Troshani, 2010), partners' conflict and trust (e.g., Lam & Chin, 2005; Munksgaard et al., 2012; Yu et al., 2021), the timing of forming effective PDC (e.g., Wu et al., 2015), technology transfer and knowledge sharing and integration mechanisms (e.g., Clauss & Kesting, 2017; Eslami, Lakemond, & Brusoni, 2018), collaborating with research centers, public institutions, and universities (e.g., Nissen, Evald, & Clarke, 2014; Zhang, Yuan, & Zhang, 2022), and innovation networks (e.g., Breslin et al., 2021; Hurmelinna-laukkanen & Nätti, 2018; Leminen, Nyström, & Westerlund, 2020). Figure (2.5) displays the connection between the most frequently used keywords in the articles.

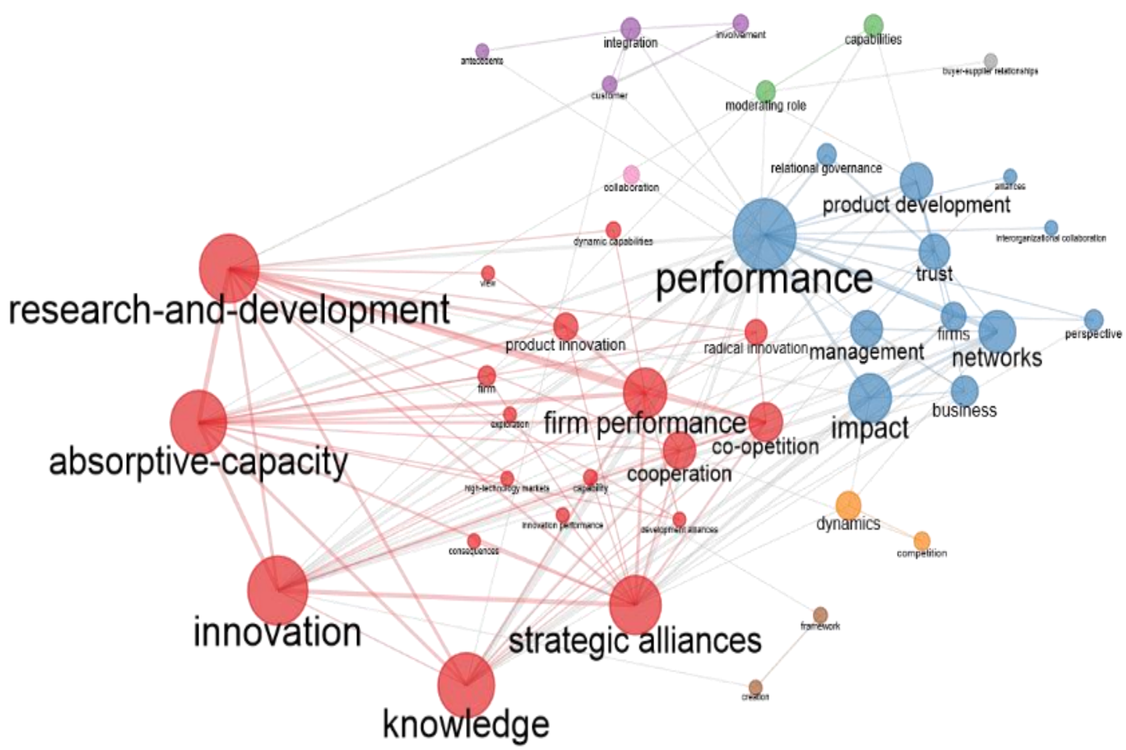
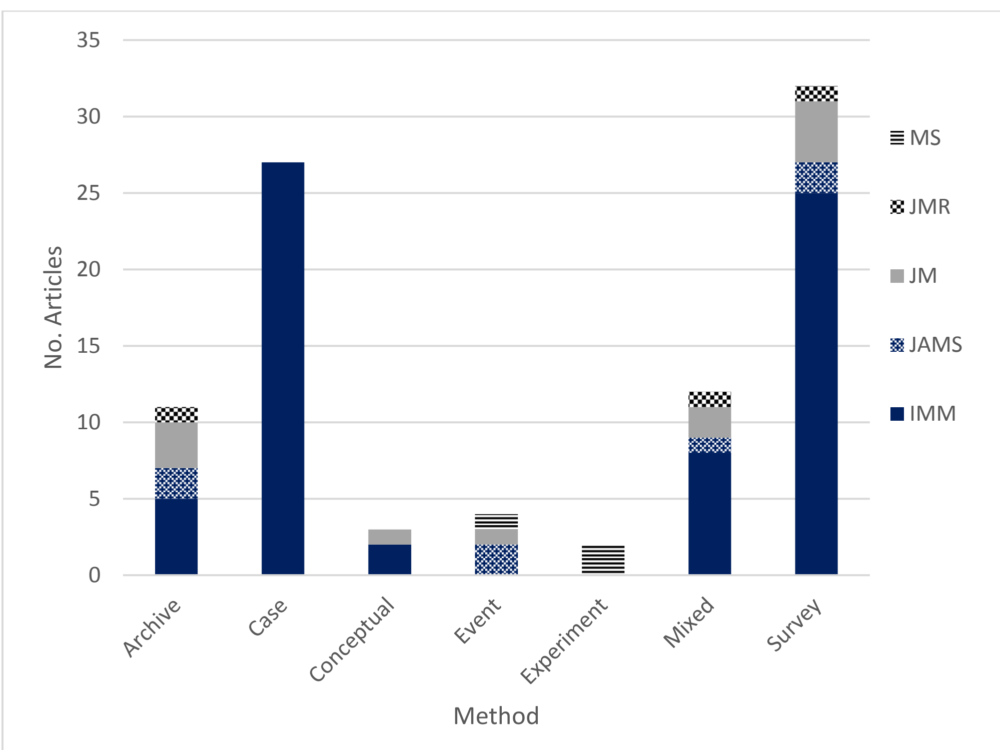


Figure (2.5): Keywords Re-occurrence Network

In examining PDC-related issues, the marketing researchers adopted different theoretical lenses such as the Transaction Cost Economics (TCE) approach, Resource-Based View (RBV), knowledge-based view, dynamic capabilities perspective, social exchange theory, and social network theory. They also utilized various qualitative (e.g., case studies and in-depth interviews), quantitative (e.g., survey, event studies, and experiments), and mixed (e.g., survey along with archival data) methods as depicted in Figure (2.6). The most frequently used method is a survey in 35% of the articles followed by case studies in 30% of the articles, while only two articles employ experiments, and three articles are conceptual papers. Extant marketing studies provided new insights and novel implications for the PDC domain. However, they offered conflicting results on some of the research questions and understated some other critical factors in their investigations. The following sections will elaborate more on these issues.

Panel (a): Methods per Journal



Panel (b): Methods per Year

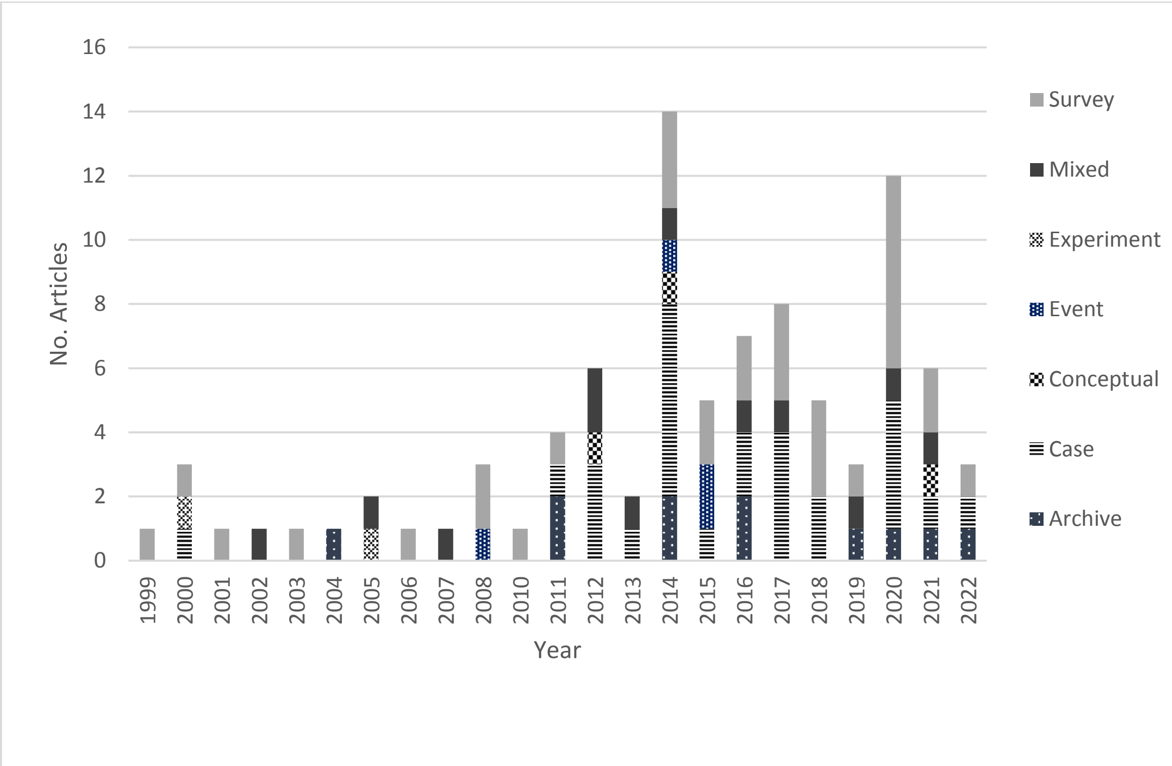


Figure (2.6): Methods Utilized in the Articles

2.3. PDC: Definition, Benefits, & Challenges:

Product Development Collaboration is a multi-dimensional, multi-disciplinary topic that received significant interest from scholars in diverse academic domains such as marketing, strategic management, operations management, information systems, economics, and law. In marketing, the subject of product development and innovation alliances is an active research question since the late 1990s.

Marketing scholars used different terminologies to refer to these interfirm partnerships such as collaborative new product development (Perks, 2000), co-development alliances (Fang et al., 2015), new product alliances (Rindfleisch & Moorman, 2001), new product development alliances (Bouncken et al., 2020), new product innovation alliances (Bouncken et al., 2016), technology alliances (Boyd & Spekman, 2008), R&D partnerships (Eng & Ozdemir, 2014), R&D collaborations (Daniel, Hempel, & Srinivasan, 2002; Du, 2021), and innovation collaborations (Hardwick & Anderson, 2019; Smirnova, Rebiazina, & Khomich, 2018).

Generally, collaborations (also called alliances or partnerships) are defined as "*collaborative efforts between two or more firms in which the firms pool their resources in an effort to achieve mutually compatible goals that they could not achieve easily alone*" (Lambe, Spekman, & Hunt, 2002, p. 141). Adapting this definition to the collaborations that target new product development, researchers provided several definitions of PDCs. For example, Rindfleisch & Moorman (2001, p. 1) defined them as "*formalized collaborative arrangements among two or more organizations to jointly acquire and utilize information and know-how related to the research and development (R&D) of new product (or process) innovations*." Whereas Buyukozkan & Arsenyan (2012, p. 47) stated that PDCs denote "*two or more partners joining complementary resource and experience with mutual aims, in order to design or develop a new or improved product.*" While Oinonen & Falkala (2015, p. 291) conceptualized PDCs as "*a collaborative approach that involves combining knowledge, technologies, and other resources across organizational boundaries to create a novel product, service, or solution.*" And Bouncken et al. (2020, p. 649) referred to PDCs as *"NPD alliances that incorporate any stage of the NPD process from concept development to market launch. Such alliances build on inter-firm complementarities in R&D capacities, intellectual property, technologies, sourcing and marketing capacities."*

The above definitions suggest that the main characteristics of PDCs that differentiate them from other inter-organizational relationships are: (a) they are collaborative arrangements between two or more organizations with an ultimate goal of developing a new product, (b) they can take place at a single or multiple phases of the product development process or cover the entire process from idea generation to market launch, (c) they can pertain to one business function (i.e., R&D/product development) or span multiple functions (e.g., product development, manufacturing, and/or marketing/commercialization), (d) partners, in these collaborations, may pool their financial resources and tangible assets, but they typically integrate their intangible resources (e.g., knowledge, technology, expertise, competences), and (e) partners also share R&D costs and innovation risks and outcomes.

Presumably, firms participate in product development alliances to gain numerous benefits. One key driver for participating in a PDC is to get access to external knowledge and technological capabilities that are not available in-house (Bouncken et al., 2020; Perks, 2000). Working with partners in these arrangements allows firms to exchange their expertise, acquire complementary knowledge, and learn new skills (Du, 2021; Ozdemir et al., 2017; Xu & Zeng, 2021). Another main driver to engage in these partnerships is to share R&D costs and product development risks (Ozdemir et al., 2017; Perks, 2000). Developing a new product usually requires massive R&D investments that can be beyond the capability of a single firm (Neill, Pfeiffer, & Young-Ybarra, 2001). Additionally, the development process is inherently risky (Kim & Song, 2007) and collaborating firms can better navigate market uncertainty together. Also, participating in a PDC might be a source of competitive advantage for firms as they are more likely to utilize their pooled heterogeneous resources to innovate unique products (Buyukozkan & Arsenyan, 2012; Xu & Zeng, 2021). PDCs might enable firms to enhance development flexibility, reduce lead time, improve product quality, and enter new markets (Buyukozkan & Arsenyan, 2012; Perks, 2000).

However, gaining these potential benefits is not costless or risk-free. Forming and managing a PDC generates transaction costs and contractual hazards. Firms would incur *ex-ante* transaction costs of searching for and selecting a qualified partner (Xu & Zeng, 2021). There are also *ex-post* costs of coordinating and monitoring the collaborative activities, and in some cases renegotiating terms of the collaboration with the partners (Buyukozkan & Arsenyan, 2012; Melander & Lakemond, 2015). Additionally, exchanging knowledge, technologies, and expertise with partners is exposing a firm's valuable resources to the risk of leakage and/or appropriability hazards (Du, 2021; Dyer & Hatch, 2006; Oxley, 1997). Out of their fear of the opportunistic behavior of partners, firms might be reluctant to share knowledge important for effective collaboration (Du, 2021; Sivadas & Dwyer, 2000). Yet, another critical issue is related to a firm's ability to effectively combine, integrate, and deploy the acquired knowledge to gain the benefits of collaboration (Xu & Zeng, 2021).

Furthermore, working with other firms in a PDC means that a firm would have less direct control over the product development process (Buyukozkan & Arsenyan, 2012; Littler, Leverick, & Bruce, 1995). This may also mean that the firm might become more dependent on its partners, and its capabilities to innovate independently would diminish (Rindfleisch & Moorman, 2003). Moreover, conflict between partners is not an unusual issue in all inter-orgaizational relationships including PDCs. For instance, partners might disagree on distributing the outcomes of the PDC (Campbell & Cooper, 1999; Perks, 2000). Table (2.2) summarizes the main benefits and drawbacks of PDCs.

Table (2.2): Benefits and Challenges of PDCs

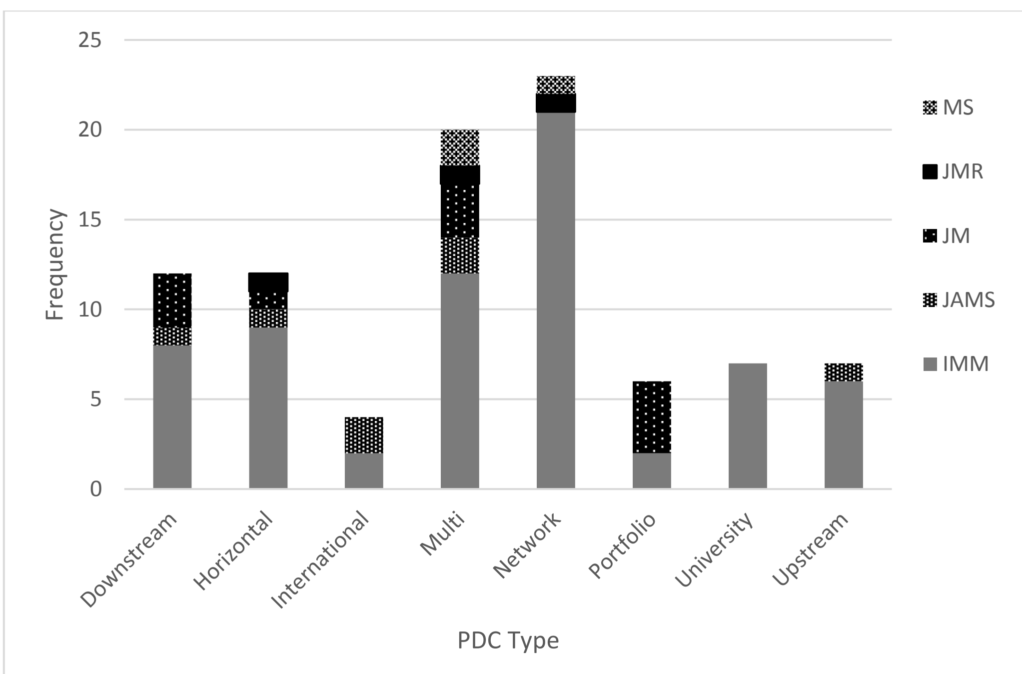
PDCs Benefits/ Drivers	PDCs Challenges/ Risks
▪ Access heterogeneous resources (Bouncken et al., 2020, Du, 2021, Perks, 2000).	▪ Partner opportunism & appropriability hazard (Du, 2021; Oxley, 1997).
▪ Exchange knowledge and expertise (Ozdemir et al., 2017; Xu & Zeng, 2021).	▪ Risk of knowledge leakage (Du, 2021; Dyer & Hatch, 2006; Oxley, 1997).
▪ Share development costs and risks (Ozdemir et al., 2017; Perks, 2000).	▪ Formation and management costs (Xu & Zeng, 2021; Melander & Lakemond, 2015).
▪ Source of competitive advantage (Buyukozkan & Arsenyan, 2012; Xu & Zeng, 2021).	▪ Require strong absorptive capacity to utilize the acquired knowledge (Xu & Zeng, 2021).
▪ Enhance development flexibility (Buyukozkan & Arsenyan, 2012).	▪ Less control over the development process (Buyukozkan & Arsenyan, 2012; Littler et al., 1995).
▪ Reduce lead time (Buyukozkan & Arsenyan, 2012; Perks, 2000).	▪ Reduce ability to innovate independently (Rindfleisch & Moorman, 2003).
▪ Improve product quality (Buyukozkan & Arsenyan, 2012).	▪ Conflict between partners over outcomes (Campbell & Cooper, 1999; Perks, 2000).
▪ Access new markets (Buyukozkan & Arsenyan, 2012; Perks, 2000).	

2.4. Types of PDCs in the Marketing Literature:

The extant marketing studies examined PDCs from three broad perspectives: (a) *dyadic or plural perspective* which focused on partnerships between two (e.g., an OEM and one supplier) or more (e.g., an OEM and several suppliers) organizations (e.g., Bouncken et al., 2016; Chakravart, Zhou, & Sharma, 2020; Fang et al., 2008; Hardwick & Anderson, 2019, Markovic et al., 2020; Wu, 2014; Statsenko & Zubielqui 2020), (b) *portfolio perspective* that examined a portfolio of multiple PDCs of a firm (e.g., Duysters & Lokshin, 2011; Greco et al., 2020; Wuyts, Dutta, & Stremersch, 2004; Zhang et al., 2022), and (c) *network perspective* that investigated innovation networks in which a firm collaborates with diverse types of partners such as customers, suppliers, competitors, and governmental units and institutions to develop new products (e.g., Breslin et al., 2021; Cremer & Loebbecke, 2020; Daniel et al., 2002; Hurmelinna-laukkanen & Nätti, 2018; Yu et al., 2021).

Along these three dimensions, the previous studies discussed several types of PDCs including vertical (upstream and downstream) alliances (e.g., Dan & Zondag, 2016; Hardwick & Anderson, 2019; Statsenko & Zubielqui, 2020), horizontal collaborations (e.g., Navío-Marco, Bujidos-Casado, & Rodrigo-Moya, 2019; Wu, 2014), partnerships with universities and research institutions (e.g., Daniel et al., 2002; Ozdemir et al., 2017; Zhang et al., 2022), and innovation networks (e.g., Perks & Moxey, 2011; Plata, Aparicio, & Scott, 2021; Poblete et al., 2022; Purchase et al., 2014). Any of these PDCs can take place between domestic or international partners. Figure (2.7) shows the popularity of each type in the marketing studies. The following sub-sections discuss each of these types briefly.

Panel (a): PDC Type per Journal



Panel (b): Types per Methods

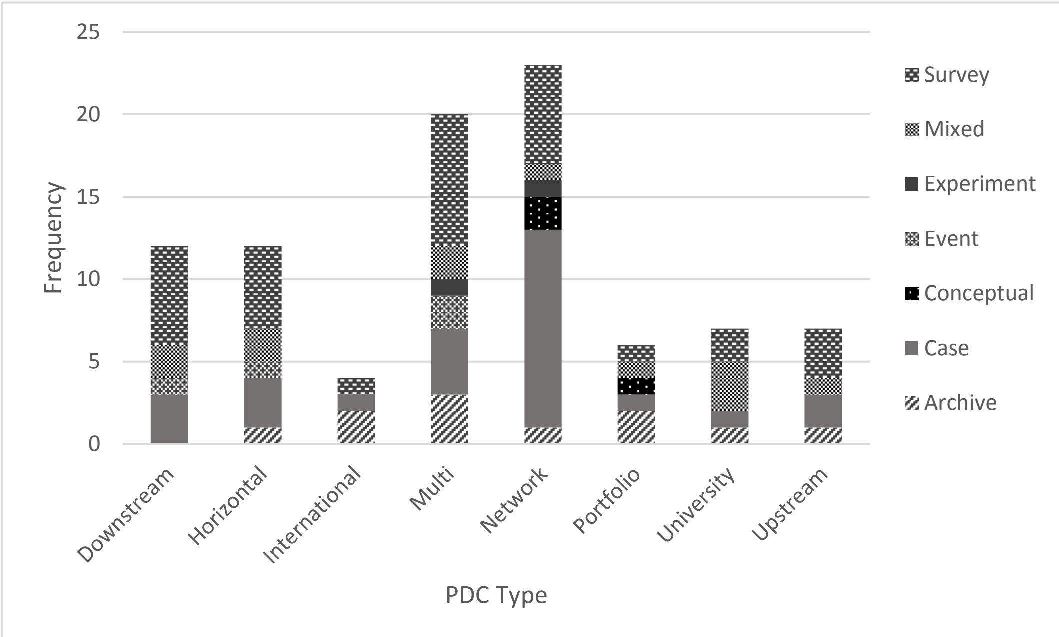


Figure (2.7): PDC Types Investigated in the Articles

2.4.1. Vertical PDCs:

A vertical PDC is a collaborative product development arrangement between a firm and one or more of the current or prospective members of its industrial channel. It could be an **upstream/supplier collaboration** in which a firm collaborates with its supplier(s) or a **downstream/customer partnership** between a firm and its business customer(s). As shown in Panel (a) of Figure (2.7), the reviewed studies gave more attention to the downstream PDCs than the upstream arrangements. Out of the 91 marketing studies reviewed, twelve (13%) articles focused on downstream PDCs exclusively. Whereas only seven (less than 8%) articles centered around upstream alliances. Several of these papers (Chang, 2017; Dan & Zondag, 2016; Li, Wu, & Zhu, 2022; Luzzini et al., 2015; Yeniyurt et al., 2014) examined the effectiveness of upstream PDCs. Yet, their results are not consistent. For instance, Yeniyurt et al. (2014) and Luzzini et al. (2015) found that supplier alliances enhance innovation performance. While Li et al. (2022)

concluded that upstream collaboration has no direct effect on innovation. Aside form studying PDC effectiveness, a few other research questions were investigated in the context of upstream PDCs such as suppliers' willingness to collaborate (Smals & Smits, 2012; Yeniyurt et al.,2014) and governance-related issues (Melander & Lakemond, 2015). Indeed, this dearth of diversified studies in the upstream PDCs is surprising especially because the importance of involving suppliers in the development process is well-recognized early in the literature (Corswant & Tunälv, 2002). Future studies need to study different aspects of upstream alliances and how a firm can structure and manage them to reap the most benefit from its relationships with suppliers.

On the other hand, marketing downstream PDC studies investigated quite diverse questions including customer alliance effectiveness in terms of superior products (Campbell & Cooper, 1999), improved development process (Fang et al., 2008), increased market value of a firm (Fang et al., 2015), and innovation performance (Statsenko & Zubielqui, 2020). They also examined customer participation roles (Fang, 2008), the benefits and drawbacks of embedded ties between partners (Noordhoff et al., 2011), the impact of singular versus plural governance mechanisms on product innovativeness (Bouncken et al., 2016), the knowledge integration mechanisms (Eslami et al., 2018), joint learning facilitators (Huikkola, Ylimäki, & Kohtamäki, 2013), and the role of video conferencing technology in enhancing customer involvement (Hardwick & Anderson, 2019).

However, some of the results of these studies are not consistent. For instance, Campbell & Cooper (1999) found that customer alliances have no value over in-house development in enhancing product performance. Similarly, Statsenko & Zubielqui (2020) concluded that customer PDC has no direct impact on innovation performance. In contrast, Fang et al. (2008) found that customer participation enhances the new product development processes. These mixed results underline the disagreement in the literature regarding PDC effectiveness and point to the importance of studying several contingent factors that might affect PDC outcomes.

2.4.2. Horizontal/Competitor PDCs:

More and more competing firms are collaborating to carry out their innovation activities (Zhao et al., 2020). This emerging relationship in which business rivals cooperate on developing new products is known as horizontal/competitor alliances. Table (2.3) summarizes the differences between vertical and horizontal PDCs. In horizontal PDCs, partners have more complementary resources and lower levels of trust than partners in vertical PDCs (Rindfleisch & Moorman, 2003). Therefore, supplier knowledge absorption and integration are more costly, while partner opportunism and appropriability hazards are higher in horizontal alliances (Zhao et al., 2020).

Table (2.3): Vertical versus Horizontal PDCs

	Vertical versus Horizontal PDCs	**Refence(s)**
Composition	In a *vertical PDC*, partners are channel members operating at different levels of the value chain. While in a *horizontal PDC*, partners are competitors at the same level.	Kotabe & Swan, (1995); Ozdemir et al. (2017); Rindfleisch & Moorman (2001).
Partners' goals	Partners in vertical PDCs have less-conflicting goals and objectives than competitor partners.	Rindfleisch & Moorman (2001; 2003).
Cooperation	The level of cooperation between partners in vertical PDCs is higher than that between competitor partners.	Boyd & Spekman (2008).
Complementary assets	Partners in vertical PDCs have greater access to complementary assets (e.g., components and materials) of other channel members in the collaboration as compared to the same-level partners of horizontal alliances.	Harabi (1998).
Relational embeddedness & trust	Channel members in vertical alliances have higher levels of mutual trust and relational embeddedness than competitors in horizontal PDCs.	Rindfleisch & Moorman (2001; 2003).
Opportunism	Partners in vertical PDCs are less concerned about partner opportunism than partners of horizontal alliances.	Rindfleisch & Moorman (2003); Zhao et al. (2020).
Specific investments	Partners in vertical collaborations are more motivated to make specific investments than competitor partners.	Rindfleisch & Moorman (2003).

	Vertical versus Horizontal PDCs	Refence(s)
Knowledge characteristics	Partners in vertical PDCs are more likely to have diverse/non-redundant knowledge as compared to competitor partners that presumably have overlapping knowledge bases.	Markovic et al. (2020); Ozdemir et al. (2017); Rindfleisch & Moorman (2003).
Knowledge absorption and utilization	Acquiring, interpreting, assimilating, and utilizing knowledge from channel members in a vertical PDC is more challenging (difficult and costly) and less efficient than absorbing and utilizing knowledge from a competitor partner.	Kotabe & Swan (1995); Rindfleisch & Moorman (2001; 2003).
Knowledge sharing	In vertical PDCs, partners are less reluctant to share valuable/new knowledge that might generate competitive advantages than competitor partners.	Markovic et al. (2020); Ozdemir et al. (2017).
Knowledge spill-over	Knowledge leakage to channel members in vertical PDCs is less costly than knowledge spill-over to a competitor partner.	Markovic et al. (2020).
Tendency for collusion	Partners of a vertical PDC are less likely to engage in collusive activities (e.g., prices, reduction in collective innovation) as compared to partners in horizontal collaboration.	Rindfleisch & Moorman (2003).

Cooperation between business competitors (i.e., co-opetition) is attracting growing interest from academic scholars (Wu, 2014). In the marketing literature, a dozen studies (e.g., Perks, 2000; Wu et al., 2015; Xu & Zeng, 2021; Xu, Wu, & Cavusgil, 2013; Yami & Nemeh, 2014) investigated the topic. Most of these studies examined the effectiveness of horizontal PDCs. For instance, Luo, Rindfleisch, & Tse (2007) studied how collaborating with competitors might affect a firm's financial performance. Their results illustrated that intensive collaboration with competitors is negatively associated with firm profitability, while a moderate intensity of partnership would increase profits. Similarly, Wu et al., (2015) examined the impact of horizontal alliances on the market value of firms. They concluded that collaborating with rivals at the initiation stage of the product development process generates positive abnormal returns, but PDCs at later stages of the development have negative impacts.

Moreover, Estrada et al. (2016), Wu (2014), and Xu et al. (2021) investigated the impact of competitor alliances on innovation performance. However, their results are inconsistent. Wu (2014) found an inverted U-shaped relationship between horizontal alliances and product innovation. While Estrada et al. (2016) concluded that competitor alliances have no direct impact on innovation performance. Yet, Xu et al. (2021) demonstrated that horizontal PDCs enhance collaborative innovation.

These conflicting results show the existing disagreement in the literature about the effectiveness of horizontal PDCs in enhancing firm innovativeness (Bouncken et al., 2016). Future studies need to investigate the conditions under which competitor alliances might be useful. Other interesting questions to be studied are identifying the alliance structure and governance mechanism that might enhance knowledge sharing and safeguard against partner opportunism, and examining the characteristics of competitors (e.g., direct versus indirect) that are more likely to form successful alliances.

2.4.3. Collaboration with Research Institutions:

Some firms prefer to get access to new knowledge and innovation ideas from academic institutions by collaborating with universities and research centers. This is, partially, because partnering with research institutions imposes less risk than business collaborations in terms of less knowledge spillover to competitors and partner opportunism (Wu, 2014).

In the marketing literature, seven studies examined these arrangements. For instance, Daniel et al. (2002) investigated the relationship between the research capacity of research centers and their outcomes in terms of satisfaction and commitment. Both Raesfeld, Geurts, & Jansen (2012) and Winkelbach & Walter (2015) studied the value creation performance in science/university-industry alliances. Also, Clauss & Kesting (2017) investigated the impact of governance mechanisms on joint goal accomplishment through knowledge sharing in university-business collaborations. Further, Canhoto et al. (2016) explored factors that drive the success of R&D collaborations between firms and universities.

A few other marketing studies (e.g., Reypens et al., 2016; Zhang et al., 2022) examined PDCs with research institutions in the context of innovation networks and alliance portfolios that are presented below.

2.4.4. Innovation Networks:

In innovation networks, firms collaborate on new product development with different entities/stakeholders that usually include customers, suppliers, competitors, research institutions, and sometimes governmental units (Najafi-Tavani et al., 2018; Rampersad et al., 2010). Generally, innovation network is a relatively new research area that is witnessing growing interest from scholars since the last decade. In our review, twenty-three studies (25% of the investigated articles) focused on innovation networks/ecosystems.

As an emerging topic, many marketing studies on innovation networks utilized exploratory research methods (e.g., case studies and conceptual frameworks) to better understand these arrangements and the factors affecting their success. For example, Perks & Moxey (2011) studied cases from the telecommunications industry to explore the effective distribution of tasks and resources among collaborating firms to enhance product innovation. Also, Munksgaard et al. (2012) considered multiple cases in the food industry to study the sources of conflict between a network's partners. Based on a case from the Irish pharmaceutical industry, O'Malley et al. (2014) explored the relationship between organizational identity and radical innovation in innovation networks.

Further, Reypens et al. (2016), based on cases from the health care industry, analyzed how value is created and captured by participating stakeholders. Both Kreye & Perunovic (2020) and Liu et al. (2020) deployed the case study method to study relationships between network partners. While Yu et al. (2021) explored the mechanisms of building trust between actors in innovation networks for developing green products in the Chinese digital infrastructure. Moreover, Poblete et al. (2022) used a longitudinal case to examine the relationship between temporary structures and innovation in networks.

Additionally, Corsaro, Cantù, & Tunisini (2012) developed a conceptual framework to explain the sources of heterogeneity between network partners and how they might impact co-development innovation. Likewise, Tracey, Heide, & Bell (2014) composed a conceptual paper to analyze clustered networks, a special form of product development collaborations formed among firms located in the same geographic area. Similarly, Hurmelinna-laukkanen & Nätti (2018) developed a conceptual framework to discuss network orchestrators, their types, capabilities, and roles in innovation networks.

However, relatively fewer articles utilized quantitative techniques to empirically study these networks. For instance, Amaldoss & Rapoport (2005) ran experiments to examine the impact of the structure of the competition between networks on investments made by network partners. Fang et al. (2016) used archival data to study the effect of a firm's position in a global network on new product launches. While others (e.g., Cremer & Loebbecke, 2020; Inigo, Ritala, & Albareda, 2020; Najafi-Tavani et al., 2018; Plata et al., 2021, Rampersad et al., 2010) utilized the survey method to investigate the development, effective management, and performance of innovation networks. Yet, more empirical investigation is needed to examine the different aspects of innovation networks in terms of effective network composition, resource configuration and management, knowledge and value sharing mechanisms, conflict management, and appropriate governance modes.

2.4.5. Collaboration Portfolio:

Typically, firms do not place their different alliances in separate silos and run them independently. Instead, they manage them as a portfolio of multiple PDCs. Relatively few marketing studies (only six in our review) addressed this phenomenon. Most focused on investigating the relationship between portfolio diversity and innovation. For instance, Greco et al. (2020) investigated the impact of alliance portfolio diversity on innovation abandonment, and found that collaborating with diverse firms reduces innovation abandonment. Likewise, Wuyts et al. (2004) concluded that the technological diversity of a portfolio enhances radical and incremental innovation. While Cui & O'Connor (2012) observed that resource diversity of alliance portfolio enhances innovation performance only when the firm has majority control of alliances and possesses alliance management capability. Also, Lee (2011) found that alignment between contract terms and knowledge creation and appropriation in a portfolio enhance radical innovation. Further, Zhang et al. (2022) revealed that a portfolio breadth (depth) has a positive (negative) impact on firm growth.

The focus of prior studies on a specific aspect of collaboration portfolio provides an opportunity for interested marketing scholars to investigate other issues such as portfolio configuration (e.g., whether and when a portfolio of diverse types of PDCs would benefit the firm more than a portfolio of similar PDCs), allocating resources across alliances in a portfolio, and aggregating knowledge and technologies from alliances in a portfolio to enhance firm innovation and financial performance.

2.4.6. International PDCs:

An international PDC is a partnership in which firms in different countries combine their resources to develop new products (Harmancioglu, Griffith, & Yilmaz, 2019). Previous studies argued that geographic distance between alliance partners provides better opportunities for learning and innovation (Kim, 2013). International partners are more likely to offer unique capabilities and diverse resources than domestic partners who might offer redundant knowledge (Tower, Hewett, & Saboo, 2021). Combining the distinctive resources and technologies of international partners would stimulate new solutions and accelerate innovation (Lavie & Miller, 2008).

However, international, compared to domestic, PDCs require higher coordination costs and raise difficulties in building trust and establishing working routines between the partners, hindering effective learning and knowledge absorption (Einola et al., 2017; Martinez-Noya & Narula, 2018).

A handful of marketing studies employed a context of international PDCs in their studies. For instance, Sivakumar et al. (2010) used archival data on US pharmaceutical companies in international PDCs to test the impact of alliance expertise and governance modes on innovation and financial performance. While Eng & Ozdemir (2014) collected survey data to study the impact of the integration of intra- and inter-firm activities on NPD performance in international alliances. Also, Einola et al. (2017) implemented a comparative case study approach to explore retrospective relational sensemaking in international R&D collaborations. Whereas Harmancioglu et al. (2019) utilized an event study method to examine the short- and long-term impacts of forming an international PDC on the market value of a firm.

Although these studies investigated important research questions, several other issues remain understudied. For instance, whether international PDCs enhance innovation more than domestic collaborations? Under which conditions would a firm prefer international partners over domestic firms? What are the effective mechanisms of knowledge sharing across-borders? And how do firm capabilities affect the effectiveness of international versus domestic PDCs?

2.5. The Effectiveness of PDCs:

One of the most intensively studied questions in the literature is the outcomes of PDCs. Many marketing researchers investigated the impact of PDCs on different aspects of firm performance including profitability, market value, innovation performance, as well as new product outcomes and performance. However, these studies presented mixed results of positive, negative, curvilinear, or no relationship between PDCs and firm performance.

For instance, Borah & Tellis (2014) and Wu et al. (2015) found that collaborating at the initiation phase of the NPD process generates positive abnormal returns. While Lee & Chang (2014) demonstrated that forming R&D collaborations generates less profits than focusing on internal R&D for low-tech firms. However, Luo et al. (2007) revealed that there is an inverted U-shaped relationship between horizontal PDCs and firm profitability for both high- and low-tech firms. Likewise, Wu (2014) demonstrated that collaborating with competitors has an inverted U-shaped relationship with product innovation performance. Yet, Estrada et al. (2016) revealed that horizontal alliances per se have no direct impact on innovation performance. In contrast, Xu et al. (2021) found that competitor PDCs directly enhance innovation performance. Similarly, Fang et al. (2008) declared that customer PDCs improve innovation processes. While

Statsenko & Zubielqui (2020) reported that customer collaborations have no direct impact on innovation performance.

Further, Rindfleisch & Moorman (2003) demonstrated that horizontal PDCs negatively affect a firm's level of customer orientation over time. While Ozdemir et al. (2017) declared that competitor alliances enhance the responsive market orientation of firms. Arguably, the conflicting findings can be partially attributed to the absence of important contingent factors, from some studies, that might have explained how and when PDCs would affect firm performance. These factors include the collaboration form, firm capabilities, and the characteristics of PDC partners. The following sections elaborate on these factors.

2.6. Factors Affecting PDC Success:

There are several conditions under which PDCs might enhance firm performance. Generally, factors that might affect the effectiveness of PDCs can be grouped into two main categories: *collaboration-related factors* (e.g., collaboration structure, partner characteristics, and relational capital) and *firm-specific factors* (e.g., firm capabilities, absorptive capacity, firm strategy). A brief discussion of these variables follows.

2.6.1. Collaboration-Related Factors:

Establishing an effective PDC requires certain decisions such as selecting a qualified partner (Tsou, Chen, & Yu, 2018) and determining the appropriate governance mechanism (transactional/formal and/or relational) that would alleviate the opportunistic behavior of partners and facilitate the transfer and combination of resources between collaborating firms (Bouncken et al., 2016; Hoetker & Mellewigt, 2009).

A) Partner Selection:

There is increasing attention in the PDC literature to the question of why firms collaborate with a particular partner. Previous studies (e.g., Emden, Calantone, & Droge, 2006; Liou, 2012; Parker & Brey, 2015; Sarkar et al., 2001; Tsou et al., 2018) illustrated that effective partner selection is a critical factor for alliance formation, success, and performance. They attributed this relationship to the influence that collaborating with partners with certain characteristics (i.e., resources portfolios) might have on the bundle of a firm's resources and skills (Liou, 2012), such that choosing partners who possess certain resources will affect the mix of resources that will be available to the collaborating firms and thus determines the alliance success (Sarkar et al., 2001). Therefore, the literature focused on the concept of ***technological diversity***.

Technological diversity (also called resource diversity, partner (dis)similarity, and R&D/ knowledge distance) refers to whether collaborating firms have similar/homogeneous or diverse/ heterogeneous resources, knowledge base, and technological capabilities (Sampson, 2004b). Several marketing studies investigated the impact of technological diversity on outcomes. For example, Rindfleisch & Moorman (2001) examined the impact of having a partner with similar knowledge on acquiring and utilizing information in new product alliances. They found that knowledge redundancy (i.e., similar knowledge) hinders information acquisition but improves information utilization.

Similarly, Khamseh, Jolly, & Morel (2017) examined the dissimilarity between partners' knowledge bases on the firm's utilization of knowledge acquired from that partner. However, they found that the dissimilarity between partners has an inverted U-shaped relationship with knowledge utilization. Yet, Zhao et al., (2020) demonstrated that technological heterogeneity improves innovation development and relationship embeddedness between partners. Also, Wuyts et al. (2004) revealed that the technological diversity of a portfolio of R&D collaborations has a positive impact on firm innovation, but it hurts its profitability. Likewise, Cui & O'Connor (2012) concluded that resource diversity of alliance portfolio enhances innovation performance only when the firm has majority control of alliances and possesses alliance management capability.

Generally, the literature has a debate regarding the effectiveness of partnerships between firms with similar resources and technological overlaps. Some scholars argue that firms with similar resources can collaborate more easily because they possess similar routines (Luo & Deng, 2009) that would enable easier communication, coordination, and transfer of knowledge between them (Lin et al., 2012). In contrast, others assert the importance of resource complementarity for effective partnering (Xu & Zeng, 2021). Firms would ally if the value resulting from their pooled resources is higher than the value created by each firm (Chung, Singh, & Lee, 2000; Rothaermel & Boeker, 2008).

Moreover, the debate goes further by suggesting that firms with overlapping technologies would be reluctant to share their valuable knowledge with partners because knowledge similarity makes the partners competitive against each other (Luo & Deng, 2009). Similar firms would have the absorptive capacity that enables them to easily acquire and assimilate partner knowledge and then they can exploit these technologies opportunistically to achieve private gains (Ho & Ganesan, 2013).

Conversely, Sampson (2004b) provided a different perspective on knowledge leakage and opportunism. She argued that partners with diverse technologies might face more opportunism because each firm would have more incentive to behave opportunistically to achieve more gain from the unique knowledge of its partner. Yet, some studies (e.g., Sampson, 2007) tried to integrate these two seemingly-conflicting perspectives by proposing that technological diversity might have an inverted U-shaped relationship with collaboration effectiveness, such that moderate levels of dissimilarity between partners would achieve better results than high or low diversity levels.

The above discussion reveals the debate and mixed results in the literature regarding partner selection and its impact on PDC effectiveness. This points to the existence of critical research gaps and opens the opportunity for carrying out further research on this topic. For example, future studies may identify the appropriate alliance structure that would govern the collaboration between partners with particular characteristics (i.e., resource profiles). Also, researchers may investigate factors (e.g., absorptive capacity, knowledge-sharing mechanisms) that would moderate the relationship between technological diversity and collaboration effectiveness.

B) PDCs Structure (Transactional/Formal Governance Mechanisms):

Product development arrangements can take one of three formal modes: *joint ventures*, *joint development agreements*, and *technology licensing contracts* (Mowery, Oxley, & Silverman, 1996; Oxley, 1997). These contracts lean towards the TCE's market governance form, while joint ventures are closer to the hierarchy governance (Lee, Yeung, & Cheng, 2009). The following paragraphs distinguish between these governance mechanisms.

a. Equity Joint Ventures (JVs):

An equity joint venture is a form of interfirm collaboration in which partners agree to jointly establish and operate a separate legal entity to achieve a common goal (Oxley, 1997). Partners are committed to bringing together their technologies and resources (Kogut, 1988) and making reciprocal specific investments (Hagedoorn & Hesen, 2007). They also share risks and rewards in proportion to their equity in the venture (Houston & Johnson, 2000). The shared equity aligns partners' incentives as the success of one partner depends on the success of the venture (Oxley, 1997). This enhanced alignment of incentives would attenuate partners' desire to act opportunistically (Oxley, 1999). Curtailing opportunism in JVs may also result from the joint management and control over the venture's activities entitled to partners. In fact, JVs are run by a board of directors that comprises members from each partner firm (Oxley, 1997).

Although it is very costly to negotiate and initiate a JV (Sampson, 2004a), JVs provide collaborating firms with major benefits. In addition to reducing the risk of a partner's free-riding behavior, curbing the appropriability hazards, and safeguarding against undesired knowledge spill-over (Sampson, 2004a); JVs support great coordination among partners and enhance their adaptability (Oxley, 1997). Through joint administrative control, partners are better able to adjust their actions in response to unanticipated changes and emerging opportunities.

Not only that but also because of the attenuated opportunism, partners are motivated to make specific investments and share their valuable knowledge and technological resources (Sampson, 2004a). Partners also have a great opportunity to acquire and assimilate new knowledge and skills from each other through their direct interactions carrying out the activities of the JV (Lane & Lubatkin, 1998). The ongoing relationship between the partners also promotes commitment and trust among them and allows them to form common routines that further improve coordination, adaptability, and knowledge sharing.

Notwithstanding these benefits do not come without costs. Establishing and terminating a JV is a very costly and complicated process (Hagedoorn & Hesen, 2007). Also, in JVs, the decision-making process is centralized and often slow, this might restrain innovation, which requires a quick response to changes. Innovation can also be frustrated in JVs because of high bureaucracy levels. Employees in JVs may lose incentives to innovate because of the “bureaucratic control” practiced on them (Sampson, 2004a). Last but not least, partners have lower incentives to exploit technologies for other uses than those determined in the agreement. Although this will significantly reduce free-riding behaviors, it will also limit firms’ abilities to fully utilize technology to its best uses (Oxley, 1999).

b. Joint Development Agreements (Agreements):

A joint development agreement is a hybrid form of interfirm partnership where partners agree to pool their technologies, skills, and resources to jointly conduct research and develop a new product, without creating a new entity (Oxley, 1997). This collaboration form is often a project-based arrangement that usually dissolves upon the completion of its mission. These agreements have fixed durations that are longer than technological licensing contracts (Hagedroon & Hesen, 2007), but they impose higher negotiation and formation costs compared to these contracts (Sampson, 2004a).

Like JVs, partners in joint development agreements have aligned incentives, they also exchange mutual hostages (Oxley, 1997). Working together on the same project facilitates the interaction and the flow of knowledge between partners (Lane & Lubatkin, 1998). Partners are also motivated to cooperate and adapt to changing circumstances. However, JV partners cooperate and interact to a greater extent and for longer periods than partners in agreements (Harrigan, 1988). Unlike JVs, decision-making in agreements is a decentralized process that might enhance partners' abilities to quickly adapt to changes and swiftly seize emerging opportunities (Sampson, 2004a). Moreover, compared to JVs, agreements are less costly to form, easier to terminate, and have lower termination costs (Oxley, 1999). Nevertheless, JVs provide a stronger safeguard against opportunism and more vigorous protection from knowledge spillover (Sampson, 2004a).

c. Technology Licensing Contracts (Licenses):

Technology licensing has increasingly become an important form of interfirm technological collaborations in our modern economy where competition has been intensified, and technology sustains hasty changes, especially for firms operating in high-tech industries (Kim & Vonortas, 2006). It can be defined as a contract-based form of interfirm partnership in which one firm (the licensor) gives another firm (the licensee) the right to use its technology in its internal activities in return for monetary compensation (Oxley, 1999). It can be deemed as a passive mode of collaboration with resources unilaterally flowing from the licensor to the licensee. This implies that there would be no reciprocal specific investments; only licensees would make such investments. Because of this unilateral flow of knowledge, licensees will learn passively through acquiring licensors' technologies and hence knowledge exchange is limited (Hagedoorn & Hensen, 2007).

A technology licensing contract is a mechanism that is designed particularly to govern the exchange of knowledge as an intangible resource that raises special exchange concerns.

Specifying technological contracts is very complex partially because of the information asymmetry between exchange parties (Bessy & Brousseau, 1998). For instance, buyer firms cannot assess the value of the technology *ex-ante*, and it is also difficult to measure the quality of the output *ex-post* (Mayer & Salomon, 2006). This special nature of technological transactions induces partners to craft incomplete technology contracts (Helm, Kloyer, & Aust, 2020) to reduce the transaction costs of specifying and enforcing the contract. Nevertheless, the contract incompleteness might increase opportunism and appropriability hazards (Oxley, 1997).

However, using licenses to govern technological transactions is not without merit. Licenses are relatively less costly to negotiate and craft than agreements and JVs (Sampson, 2004a). They can also be terminated easily and with low costs (Hagedroon & Hensen, 2007). Partners have complete autonomy to make decisions and great flexibility to end the partnership at any time. Firms also have a high-powered incentive to make the best use of technology and to utilize it in all possible areas (Mayer & Salomon, 2006). Table (2.4) summarizes the main advantages and costs of the three governance mechanisms.

Table (2.4): A Summary of the Major Benefits and Costs of Formal Governance Mechanisms

Governance	Definition	Advantages/ Major Benefits	Disadvantages/ Major Costs
Equity Joint Ventures	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). ▪ Improve adaptability to unforeseen circumstances and emerging opportunities (Sampson, 2004b).	▪ 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).

Governance	Definition	Advantages/ Major Benefits	Disadvantages/ Major Costs
Joint Development 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).	▪ Relatively high formation and negotiation costs (Sampson, 2004a). ▪ Higher risk of opportunism than JVs (Oxley, 1997). ▪ High adaptation costs (Pisano, 1990).
Technology Licensing Contracts	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).	▪ 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).

As inspired by the TCE approach, scholars in various academic domains such as economics, strategic management, marketing, and law gave great attention to the interfirm governance topic. Several non-marketing studies (e.g., Hagedoorn, Cloodt, & Kranenburg, 2005; Li et al., 2008; Sampson, 2004b) examined the conditions under which a firm would prefer one governance mechanism over the others in product development alliances. However, the performance implications of these formal mechanisms, in a PDC context, received less research attention with few exceptions such as Sampson (2004a).

In marketing, few scholars explicitly investigated PDC governance. For example, Sivadas & Dwyer (2000) studied the indirect impact of three administrative mechanisms (formalized, decentralized, clannish) of development alliances on alliance success through cooperative competency. While Bouncken et al. (2016) investigated the effect of utilizing singular (transactional or relational) versus plural (transactional and relational) governance mode on product innovation. Also, Sivakumar et al. (2011) studied the impact of JVs versus non-equity mechanisms on innovation generation. While Melander & Lakemond (2015) investigated the separation of relational and transactional governance issues between R&D and purchasing entities in a firm. Similarly, Clauss & Kesting (2017) examined the impact of relational versus transactional governance mechanisms on knowledge sharing between PDC partners.

Other marketing studies treated governance as a mediator or moderator variable. For instance, Noordhoff et al. (2011) studied the moderating role of relational versus formal contractual rules in the relationship between embedded ties and innovation. Also, Tracey et al., (2014) developed a conceptual framework to illustrate the relationship between network cluster configuration and new product outcomes through relational versus hierarchical governance mechanisms. Whereas Fang et al. (2015) focused on equity versus non-equity governance mechanisms as moderators of the relationship between collaboration timing and firm value.

As discussed above, most of the marketing studies focused on the trade-off between relational versus transactional governance mechanisms. Surprisingly, little effort has been done to scrutinize the nuances between the different formal/transactional mechanisms. Indeed, identifying the differential impact of the formal modes and the conditions under which each might yield superior performance would guide executives in choosing the appropriate structure for successful PDCs. Future studies are needed to investigate the impact of the continuum of formal governance modes on different aspects of firm performance and identify the contingent factors that might affect this relationship.

C) Relational Capital:

Previous studies denoted the important role of relational investments resulting from repeated interactions between firms in (a) promoting trust, commitment, and mutual understanding, (b) restraining opportunism (Bouncken et al., 2016; Sarkar et al., 2001), and (c) facilitating knowledge sharing and learning (Subramanian, Bo, & Kah-hin, 2018). Through repetitive partnerships, firms would build trust that would reduce the tendency to behave opportunistically and develop work routines that would facilitate coordination and reduce the transaction costs of knowledge sharing (Li et al., 2008). Also, the expectation of continuity resulting from the embedded social ties between partners would motivate reciprocal investments in specific assets (Poppo & Zenger, 2002).

Due to these benefits of relational governance, some studies demonstrated that supporting formal mechanisms with social relationships would result in better outcomes. For instance, Bouncken et al. (2016) reported that utilizing singular relational governance would enhance innovation performance in vertical alliances with high levels of coopetition. In contrast, following singular transactional governance can hurt product innovativeness in these partnerships. While complementing relational governance with transactional governance might improve product innovativeness even more. Likewise, Noordhoff et al. (2011) found that a supplier with a long-term relationship with customers that utilizes formal governance rules would obtain positive innovation outcomes from its embedded ties with those partners.

On the other hand, other studies illustrated the conditions under which each governance mode would be more effective. For example, Tracey et al. (2014) argued that relational governance would enhance product novelty when networks are formed as dense clusters, while hierarchical governance would increase speed to market when they are centralized clusters. Future work is needed to examine in different contexts when the two governance mechanisms would work better together and when each would excel.

2.6.2. Firm-Specific Factors:

Making important collaboration-level decisions about selecting a qualified partner and choosing the appropriate governance mode are crucial to forming an effective PDC. Notwithstanding, for a firm to benefit from these collaborations, it has to possess certain levels of absorptive capacity (Cohen & Levinthal, 1990; Dobrzykowski et al., 2015; Bosch, Volberda, & Boer, 1999) which is directed by its capabilities of R&D, marketing, and operations; such capabilities are not native to a firm and are generated from resources that the firm invests in (Narasimhan, Rajiv, & Dutta, 2006). These investments are thus strategic in nature and are driven by the firm strategy (Chen, 2004). The following sub-sections elaborate on absorptive capacity, firm capabilities, and firm strategy as three firm-specific factors that affect how a firm can acquire and utilize partner knowledge and technologies to achieve its goals.

A) Absorptive Capacity:

Absorptive capacity is an organizational capability that enables a firm to recognize the value of external knowledge, acquire, assimilate, and apply it to create value and improve its performance (Cohen & Levinthal, 1990). This capability to value, leverage, and utilize external knowledge enables firms to develop products that enhance their competitive advantage and boost their financial performance (George, Zahra, & Wheatley, 2001).

Although external knowledge is a key resource for innovation, it is not just the mere exposure or even the capture of such knowledge that would improve firm innovativeness. A firm needs a strong absorptive capacity to understand, assimilate, and integrate the acquired knowledge into its internal knowledge base and utilize the resulting new knowledge in its activities. Thus, firms with higher absorptive capacity would gain more benefits than those with lower capacity even if they are both exposed to the same external knowledge (Chen, Lin, & Chang, 2009; Wang & Han, 2011).

In the PDC literature, numerous marketing studies (e.g., Bouncken et al., 2020; Cui & O'Connor, 2012; Estrada et al., 2016; Lee & Chang, 2014; Rindfleisch & Moorman, 2001, 2003) built some of their arguments on the absorptive capacity perspective to posit that firms can easily acquire and assimilate the knowledge that is related to their existing knowledge repositories (Cohen & Levinthal, 1990).

However, marketing studies that formally examined absorptive capacity, in the context of PDCs, as a focal variable are scant. Two notable exceptions are Winkelbach & Walter (2015) that investigated the moderating effect of absorptive capacity in the relationship between knowledge complexity and value creation in PDCs and Najafi-Tavani et al. (2018) that examined the indirect impact of absorptive capacity on new product performance through product and process innovation capabilities.

Future studies may study the relationship between absorptive capacity and governance mechanisms of effective PDCs, such as whether firms with strong absorptive capacity would benefit more from forming JVs or other non-equity mechanisms. Also, studies may examine the effect of a partner's absorptive capacity on a firm's choice of governance mechanisms that safeguard against unintended knowledge leakage.

B) Firm Functional Capabilities:

Capabilities refer to an organizational capacity of a firm to combine resources and deploy them through its processes to attain desired goals (Narasimhan et al., 2006). These capabilities are firm-specific bundles of knowledge and skills that are developed through the complex interaction of resources over time. Because they are deeply embedded in organizational processes and cannot be easily transferred or imitated, they are a good source of competitive advantage (Krasnikov & Jayachandran, 2008). Three functional capabilities (i.e., marketing, technological, and operations) have been identified as the core capabilities for product innovation as they underlie the processes of developing, manufacturing, and commercializing new products (Danneels, 2002).

Marketing capabilities refer to a firm's ability to understand and satisfy customer needs and wants ahead of competitors combined with its ability to build and sustain strong relationships with customers and business partners (Krasnikov & Jayachandran, 2008). A firm's marketing capabilities work as an integrative process that enables it to integrate tangible and intangible resources to understand market trends, identify market opportunities, and develop differentiated products that can satisfy customer needs better than rivals (Su, Tsang, & Peng, 2009).

While ***technological capabilities*** denote a firm's capacity to convert its resources (i.e., R&D expenditure) into innovation (Narasimhan et al., 2006) through investing in internal R&D activities to build a stock of technological knowledge (Berchicci, 2013). They also refer to a firm's skills in developing and utilizing various technologies to innovate new products and processes (Krasnikov & Jayachandran, 2008; Moorman & Slotegraaf, 1999).

Whereas ***operations capabilities*** indicate a firm's skills in coordinating a complex set of activities to enhance its outputs through the most efficient use of technologies, production processes, and flow of materials (Nath, Nachiappan, & Ramanathan, 2010). They qualify the firm to deploy the available resources efficiently and flexibly to manufacture innovative products (Cousins et al., 2011).

Functional capabilities would affect how firms benefit from PDCs (Subramanian et al., 2018). Firms with technological capabilities can evaluate their potential partners and better select among them (Berchicci, 2013). Technological capabilities would enable firms to better evaluate, acquire, and assimilate knowledge and technologies from their partners (Berchicci, 2013) and effectively convert these resources into innovations (Narasimhan et al., 2006). Similarly, firms with marketing capabilities can extract more value from the partnership. Their strong brands and other valuable market resources will grant them bargaining power over their partners (Xiong & Bharadwaj, 2011). Also, marketing capabilities would enable them to exploit the knowledge acquired from partners to respond quickly to changing customer needs (Su et al., 2009). In addition, they can efficiently and independently commercialize the co-developed products (Zang & Li, 2017). Likewise, firms with operations capabilities can effectively manage their new product development processes and collaborations. Operations capabilities would enhance a firm's ability to efficiently coordinate and process a mix of resources acquired from diverse sources to produce new products (Cousins et al., 2011; Nath et al., 2010).

However, some studies pointed to the shortcomings of having strong capabilities and argued that there is a curvilinear relationship between capabilities and firm performance (Lichtenthaler, 2016; Volberda, Foss, & Lyles, 2010; Wales, Parida, & Patel, 2013). Firms with strong capabilities might suffer from organizational inertia such that they would focus on acquiring knowledge related to their existing fields of competencies and ignore knowledge and opportunities in new areas. By doing so, a firm would raise a core rigidity and fail to gain the benefits of radical technological advances that might result from adopting solutions from outside its core experiences (Lichtenthaler, 2016).

Generally, functional capabilities received remarkable interest from marketing scholars. Most of them (e.g., Moorman & Slotegraaf, 1999; Narasimhan et al., 2006; Nath et al., 2010; Yu, Ramanathan, & Nath, 2014) draw on the RBV perspective to explain the relationship between capabilities and firm performance. However, in a PDC context, few marketing studies explicitly considered the effect of functional capabilities on PDC effectiveness. For example, Wu (2014) examined the moderating role of technological capabilities in the relationship between competitor alliances and innovation performance. Also, Fang et al. (2015) studied technological capabilities as a moderator between the timing of collaboration and the market value of a firm. Likewise, Fang et al., (2016) investigated the moderate role of technological capabilities in the relationship between a firm's position in a network and new product launches.

With only a handful of marketing studies that formally examined just one of the three capabilities (i.e., technological capabilities), the effect of firm capabilities on PDC effectiveness is understudied. Further investigation is required to analyze how functional capabilities might affect the outcomes of PDCs. Also, future studies may identify the appropriate governance mechanism that firms need to utilize given the level of their capabilities to yield the most outcomes of their collaborations.

C) Firm Strategy:

Firm strategy defines organizational goals, sketches directions for firms' activities, integrates and motivates efforts, and provides criteria to measure performance (Spyropoulou et al., 2018). Also, strategy designates what capabilities are needed and how resources should be allocated to create value; and it delineates the value propositions of firms (Jin et al., 2019). As such, firm strategy, especially its product positioning strategy, is a key driver of PDC success as positioning a new product is one of the key strategic decisions that determine the product's performance in a market (Kaul & Rao, 1995).

Some scholars argued that it is not the governance mode of a PDC alone that may bring success to firms, but their effectiveness in aligning governance with strategy (Merchant, 2014). Keil et al. (2008) contended that previous PDC studies provided a "*simplistic picture of these complex relationships*," because they focused on studying governance mechanisms in isolation of firm strategy.

In fact, firm strategy is almost absent from the reviewed marketing studies. Three notable exceptions are Rindfleisch & Moorman (2003) that studied the impact of PDCs on customer orientation of a firm, Luzzini et al. (2015) that examined the indirect impact of innovation strategy on innovation performance through strategic sourcing and supplier collaboration, and Ozdemir et al. (2017) that investigated the effect of different types of PDCs on the market orientation of a firm. However, the role of firm strategy in guiding a firm in forming effective PDCs is still unknown. This is one of the existing research gaps that needs consideration from marketing scholars.

2.7. Dynamics and Termination of PDCs:

Despite the great efforts and costs invested in establishing and governing PDCs, conflict between partners is inherent and may lead to alliance termination (Sivadas & Dwyer, 2000). Generally, partnerships face a termination rate of more than 50% (Kumar, 2005). Partnership termination is the mirror image of an alliance formation, it involves taking actions to end a relationship between organizational partners before the expiration date of their agreement (Das & Teng, 2000; Sadowski & Duysters, 2008). The most common alliance termination forms are: (a) *the dissolution of the collaboration* which indicates that partners are liquidating their partnership and returning to market transactions (Bierly & Coombs, 2004), and (b) *the acquisition of one partner by the other partner* which means that the acquiring firm will be carrying out the activities internally and thus it will be moving from hybrid form (i.e., JV) to hierarchy (Das & Teng, 2002).

Extant studies discussed different causes of alliance termination. These causes can be classified as (a) *negative causes* that might indicate alliance failure (Kale, Dyer, & Singh, 2002) or (b) *positive causes* that may signal a higher ability of the firm to learn and reallocate its resources in a more profitable investment (Bierly & Coombs, 2004; Makino et al., 2007). On one side, the negative causes can include a lack of strategic and organizational fit between partners, an inappropriate choice of a governance mechanism to control the partnership leading to adaptation problems and conflict, unpredicted environmental changes that diminish the value of maintaining an alliance, and/or a lack of organizational experience in establishing and managing alliances (Kale et al., 2002).

On the other side, under some conditions, firms might find it more valuable to terminate an alliance than to keep it running (Das & Teng, 2000; Kumar, 2005). For instance, firms may form a partnership to get access to certain resources that are necessary for their activities, and which are not available to the firm at that time. However, over time, the firm might develop these resources internally and thus a redundancy between these internal resources and the similar resources acquired through the partnership would reduce the value of the alliance to the firm (Cui, Calantone, & Griffith, 2011). Alternatively, a change in a firm's strategy might motivate it to end the collaboration to redirect its resources toward a more profitable opportunity (Kumar, 2005).

Although conflict between collaboration partners is inevitable and alliance termination is probable, extant marketing studies gave marginal attention to post-formation dynamics and termination of PDCs. In our review, we spotted just three studies that addressed conflict and alliance termination. Lam & Chin (2005) attempted to identify the key success factors of conflict management in NPD collaborations. Similarly, Munksgaard et al. (2012) explored sources of conflict in NPD networks. While Dan & Zondag (2016) sought to predict the propensity to terminate a PDC given particular characteristics of the partnering firms.

Yet, more research questions about collaboration dynamics and termination are still understudied. Further research may investigate the conditions (e.g., the level of firm-specific investments, and /or the PDC type) under which it might be more profitable for a firm to liquidate its PDC versus acquiring its partnering firm. Also, future studies may examine the relationship between the different governance mechanisms and the likelihood of terminating a collaboration. Another open research question is to study the conditions (e.g., possessing stronger capabilities than partners, and/or having more alliance experience) under which terminating a PDC would result in positive outcomes for the focal firm.

2.8. Theoretical Lenses Underlying PDC Research:

In their studies of PDCs, extant marketing scholars adopted different theoretical lenses. The frequently employed theories are the TCE (e.g., Clauss & Kesting, 2017; Estrada et al., 2016; Fang et al., 2015; Harmancioglu et al., 2019), the RBV (e.g., Najafi-Tavani et al., 2018; Perks & Moxey, 2011; Smirnova et al., 2018; Statsenko & Zubielqui, 2020), the dynamic capabilities approach (e.g., Carlson et al., 2011; Estrada et al., 2016; Kandemir, Yaprak, & Cavusgil, 2006; Luzzini et al., 2015; Statsenko & Zubielqui, 2020), the organizational learning perspective (e.g., Najafi-Tavani et al., 2018; Ozdemir et al., 2017), and the social network theory (e.g., Fang, 2008; Hardwick & Anderson, 2019; Rindfleisch & Moorman, 2001; Tracey et al., 2014). The following sub-sections present a brief discussion on each of these theories.

2.8.1. The Transaction Cost Economics (TCE):

In an attempt to explain why firms exist, Williamson (1979, 1989, 1991) advanced the TCE approach. Originally, this theory discussed two alternative mechanisms (i.e., bureaucratic organizations and arms-length market contracts) that can govern firms' activities. Later, Williamson responded to the criticism of this simplified classification of organization types and added the "hybrid" form to admit the existence of an intermediate form of organization such as collaborations and franchising.

Basically, TCE suggested that a firm would choose the governance mode that minimizes the sum of the production and transaction costs of its activities (Kogut, 1988). These transaction costs include not only the costs of initiating, monitoring, and enforcing a contract, but also the negotiation and adaptation costs that a firm incurs while acquiring a certain function or activity from the market (Jones & Hill, 1988). These costs can be classified as *ex-ante costs* (ink-costs) that are related to writing and negotiating a contract at the initial stage of a relationship and *ex-post costs* that include the costs of monitoring, enforcing, and adapting a contract throughout the ongoing life of a relationship (Rindfleisch & Heide, 1997).

Williamson assumed two attributes of human nature, namely: bounded rationality and moral hazard. The *bounded rationality assumption* deals with the limitations of individuals' knowledge, skills, foresight, and time that affect their ability to make rational decisions. The *moral hazard/ opportunism assumption* which Williamson defined as "*self-interest seeking with guile*." This can be in a form of cheating, misleading, omitting critical information, or altering facts. Pairing these two behavioral assumptions with certain exchange attributes enabled Williamson to predict the appropriate governance mechanism for a given transaction. TCE thus presumes that efficiency can be achieved when firms deploy a governance mechanism that matches the attributes of their exchanges.

Williamson discussed the following attributes and predicted that if they were the characteristics of a transaction, then it would be more efficient for a firm to govern its exchange through vertical integration. First, *asset specificity* refers to the extent to which a firm needs to assign, to an exchange, specialized investments/resources that cannot be easily redeployed outside the relationship (Anderson, 1985; Rindfleisch & Heide, 1997). The value of these assets is thus limited to the relationship, and this may motivate an exchange's partner to act opportunistically against the firm; the matter that raises the importance of taking safeguarding actions (Rindfleisch & Heide, 1997). Therefore, when an exchange requires a high level of transaction-specific assets, it will be more efficient to internalize the activity (i.e., deploy a hierarchy mechanism) (Anderson, 1985). Second, the *frequency of an exchange*. The more frequent the transaction between partners is, the more likely the transaction costs of contracting would exceed the production and administrative costs and, as a result, bureaucratic organizations would be more efficient. Third, *Uncertainty* may arise due to external unexpected circumstances that cannot be specified ex-ante the exchange or due to difficulty in verifying partners' performance ex-post (Jones & Hill, 1988; Rindfleisch & Heide, 1997). The presence of high levels of uncertainty increases the transaction and adaptation costs and makes it more efficient to conduct the activity internally (Anderson, 1985). Consequently, TCE postulates that when a high level of asset specificity is required to support exchange, the exchange occurs frequently, and/or is surrounded by uncertainty that is combined with performance ambiguity; it would be more efficient for a firm to govern the transaction through a hierarchy mechanism.

In the context of PDCs, previous marketing studies deployed the assumptions of the TCE approach to explain the appropriate governance mechanism that firms participating in product development collaboration would utilize to safeguard their specific investments and valuable knowledge and control for performance uncertainty that is usually present in these kinds of alliances (Fang et al., 2015). In general, the results of these studies are consistent with the predictions of the TCE. For instance, Estrada et al. (2016) found that collaborating with competitors enhances innovation performance only when a firm shares knowledge internally and utilizes formal mechanisms to protect its knowledge. Likewise, Bouncken et al. (2016) demonstrated that complementing relational governance with transactional governance enhances product innovativeness. Also, Fang et al. (2015) found equity governance to be an effective mechanism for the upstream partner and a harmful mechanism for the downstream partner in a downstream alliance.

Although the success of the TCE in explaining many inter-organizational relationships, it has some limitations including its (a) focus on cost minimization as a key for achieving efficiency instead of targeting value maximization (Carson et al., 1999; Wernerfelt, 1994; Zajac & Olsen, 1993), (b) understatement of social relationships and institutional arrangements (Granovetter, 1985; Hill, 1990), and (c) overstatement of opportunism and utilization of reliance on more idiosyncratic assets as an explanation of market failure rather than as a key element of enhancing the efficiency of bureaucratic organizations (Ghoshal & Moran, 1996; Poppo &

Zenger, 1998). In addition to that, TCE could not explain why firms with the same exchange attributes and governance mechanisms differ in their performance. In other words, TCE neglected the strategy in its analyses (Ghosh & John, 1999). These limitations of TCE encouraged other researchers to propose other assumptions for exploring firm performance. For instance, the RBV approach proposed that firms operate differently because they possess heterogeneous resources (Wernerfelt, 1984) as we discuss below.

2.8.2. The Resource-Based View (RBV) of the Firm:

The RBV was first introduced by Wernerfelt (1984) and formalized by Barney (1991). In this perspective, resources are defined as all the tangible (e.g., machines, capital, skilled workers) and intangible (e.g., knowledge, brand names, technology) assets that can be seen as a strength or weakness of a firm (Wernerfelt, 1984). Resources also "*include all assets, capabilities, organizational process, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness*" (Barney, 1991, p. 101). In light of this conceptualization of firm resources, Barney anchored the RBV on two main assumptions: (a) *firm resources are heterogenous* (i.e., firms in an industry possess diverse resources) and (b) *firm resources are imperfectly mobile* (i.e., unique firm resources cannot be acquired easily by other firms).

Based on these assumptions, the RBV argues that firms are different in their performance due to the heterogeneous resources they possess. It postulates that a firm would gain and sustain a competitive advantage and thus be able to generate abnormal returns if its resources are: (a) ***valuable*** (i.e., resources enable the firm to develop strategies to exploit opportunities or neutralize threats), (b) ***rare*** (i.e., resources are not possessed by nor available to a large number of other firms), (c) ***inimitable*** (i.e. firms that do not have the resources are unable to obtain it because the resource is characterized by path dependency, causal ambiguity, and/or social complexity), and (d) ***non-substitutable*** (i.e., there are no equivalent resources available).

Some of the extant marketing studies in the PDC domain (e.g., Najafi-Tavani et al., 2018) adopted the RBV perspective to argue that since firms with particular resources and capabilities might achieve superior performance, firms would engage in product development alliances to acquire complementary resources that enhance their performance. While others (e.g., Perks & Moxey, 2011) built on the RBV to explain how firms might manage and allocate resources efficiently within a PDC to enhance firm performance. In general, the findings of these studies found support for the RBV arguments. For instance, Najafi-Tavani et al. (2018) found that product and process innovation capabilities have a positive impact on the new product performance of firms participating in innovation networks. Likewise, Perks & Moxey (2011) demonstrated that when a leading firm in a network controls the tasks and resources within the network to achieve efficiency, it will enhance its innovation performance, but this approach would render the network unutilized for innovation. Nevertheless, when a lead firm devises mechanisms to share tasks and resources within a network, all partnering firms will participate in enhancing network-level innovation.

2.8.3. The Dynamic Capabilities Approach:

The dynamic capabilities approach can be viewed as an extension of the RBV. It mainly focuses on explaining how and why firms can maintain competitive advantages in a dynamic environment with rapid technological changes (Eisenhardt & Martin, 2000). The crux of this perspective is that firms that can develop dynamic capabilities to navigate relentless market fluctuations would outperform their rivals. Dynamic capabilities are defined as "*the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*" (Teece, Pisano, & Shuen, 1997, p. 516). They are a set of specific organizational processes and routines such as partnerships, product development, and strategic decision-making that enable firms operating in dynamic environments to redeploy and manipulate their resources to create value (Eisenhardt & Martin, 2000).

Some marketing studies (e.g., Carlson et al., 2011; Estrada et al., 2016; Kandemir et al., 2006; Statsenko & Zubielqui, 2020) adopted the dynamic capabilities approach to explain how firms participating in PDCs may enhance their performance. They argued that collaborating firms that possess dynamic capabilities can combine and integrate their complementary knowledge to innovate new products to respond effectively to market dynamics ahead of rivals.

Generally, the results of these studies are consistent with the dynamic capabilities perspective. For instance, Statsenko & Zubielqui (2020) deemed customer PDCs as a mechanism that enables firms to acquire new knowledge and enhance their dynamic capabilities to sense and seize opportunities in the market and improve their market position. The results indicated that customer collaborations are positively associated with market diversification, supporting their argument. Similarly, Estrada et al. (2016) studied internal knowledge-sharing mechanisms as a dynamic capability that would enable collaborating firms to learn from their partners. Their findings demonstrated strong evidence for the important role of this capability in enhancing firms' benefit from collaborations. Particularly, they found that horizontal alliances improve innovation performance only when a firm deploys internal knowledge-sharing and formal knowledge protection mechanisms. Also, Kandemir et al. (2006) conceptualized the "alliance orientation" construct to include three dynamic capabilities of alliance scanning, coordination, and learning. Based on a sample of US high-tech companies, they found that alliance orientation enhances alliance network performance, which in turn improves firm market performance.

2.8.4. The Organizational Learning Perspective:

The organizational learning perspective suggests that firms, over time, are accumulating experiences and skills in performing particular tasks and activities and thus their performance is improving as they acquire new experiences. These experiences help firms to build their idiosyncratic knowledge repositories that can be applied to similar activities in the future. The organizational learning process starts with the frequent engagement of a firm in performing an activity. Over time, the firm accumulates knowledge and skills in carrying out this task. Then, the firm codifies and stores this acquired experience in form of organizational routines. These routines are deemed as intangible resources that improve the firm's efficiency in performing its activities and reduce potential errors, enhancing firm performance (Hoang & Rothaermel, 2005; Pangarkar, 2009).

Previous marketing studies (e.g., Ozdemir et al., 2017; Khamseh et al., 2017) built on the organizational learning perspective to differentiate between explorative and exploitative learning from alliance partners. According to the *explorative learning approach*, a collaborating firm develops learning processes to internalize the acquired knowledge from its partner and integrate it into its knowledge base to create new solutions for its activities. In contrast, based on the *exploitative learning approach* the firm would apply the acquired knowledge directly without internalizing it. While other marketing scholars (e.g., Najafi-Tavani et al., 2018) studied absorptive capacity as one of the core organizational learning mechanisms that facilitates partner knowledge acquisition, assimilation, and utilization.

In general, the results of these studies are in line with the overall perspective of the organizational learning approach. For example, Khamseh et al. (2017) noticed that firms that adopt an exploratory learning approach would utilize the acquired knowledge better than firms that just apply acquired knowledge without completely assimilating it. Also, Najafi-Tavani et al. (2018) found that innovation networks have a significant relationship with product and process innovation capabilities only in the presence of an organizational learning mechanism (i.e., absorptive capacity).

2.8.5. The Social Network Theory:

Instead of viewing organizations as separate entities that compete against each other in the marketplace, the social network theory suggests that organizations operate as sets of interconnected social networks (Gulati, Nohria, & Zaheer, 2000). A social network is broadly defined as "*a set of nodes (e.g. persons, organizations) linked by a set of social relationships (e.g. friendship, transfer of funds, overlapping membership) of a specified type*" (Laumann, Galaskiewicz, & Marsden, 1978, p. 458). From an inter-organizational perspective, a focal firm is connected with a web of embedded ties and social relationships with other organizations of customers, suppliers, competitors, governmental institutions, and/or other entities (Granovetter, 1985).

One of the main assumptions of the social network theory is that firm performance is partially impacted by the composition of the networks it is connected to and its location/role in them. For instance, one firm might relate to a network that gives it access to valuable resources, knowledge, technologies, and/or markets. While another firm may participate in an incompetent network that hinders its success (Gulati et al., 2000).

Laumann et al. (1978) identified two criteria for considering a group of organizations as a "bounded system of interaction" or network: functional and geographical standards. A functional network would consist of a group of organizations that operate interdependent functions or pursue a common goal. On the other hand, firms that are located in a particular geographic area may form their own network based on the geographic criteria. However, this distinction does not suggest that they are two mutually exclusive standards. Networks can be formed by firms that operate in close proximity and share a common goal.

Some marketing studies (e.g., Fang, 2008; Rindfleisch & Moorman, 2001; Tracey et al., 2014) drew on the social network theory to examine the effectiveness of innovation alliances. Most of the studies in this domain (e.g., Fang, 2008; Rindfleisch & Moorman, 2001) utilized functional criteria to define a network as a group of firms working together in developing new products. While Tracey et al. (2014) blended the functional and the geographic criteria in defining a network in their study as they examined a sample of regional clusters of innovation networks.

Generally, the results of these studies are consistent with the assumptions of the social network theory. For example, Rindfleisch & Moorman (2001) found that relational embeddedness facilitates both the acquisition and utilization of information in alliances. Also, Fang (2008) demonstrated that when customer network connectivity is high, customer participation as an information source in the innovation process increases the new product's speed to market. Additionally, Tracey et al. (2014) reported that the interaction between dense clusters and relational governance would enhance product novelty, whereas the interaction between centralized clusters and hierarchical governance would increase speed to market.

2.9. Conclusion and Agenda for Future Research:

Product development collaborations offer numerous benefits to firms. However, they also expose partnering firms to several risks and are prone to failure if not carefully established and effectively managed. Due to their strategic importance to firm performance, many academic scholars across several disciplines set to investigate these inter-organizational arrangements to guide executives in making their collaboration decisions. In Marketing, there is a quite large body of studies on this topic. Our comprehensive review of the 91 studies published in the top marketing journals over the last two decades highlighted the diversity of the research questions investigated in these studies, the different theoretical lenses underlying this stream of research, and the numerous research methods and data collection techniques utilized by the researchers to conduct their studies and empirically test their theories in a wide range of empirical contexts and diverse industries.

Nonetheless, our review also uncovered the disagreement in the marketing literature about the PDC effectiveness of the PDCs and other related research questions such as the benefit of partner diversity. Additionally, despite the significant contributions of marketing scholars in investigating diverse areas of the PDCs, our review found that some research questions are understudied. Further, there are emerging aspects of the PDCs that require future investigations. Over the next sub-sections, we highlight some of the research questions that need further consideration from the marketing scholars interested in the PDC topic.

2.9.1. The effectiveness of PDCs:

Presumably, firms engage in PDCs with an ultimate goal of enhancing their innovation and financial performance. This link between PDCs and firm performance is well-reflected in academic studies. Several scholars investigated the effectiveness of these arrangements. However, the results of these studies are inconsistent. One of the potential sources of disagreement in the previous studies is the absence of critical contingent factors from some studies. Future research needs to carefully identify the conditions under which such partnerships would enhance firm innovativeness and result in positive financial returns.

Moreover, the focus of the extant studies is on examining PDC effectiveness from the perspective of one side of the alliance, usually the focal firm. However, as these partnerships are meant to be win-win arrangements, future studies need to focus on the impact of such alliances on the mutual performance of the partnering firms and highlight the conditions under which they might result in mutual gains.

2.9.2. The Formation of PDCs and Partner Selection:

Arguably, forming an effective collaboration starts with choosing the "right" partner. However, the topic of partner selection received little attention in the marketing PDC literature. Further studies are required to explain when collaborating with partners with diverse versus similar resources would be more effective. Other studies may identify the appropriate collaboration form for partnering with firms with particular characteristics (e.g., resource bundles). Also, future research may examine how firm strategies and capabilities may drive its partner selection decisions. Moreover, the selection between domestic and international partners is also an important research question to be considered.

2.9.3. The Collaboration Structure and Governance Mechanisms:

Choosing the appropriate structure for a PDC is a critical decision for its success as it sets the governance mechanism that would safeguard partners' valuable resources, attenuate their opportunism, and motivate and facilitate smooth knowledge sharing between them. Most of the previous marketing studies that addressed the governance question focused on comparing relational to transactional governance. Yet, they presented mixed results. Further studies may investigate when the two governance mechanisms (relational versus transactional/formal) would work better together and when each would stand out. In addition, the emphasis on the broad categories of relational versus formal mechanisms leaves out the nuances among the different formal modes understudied. Future studies may investigate the impact of the different transactional governance modes on firm performance and identify the conditions under which each mode may generate superior benefits.

2.9.4. Firm Strategic Factors:

The success of a PDC is also hinged on some firm-related strategic factors such as a firm's strategy and the level of its internal capabilities. The extant marketing studies overlooked the role of firm strategy in their investigations. Future studies may examine the relationship between firm strategy and the choice of a particular partner or a specific collaboration form and its impact on firm performance. Additionally, further studies may investigate the role of firm capabilities in benefiting from their collaborations. Also, future research may identify the appropriate governance mechanism given the level of firm capabilities that might generate the highest outcome of a partnership.

2.9.5. Collaboration Dynamics and Termination:

The topic of partner conflict and collaboration termination is one of the understudied areas in the marketing PDC literature. Future studies need to identify the common causes of conflict between PDC partners, explicitly demonstrate how it might affect firm performance, and identify how partnering firms may deal with this conflict and turn it into a positive situation. Moreover, further studies may examine the conditions (e.g., possessing stronger capabilities than partners, and/or having more alliance experience) under which terminating a partnership might result in positive outcomes for the firm. Also, future research may investigate when a firm might prefer one form of alliance termination over the other. For instance, researchers may examine whether a firm with large specific investments in the collaboration might find it more profitable to acquire its partner than liquidate the alliance.

2.9.6. Emerging Topics:

As our review revealed, two emerging topics in this stream of research are innovation networks and alliance portfolios. Many of the studies that covered innovation networks are exploratory in nature. Further empirical work is needed to investigate the different aspects of these emerging forms of collaboration. Future studies may investigate questions such as how to effectively choose network partners and which structure of the network to deploy to optimize the benefits of the participating parties.

The other emerging topic is partnership portfolios. As firms manage their alliances as a portfolio, more research is needed to sort out the interdependences between the different partnerships in a portfolio. Future studies may investigate research questions such as the role of marketing and technological capabilities in integrating diverse knowledge and technologies acquired from different alliances in a portfolio to enhance firm innovativeness, how to effectively allocate resources across alliances in a portfolio, and whether a portfolio comprised of similar PDCs would benefit the firm more or less than a portfolio of diverse PDCs.

In addition to these two emerging topics in the marketing literature, one of the most recent topics that requires significant attention from marketing scholars is “green” collaborations. As sustainability and green product development are greatly impacting business policies in recent times, many firms are looking for partners to help them develop and manufacture environment-friendly products. In our review, we spotted only two papers that explored this research question. Inigo et al. (2020) examined the impact of alliance proactiveness and alliance portfolio coordination capabilities on a firm’s sustainability-oriented innovation. While Yu et al. (2021) explored the mechanisms of trust-building among multiple actors in innovation networks for developing green products. However, the research on this area is still in its infancy and more questions need to be investigated. Future studies may examine the impact of green collaborations on firm performance, which partners (e.g., competitors, customers, suppliers, and/or research centers) might be more effective, and at which stage of product development these collaborations might generate superior outcomes to firms.

3. Strategic Capabilities and Competency Traps in Innovation Collaborations

Abstract

Competency trap, where stronger capabilities may no more be a competitive advantage and turn out to be a liability for the firm, is often suggested as a reason why many large firms are unable to keep up with their legacy of success, particularly in innovation. However, much of the evidence is anecdotal and empirical evidence is scant in the research literature. In this study, we examine the competency trap effect by studying the impact of strong functional capabilities on innovation performance of original equipment manufacturers, when they engage in product development collaborations with their suppliers. We use a unique dataset of firms operating in several high-tech industries that formed supplier collaborations between 1985 and 2016.

We estimate our models using negative binomial generalized linear models, correcting for potential endogeneity using a control function method. We find strong evidence of curvilinear relationships between capabilities and innovation performance, demonstrating competency traps faced by the firms. We find certain combination of capabilities can aggravate competency traps, and that international collaborations can mitigate competency traps under certain circumstances. Our findings are among the first to show these effects.

Keywords: Competency traps, Marketing capabilities; Technological capabilities; Operations capabilities; Innovation performance; Innovation collaborations.

3.1. Introduction:

Heterogeneity in firms' successes in building strategic capabilities that underline their sustainable competitive advantages, sort high performers from low performers in the market. Successful innovation is one such key performance metric. Yet, success in innovation or any business outcome, for that matter, is not immutable. Some industry commentaries suggest that over a five-year period, as many as one in three companies in the US fail to keep up with their legacy of success (Reeves & Harnoss, 2015). Thus, much attention is rightly drawn toward the question of why apparently successful companies fail. One line of thought suggests that successful firms should build on their competitive advantages by exploiting their existing capabilities for greater efficiency and effectiveness. Firms that do not do so, risk being supplanted in the market by others. A counter explanation contends that dynamic business conditions require firms to adapt to changing situations and ensure they are open to exploring new ideas and opportunities. It is firms that do not do so, in fact, that risk being supplanted in the market.

Looking at levels of market capitalization and growth, Reeves & Harnoss (2015) estimate that firms that focus on exploring more may outperform firms that tend to focus on building on their market advantages by a factor of two in terms of revenue growth. Nevertheless, the research literature is equivocal on this issue. While the findings of Katila, & Ahuja (2002) tend to support this latter perspective, Osiyevskyy, Shirokova, & Ritala (2020) suggests otherwise. A candidate explanation suggests that firms reap the benefits of building on their strengths by boosting their strategic capabilities, but that such benefits necessarily give way to other costs eventually, and those same strengths become liabilities for the firm (Leonard-Barton, 1992; Levitt & March, 1988; Atuahene-Gima, 2005). This latter effect, where stronger capabilities may no more be a competitive advantage and turn out to be a liability for the firm, we call a "competency trap".

There are several candidate examples of firms facing competency traps. Kodak for example, went from being the "fourth-most-valuable global brand" with a $31 billion market capitalization in 1996 to a company that filed for bankruptcy protection in 2012 (Anthony, 2016). In this period, while digital imaging technology took hold, Kodak focused on sharpening its film-based capabilities; this despite the fact that they were one of the early innovators of the digital camera (Mui, 2012). Similarly, there is the example of Blackberry, a market leader in handheld phones with a dedicated installed base of Blackberry Messenger users (50 million users in 2011) – steadily losing all that to the emerging smartphone markets pioneered by Apple iPhones, and eventually ending phone manufacturing in 2016. Several reasons are offered; among them are Blackberry's overreliance on enterprise customers, its traditional base, which came in the way of it seeing how individual user preferences were changing, especially the role of the touchscreen interface (Phan, 2022). Several such accounts proliferate the popular press and are offered as examples of how past success can be a drag on future success. However, it is difficult to accurately infer competency traps from these observations.

Firms' decisions to focus on extant capabilities and product markets can have multiple reasons outside of the competency trap. For example, these firms may make conscious strategic decisions to let go of emerging opportunities. These decisions could be simply due to calculation mistakes leading to negative outcomes. The negative outcomes could also be related to unobserved and unpredictable exogenous events. Or it could also be that despite their early mover advantages in technology, the firms lacked the ability to deploy the necessary resources and develop the capabilities needed to outcompete new entrants in the market. These mean inferring competency traps is a difficult task, in particular, inferring it from a negative business outcome is fraught. Indeed, while discourses on competency trap populate the popular press (Reeves & Harnoss 2015; IBM 2022), and is recognized as an important strategic consideration for firms in the research literature (Levitt & March 1988; Michael & Palandjian, 2004; Wang, Senaratne, & Rafiq, 2015); there is very little empirical work in the domain. This combination of measurement difficulty and managerial importance makes this gap a significant one for the literature.

This gap is particularly significant in the case of innovation outcomes. With much of the extant discourse focused on the firm's finances, the firm's innovation performance has tended to take a back seat in the sense-making for competency traps. Yet, the underlying argument for competency traps has strong undertones related to a firm's inability to innovate, and innovation has been pegged as a key performance indicator for firms (e.g., Moorman & Slotegraaf, 1999; Sok & O'Cass, 2011). Patents, patent citations, and new product announcements are typically taken as key indicators of innovation performance (Hagedoorn & Cloodt, 2003; Zhang et al., 2010). So, in our paper, we set out to look for evidence of competency traps, focused on a firm's innovation performance as reflected in the three different indicators. In looking for such evidence, we take the view that data on a firm's actual processes, would be the key lens to study competency traps. Dutta, Narasimhan, & Rajiv (1999) point to the important roles of marketing, technological, and operations capabilities as key contributors to a firm's competitive advantage. Thus, we focus on those three strategic functional capabilities of the firm, as inferred from its actual resource deployments.

Nevertheless, some capabilities of the firm may be unobserved, or otherwise not adequately metered. So, to increase the power of our tests, we look for a context where firms, a priori, invest in processes to avoid competency traps. For example, while the internal functional capabilities could be important, firms may complement these with external ones. To this end, we draw upon the dynamic capabilities literature that suggests innovation collaborations are a key organizational arrangement firms can use to avoid competency traps (Teece, 2014). The argument hinges on the broader spectrum of information and knowledge sharing associated with such collaborations. So, we choose the context of vertical Product Development Collaborations (PDC) that Original Equipment Manufacturers (OEMs) strike with their suppliers as our context to study competency traps faced by the OEMs in their innovation performance. Arguably, international PDCs offer even broader spectrum of information and knowledge-sharing possibilities, so we also look for evidence of competency traps in such international collaborations.

Our theoretical approach to this task is informed primarily by the literature on strategic capabilities. We also draw upon complementary insights from the literature on organizational inertia and dynamic capabilities. The strategic capability literature is quite fragmented on the impact of stronger capabilities on firm performance. While Krasnikov & Jayachandran (2008) finds evidence that some of these capabilities increase firm performance, others such as Morgan et al. (2009) find more equivocal evidence. Evidence on any possible negative impact of capabilities, an important aspect of studying competency traps, is sparse, notably, for innovation collaborations, domestic or otherwise. Further, there are only a handful of papers that study how different functional capabilities interact with each other (e.g., Dutta et al., 1999, Feng et al., 2017; Moorman & Slotegraaf, 1999; Yu et al., 2014). Thus, the literature offers limited insights into how a firm's spectrum of functional capabilities might work together to mitigate or aggravate competency traps.

To frame our proposed contributions to the literature, we pose the following research questions: (1) Do firms face competency traps in their innovation collaborations? (2) Do stronger functional capabilities help or hinder the innovation performance of a firm? (3) Do the functional capabilities work together to mitigate or aggravate competency traps? (4) Do international product development collaborations mitigate competency traps?

Our empirical approach is built on a manually created unique dataset of 202 observations representing dyadic PDCs between OEMs and suppliers in several high-tech industries. We estimate firm capabilities using stochastic frontier models and use three indicators to measure innovation performance. Our estimations use generalized linear models, utilizing the two-stage residual inclusion method (Terza, Basu, & Rathouz, 2008) to control for potential endogeneity.

Our results provide empirical evidence of the competency trap effect of strong functional capabilities on innovation performance. We find that high levels of marketing, technological, and operations capabilities are associated with lower innovation performance than moderate levels. Our findings also indicate that capabilities interact differently with each other to affect innovation performance. Certain combination of capabilities can aggravate competency traps. For instance, marketing capabilities interact positively with strong technological capabilities, but its interaction with strong operations capabilities is negatively associated with innovation performance. We also find international collaborations can mitigate competency traps under certain circumstances. Collaborating with international, versus domestic, partners is associated with higher (lower) innovation performance for firms with strong marketing and operations (technological) capabilities.

Our study extends our understanding of competency traps by contributing to the existing literature on firm capabilities and innovation collaborations in five main ways. *First*, we demonstrate the downsides of strong capabilities, adding to the body of empirical evidence on the competency traps effect, and being the first, as far as we know, to show this effect for the three core capabilities simultaneously. *Second*, we illustrate how the three capabilities interact with each other to impact the competency trap effect. To the best of our knowledge, these are new results. *Third*, we are the first, as far as we know, to study the competency trap phenomenon in the context of innovation collaborations, illustrating the role of international partners in the relationship between firm capabilities and innovation performance. *Fourth*, we also contribute to the innovation collaboration literature by demonstrating that considering the type and level of firm capabilities is important when choosing between foreign and domestic partners. *Fifth*, we are among the few studies that examine the relationship between functional capabilities and the innovation aspect of firm performance. In the rest of the paper, we review the related literature, develop our theory and hypotheses, present our empirical efforts, discuss the results, and conclude our study.

3.2. Literature Review:

The competency trap phenomenon received early recognition from the organizational learning literature (*cf.* Levitt & March, 1988). Several scholars (e.g., Leonard-Barton, 1992; Atuahene-Gima et al., 2005; Rhee & Kim, 2015; O'Driscoll et al. 2001) draw on the Resource-Based View (RBV) to explain the competency trap in terms of a capability-rigidity paradox where excessive focus on exploiting existing capabilities of firms and marginalizing the development of new ones can negatively impact firm performance and innovation.

Others (e.g., Lichtenthaler, 2016; Zhou & Wu, 2010) see the competency trap from an organizational inertia lens. Firms suffer from organizational inertia if they are inflexible, rigid, and resistant to changing their processes, structures, and strategies to adapt to market changes (Hannan & Freeman, 1984). This line of research argues that capabilities are path-dependent processes that emerge from reinforcing and repeating positive learning experiences. By accumulating more successful experiences in a specific domain, the firm will eventually master the capability and embed it in its organizational structure (Zhou & Wu, 2010). As such, the embedded capability will facilitate the efficient deployment of current processes, making the switching costs to another process significantly high. Consequently, the firm will support the status quo and resist the change, eventually failing to respond effectively to the rapid technological discontinuities in its industry (Day, 2011; Kaleka & Morgan, 2019).

In contrast to the richness of the theoretical literature, the empirical literature is quite sparse. Michael & Palandjian (2004) find that the survival of a firm's brand decreases as the firm gains more experience in new product introductions. Atuahene-Gima (2005) is another notable study which finds that the firm's market orientation may be strategically inefficient, negatively impacting innovation outcomes. The other notable empirical study is Wang et al. (2014) who find, competency traps negatively impact the firm's dynamic capabilities and thus, form performance, by reducing its absorptive and transformative capabilities. In this and the other papers, an underlying theme is that the core rigidities driving competency traps in innovation may be seen through the lens of capabilities. However, the capabilities literature itself is somewhat limited in addressing this issue.

Capabilities are firm-specific bundles of knowledge and skills that are developed through the complex interaction between firm resources over time and are deeply embedded in the organizational processes (Narasimhan et al., 2006; Theodosiou, Kehagias, & Katsikea, 2012). They cannot be easily transferred or imitated, and according to the RBV, are a source of competitive advantage (Krasnikov & Jayachandran, 2008). A large literature in marketing points to the important role played by the three functional strategic capabilities – marketing, technological, and operations, in determining firm performance (see Appendix B). Most of these studies (e.g., Morgan et al., 2009, Dutta et al., 1999, Nath et al., 2010; Yu et al., 2014, Zhou et al., 2014) focus on the financial aspect of firm performance (e.g., profitability, profit growth, efficiency).

Yet, even if about 80% of global executives placed innovation in the top three priorities of their businesses (Ringel et al., 2015), only a few studies consider the impact of capabilities on firm innovativeness (e.g., Moorman & Slotegraaf, 1999; Danneels, 2002; Sok & O'Cass, 2011). This leaves a significant gap in our understanding of the firm's strategy spectrum. In a partial attempt to address this gap, in this paper, we study the impact of capabilities on *Innovation Performance* (Innov-Perf) which we define as *the extent to which a firm is successful in developing and commercializing new products*.

The predominant theme in the above studies is that capabilities are linearly and positively associated with firm performance (e.g., Nath et al., 2010; Moorman & Slotegraaf, 1999; Narasimhan et al., 2006). Nevertheless, the evidence is fragmented. Krasnikov & Jayachandran (2008), based on a meta-analysis, conclude that all three capabilities (marketing, R&D, and operations) have a positive direct impact on firm performance, even though marketing capability has the strongest effect among them. Likewise, Nath et al. (2010) find that marketing and operations capabilities have a direct positive impact on performance. However, both Song et al. (2007) and Morgan et al., (2009) find that variously, marketing and technology capabilities do not have a significant impact on performance. The equivocal nature of the evidence is compounded by claims that capabilities may turn into core rigidities to hurt firm performance (Krasnikov & Jayachandran, 2008). Yet, robust studies of these potential downsides are sparse and thus, only a few strands of empirical evidence exist. Among these are Zhou & Wu (2010) who find that technological capability has an inverted U-shaped relationship with explorative innovation; and Wales et al. (2013) who find a similar relationship between absorptive capacity and firm growth. We address the downsides of the three capabilities explicitly, investigating if they can negatively impact Innov-Perf.

The challenge of understanding the impact of capabilities on the firm's innovation performance is complicated further when we recognize that firms hold a portfolio of capabilities simultaneously. Thus, their interaction becomes an important ingredient of the mix. Several marketing studies (e.g., Dutta et al., 1999, Feng et al., 2017; Yu et al., 2014) investigate if interactions between different capabilities boost or dampen firm performance. The results are equivocal. For instance, Yu et al. (2014) find that the interaction between marketing and operations capabilities has a positive impact on firm performance. However, Feng et al., (2017) find that operations capabilities negatively affect the relationship between marketing capabilities and firm performance. We attempt to complement this literature by studying how the two-way interactions among the three capabilities impact Innov-Perf.

The roles of external factors such as competitors and collaborators are well-recognized in paradigmatic marketing strategy. In fact, many studies (e.g., Bouncken et al., 2016; Du, 2021; Noordhoff et al., 2011) contend that collaborating with external entities, such as suppliers and customers, would enhance firm performance. Collaborations are particularly important in our modern economy where technology shifts rapidly, customers change their preferences frequently and unpredictably, and ever-intensifying competition. These market dynamics make it difficult for firms, in general, and those operating in high-tech industries, in particular, to survive by relying exclusively on their internal resources. In collaborations, partnering firms pool their resources to achieve one or more common goals such as jointly developing new products, co-marketing, co-manufacturing, and/or co-distributing products (Lee, Yeung, & Cheng, 2009; Zhang, Yuan, & Zhang, 2022). Yet, much of the research focused on capabilities in marketing tended to limit their studies to the impact of internal firm resources on performance (e.g., Feng et al. 2017; Narasimhan et al., 2006; Yu et al., 2014). This left the question of how the internal capabilities would interact with external resources (e.g., partners' knowledge and technologies) understudied. We address this limitation in the literature by studying how capabilities impact Innov-Perf explicitly in the context of Product Development Collaborations (PDC) between Original Equipment Manufacturers (OEMs) and their suppliers.

PDCs expose firms to risks of appropriation, knowledge spillover, and partner opportunism (Sampson, 2004) and have been shown to have a high failure rate (Noordhoff et al., 2011). Yet, many executives see PDCs as an effective means of innovation (Gutierrez et al., 2020). PDCs enable firms to get access to external knowledge and technological capabilities that are not available in-house (Bouncken et al., 2020). The partners exchange expertise, acquire complementary knowledge, learn new skills, and share the risks and costs of developing new products (Du, 2021). Thus, a PDC might be a source of competitive advantage since the pooled resources will likely improve innovation outcomes (Xu & Zeng, 2021), and consequently, firms engaged in PDCs should be better at avoiding competency traps. This means our study will be conducted in a context where any test of competency traps will have higher statistical power.

In the context of collaborations, international collaborations offer an added layer of complexity that has not been studied in the context of competency traps. Previous studies argued that collaborating with international partners with different national backgrounds might offer greater opportunities for learning and innovation than domestic partners (e.g., Colombo et al., 2009; Lavie & Miller, 2008; Tower et al., 2021). Kim & Inkpen (2005) find that international PDCs increase technology learning more than domestic ones; Colombo et al (2009) find international R&D alliances enhance the productivity of high-tech start-ups; and Clausen (2014) find they are positively associated with Innov-Perf. Nevertheless, coordination challenges, including difficulties in building trust and establishing working routines between the partners, could hinder effective learning and knowledge absorption (Colombo et al., 2009; Martínez-Noya & Narula, 2018). Not surprisingly, the evidence of the impact of PDCs is mixed. Lucena's (2016) results show that collaborating with international partners on exploitation activities has no significant impact on Innov-Perf, and Harmancioglu, Griffith, & Yilmaz (2019) find that international PDCs have a negative long-term impact on firm market value. These contrasting results, together with the prevalence of international collaborations and lack of studies on how competency traps operate in international PDCs, suggest this is an important gap in our understanding. By considering the moderating impact of international PDCs, we hope to contribute to addressing it. We explain our theory in the next section.

3.3.Theory and Hypotheses:

Firm capabilities of marketing, R&D, and operations are crucial factors for innovation (Danneels, 2002). However, as a firm intensifies its investments in building capabilities in certain functional areas, the switching costs into other processes will significantly increase. Thus, the firm will promote exploiting the existing capabilities in related fields and ignore investing in “unfamiliar” areas that require adopting solutions from outside its core competences, causing its core capabilities to turn into core rigidities and accelerating the risk of falling into a competency trap (Lichtenthaler, 2016). Nonetheless, according to the dynamic capabilities approach, the firm can alleviate this risk by deploying dynamic capabilities, such as establishing strategic alliances and developing new products, that enable transforming and reconfiguring the ordinary capabilities and their underlying resources (Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997; Teece, 2014).

Accordingly, when a firm establishes a PDC, it will get access to novel knowledge and technologies of its partner, allowing it to update its existing knowledge base, reconfigure its existing functional capabilities and their underlying routines, and adjust its current processes to incorporate the acquired resources to effectively innovate. As such, the external resources acquired from PDC partners play an important role in protecting against the competency trap of strong functional capabilities. Yet, the heterogeneity of these resources might be significantly different based on the geographic location of a firm’s partners. For instance, international, versus domestic, partners might give access to more diverse knowledge, technologies, and network resources (Harmancioglu et al., 2019; Tower et al., 2021). However, acquiring these heterogeneous resources across borders is also more challenging (Colombo et al., 2009).

The above discussion illustrates that the relationship between firm capabilities and Innov-Perf is more involved than being direct positive as widely depicted in the marketing literature. Hence, in this study, we set out to advance our understanding of this relationship by incorporating insights from the RBV and dynamic capabilities perspectives to investigate the competency trap effect of functional capabilities on Innov-Perf in the context of innovation collaborations. Our conceptual framework shown in Figure (1) proposes that there would be a curvilinear (i.e., an inverted U-shaped) relationship between each of the three capabilities (marketing, technological, and operations) and Innov-Perf of high-tech OEMs in PDCs. Since different capabilities often work together - (Dutta et al., 1999, Moorman & Slotegraaf, 1999; Feng et al., 2017), we argue that a particular capability would mitigate (amplify) the negative effect of another strong capability on Innov-Perf. We also posit that forming a PDC would curtail this competency trap effect on Innov-Perf.

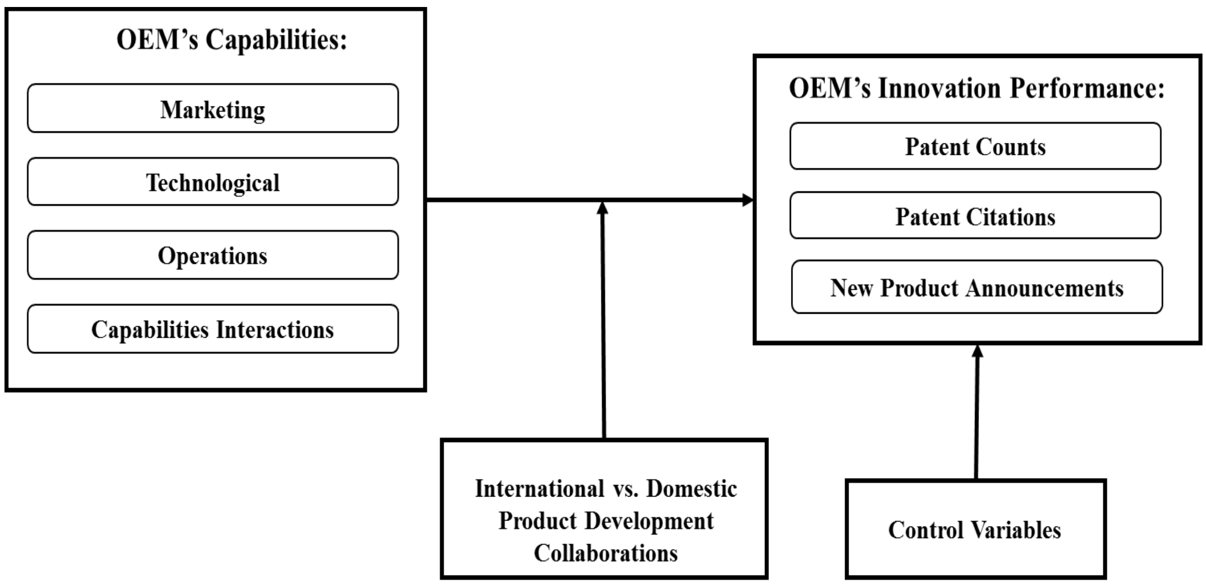


Figure (3.1): Research Framework

The relationship between capabilities and Innov-Perf is said to be in a form of an inverted U-shaped curve if Innov-Perf first starts to increase at a decreasing rate with the increase in capabilities until it reaches a maximum (turning) point after which it then starts decreasing at an increasing rate. We can explain the inverted U-shaped relationship, as shown in Figure (3.2), as a net effect of two latent mechanisms (i.e., benefits and costs) driving the relationship between capabilities and Innov-Perf (Haans et al., 2016). On one hand, the benefits of capabilities to Innov-Perf are arguably growing constantly (Krasnikov & Jayachandran, 2008; Sok & O'Cass, 2011; Moorman & Slotegraaf, 1999). On the other hand, there is an exponential cost curve of capabilities since costs materialize only when capabilities become strong. As firms invest in building a functional capability, it might give rise to additional coordination costs that might be efficiency-depleting. For example, if a firm develops its marketing capability significantly, there is the possibility it might come at the cost of resources for other functions, such as R&D and operations. Lopsided emphases might trigger jockeying for resources between different functional teams, and in the extreme, directly or indirectly frustrate the performance objectives of the group/ activity endowed with extra resources. While management may anticipate and work towards smoothening these intra-organizational tensions, those efforts may also come at the cost of efficiency loss. We expect these will be part of the costs faced by the OEMs as they work to build stronger capabilities[6]. In the following subsections, we elaborate on the merits and downsides of the three capabilities (as summarized in Table 3.1) and their relationships with Innov-Perf.

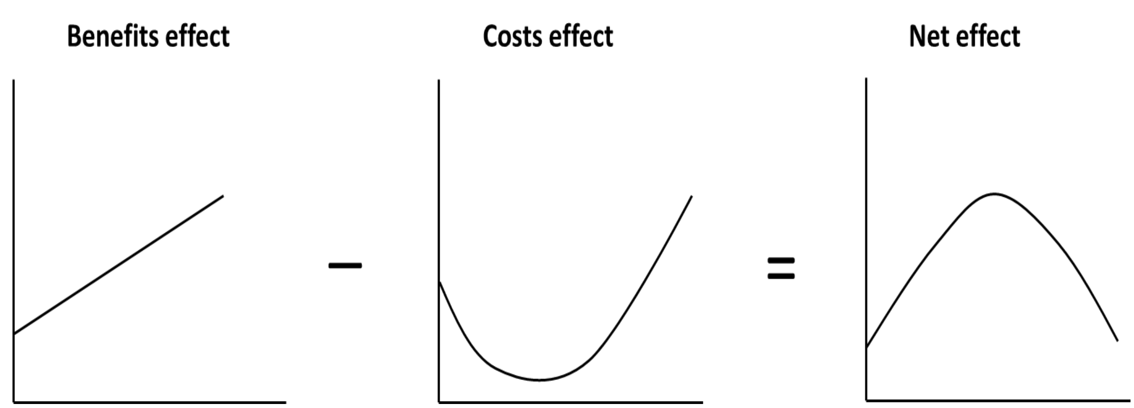


Figure (3.2): An Illustration of How an Inverted-U shaped Relationship Can Be Formed

[6] Organizational inertia means companies are not easily able to redeploy their resources if needed. This inertia is particularly relevant when significant resources are committed, as in high resources deployments for building stronger capabilities. These types of rigidities can become significant liabilities when business environments change. However, we argue that the high levels of capabilities, per se, can sometimes come with its own costs that can negatively impact firm performance. In building our hypotheses, we build on these tensions associated with high capabilities.

Table (3.1): The Benefits and Drawbacks of Functional Capabilities:

Capabilities	Definition	Benefits/Advantages	Costs/Drawbacks
Marketing Capabilities (MCAPs)	The ability of a firm to sense and understand customer needs and wants better than rivals, and to deploy its marketing-based resources efficiently to satisfy them ahead of competitors (Day, 2011).	- Strong market orientation (MO), a substantial source of innovative ideas (Dutta et al., 1999). - 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 (Ngo & O'Cass, 2012). - Enable forecasting potential returns to investments of innovation projects and thus allocate resources effectively among them (Zang & Li, 2017).	- It is the R&D activities that lead to innovation rather than customer needs (Grinstein, 2008). - Listening too carefully to customers can limit innovation. Customers are technologically bounded with what currently exists (Im & Workman, 2004; Lukas & Ferrell, 2000). - Competitor orientation hinders innovation (Gatignon & Xuereb, 1997). Firms that eye competitors closely may find it more convenient to imitate their innovation rather than initiate their projects (Lukas & Ferrell, 2000).
Technological Capabilities (TCAPs)	The ability of a firm to deploy its technological resources (e.g., R&D expenditures) in innovating new products and processes (Moorman & Slotegraaf, 1999; Saboo, Kumar, & Anand, 2017).	- Enable firms to utilize various technologies to innovate new products and processes (Krasnikov & Jayachandran, 2008; Moorman & Slotegraaf, 1999). - Important source of absorptive capacity (Zhou & Wu, 2010) 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 (Berchicci, 2013; Ruiz-Ortega & García-Villaverde, 2008).	- Intensive focus on internal R&D distracts from listening to customer needs, resulting in over-reliance on technological competences to develop products that might not satisfy market demand (Dougherty & Heller, 1994). - As the firm accumulates diverse technological knowledge, it would increasingly become costly to integrate additional knowledge (Zhou & Wu, 2010). - The richer the knowledge base of the firm, the more difficult it becomes to identify additional novelty in external knowledge (Lichtenthaler, 2016). - As the firm adds more success in developing innovations, it would aim at reinforcing success by exploiting current know-how and restraining from exploring new technologies (Kaleka & Morgan, 2019; Zhou & Wu, 2010).

Capabilities	Definition	Benefits/Advantages	Costs/Drawbacks
Operations Capabilities (OCAPs)	The ability 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 (Nath et al., 2010).	- Cost-reduction systems such as TQM, and six sigma help in significantly cutting product development time (Nath et al., 2010; Tan, Kannan, & Narasimhan, 2007), freeing-up valuable resources, and generating returns to be reinvested in innovating new products (Sarkees & Hulland, 2009). - Early supplier involvement (Lizarelli, Toledo, & Alliprandini, 2021) 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 (Tan et al., 2007).	- Too much focus on continuous improvement might promote routinization and standardization of processes and activities that reinforce the repetition of the best practices and discourage the generation of novel solutions (Prajogo & Sohal, 2001), driving the firm into a "success trap" (Wang, Senaratne, & Rafiq, 2015). - Developing organizational routines entice firms to resist the change of the status quo to avoid the risks and costs of the change, hurting innovation in efficiently operating firms (Chandy & Tellis, 2000). - More awareness of costs to eliminate wastage and be as efficient as possible. This excessive efficiency focus might hinder innovation because of the lack of investments in novel processes (Prajogo & Sohal, 2001).

3.3.1. Marketing Capabilities (MCAPs) and Innovation Performance:

MCAPs denote the ability of a firm to sense and understand customer needs and wants better than rivals (Day, 1994; Saboo et al., 2017), and to deploy its marketing-based resources (e.g., ad expenditures, customer relationship) efficiently to satisfy these requirements ahead of competitors (Nath et al., 2010; Zang & Li, 2017). MCAPs are reportedly associated with positive firm performance (Kaleka & Morgan, 2019; Nath et al., 2010; Krasnikov & Jayachandran, 2008), and can impact the effectiveness of a firm's collaborations and its Innov-Perf (Mariadoss et al., 2011). They play a paramount role in a firm's success in introducing innovative products to the market ahead of rivals (Theodosiou et al., 2012). Also, they imply a strong market orientation that is considered a substantial source of innovative ideas (Dutta et al., 1999). A firm with high MCAPs is engaged in a continuous process of sensing market trends, opportunities, threats, and emerging technologies (Day, 1994; Krasnikov & Jayachandran, 2008). Understanding these market dynamics motivates innovation to exploit them ahead of rivals (Ngo & O'Cass, 2012). They also enable firms to forecast the potential returns to their investments in innovation projects and thus allocate resources effectively among them (Zang & Li, 2017). In addition, having built strong relationships with customers and channel members (Day, 1994; Nath et al., 2010), firms with high MCAPs can benefit from pioneer entry to the market and effectively commercialize their innovative products (Su, Tsang, & Peng, 2009).

On the other side, MCAPs have several drawbacks. Strong MCAPs might drive firms to focus heavily on their relationships with current customers and work on satisfying their needs (Zang & Li, 2017). Paying much attention to satisfying customer needs may lead firms into competency traps that limit their efforts to utilize existing technologies and products to serve familiar market domains and distract them from developing new technologies to explore emerging markets (Atuahene-Gima et al., 2005). Moreover, strong MCAPs are supported by a strong market orientation that can hurt innovation (Gutignon & Xuereb, 1997; Grinstein, 2008; Im & Workman, 2004). Grinstein (2008) contends that innovation is less likely to result from strong market orientation because it is the R&D activities that drive innovation rather than customer needs, especially in technology turbulent environments like the ones in which high-tech companies operate. Arguably, listening too carefully to customers can limit innovation because customers are technologically bounded with, and have inertia toward, what currently exists and do not know what is technologically possible (Im & Workman, 2004; Lukas & Ferrell, 2000). In addition, Christensen & Bower (1996) argue that firms that listen too closely to customers may lose their leadership in the market when emerging technologies dominate the industry. Likewise, Gutignon & Xuereb (1997) demonstrate that competitor orientation hinders innovation. Firms that eye their competitors closely may find it more convenient to imitate their innovative ideas rather than initiate new projects (Lukas & Ferrell, 2000). By doing so recurrently, the competitor-oriented firm's ability to innovate may deteriorate over time.

Moreover, strong MCAPs may hurt innovation because of the information overload resulting from acquiring massive market data about current and potential customers and competitors. Nowadays firms are struggling to process and make use of the flood of information they receive from their markets (Day, 2011). As such, they may incur significant costs to coordinate and assimilate them. Also, because of the huge diversity in the collected information, firms may frustrate their innovation efforts over several markets rather than invest their scarce resources in a few qualified projects. Considering the benefits and costs of MCAPs, we propose that:

H1: Ceteris Paribus, there is an inverted U-shaped relationship between MCAPs and Innov-Perf, such that moderate, versus high and low, levels of MCAPs are associated with higher Innov-Perf.

3.3.2. Technological Capabilities (TCAPs) and Innovation Performance:

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 and Slotegraaf 1999; Krasnikov & Jayachandran, 2008; Saboo et al., 2017). TCAP is a key source of absorptive capacity that enable firms to identify and evaluate knowledge and technologies from external sources, and enhance their abilities to acquire, assimilate, and integrate these resources into their internal processes to develop new products (Zhou & Wu, 2010). As such, as TCAPs increase, the firm's ability to benefit and learn from business partners, and thus innovate, increases (Saboo et al., 2017). Moreover, 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 (Sarkees, Hulland, & Chatterjee, 2014; Dutta et al., 1999).

However, strong TCAPs have various downsides (Lichtenthaler, 2016; Wales et al., 2013; Zhou & Wu, 2010). The intensive focus on internal R&D activities distracts a firm from listening to customer needs and makes it over-reliant on its technological competences to develop products that may not satisfy market demand (Dougherty & Heller, 1994). Also, while strong absorptive capacity enhances a firm's ability to locate and acquire superior technology and valuable know-how from outside, it would generate diminishing returns as the firm accumulates more and more technological knowledge. That is because the richer the knowledge base of the firm, the more difficult it becomes to identify additional novelty in external knowledge (Lichtenthaler, 2016; Wales et al., 2013). Also, as a firm accumulates diverse technological knowledge, it would increasingly become costly to integrate additional knowledge and restructure its current knowledge base. As a result, the firm may refrain from acquiring additional external knowledge (Zhou & Wu, 2010).

In addition, strong TCAPs might turn into core rigidities and hinder innovation. As the firm develops extensive TCAPs and succeeds in developing more innovations, it would aim at repeating its success by exploiting its current know-how and restraining from exploring new technologies, this would impede innovation as new technologies emerge in the market (Zhou &

Wu, 2010; Kaleka & Morgan, 2019). Considering the benefits and costs of TCAPs, we postulate that:

H2: Ceteris Paribus, there is an inverted U-shaped relationship between TCAPs and Innov-Perf, such that moderate, versus high and low, levels of TCAPs are associated with higher Innov-Perf.

3.3.3. Operations Capabilities (OCAPs) and Innovation Performance:

OCAPs refer to 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 (Nath et al., 2010; Saboo et al., 2017). Thus, they entail the efficient and flexible execution of operational activities with a minimum waste of organizational resources (Krasnikov & Jayachandran, 2008). Firms that possess high OCAPs emphasize cost reduction, maximum utilization of production factors and resources, operational flexibility, responsiveness to changes in the production process, and speed delivery of products to the market (Tan et al., 2007; Yu et al., 2014).

OCAPs are critical to the success of converting innovations into viable commercial products (Saboo et al., 2017; Narasimhan, Rajiv, & Dutta, 2006). They enable firms to process the available resources efficiently and flexibly to manufacture various new products that satisfy diverse customer needs (Saboo et al., 2017; Krasnikov & Jayachandran, 2008). They also allow firms to respond quickly to changes in market demands and to react flexibly to modifications in product designs (Saboo et al., 2017). Furthermore, high OCAPs can enhance a firm's Innov-Perf. A firm with high OCAPs adopts cost-reduction and waste-elimination systems such as just-in-time, TQM, and six sigma (Tan et al., 2007). Not only would these systems significantly reduce the development time of new products (Nath et al., 2010), but they would also free-up valuable resources and generate returns that can be reinvested in innovating new products (Sarkees & Hulland, 2009).

Also, a firm with high OCAPs frequently involves suppliers early in the product development process (Lizarelli et al., 2021). Such interaction with suppliers would bring in new knowledge that the firm would integrate into its innovation activities. Further, a firm that possesses high OCAPs is committed to continuous improvement. As part of their continuous improvement process, employees are trained to think critically to solve problems and to utilize diverse tools and techniques to improve their performance, and this in turn would create an organizational culture of innovation (Tan et al., 2007).

Notwithstanding, OCAPs might turn into rigidities that hinder firm performance. Possessing strong OCAPs means too much focus on continuous improvement. This might promote routinization and standardization of processes and activities that reinforce the repetition of best practices and discourage the generation of novel solutions (Prajogo & Sohal, 2001). Sticking to their best practices may drive firms into a success trap, such that as they advocate and reinforce the operating way that brought success, they may refrain from engaging in further learning and development processes (Wang et al., 2015). Also, as firms develop organizational routines, they may resist changing the status quo to avoid the risks and costs associated with change. Thus, innovation may be negatively affected by the growth of routines in efficiently operating firms (Chandy & Tellis, 2000).

Further, as OCAPs intensify, firms will be more aware of their costs to eliminate wastage and be as efficient as possible. This excessive efficiency focus might hinder innovation not just because of the lack of investments in novel processes, but also because employees will not be able to participate in development projects as they are efficiently assigned to the production activities that they do not have time for other activities (Prajogo & Sohal, 2001). Considering the benefits and costs of OCAPs, we propose that:

H3: Ceteris Paribus, there is an inverted U-shaped relationship between OCAPs and Innov-Perf, such that moderate, versus high and low, levels of OCAPs are associated with higher Innov-Perf.

3.3.4. Capabilities Interaction and Innovation Performance:

In addition to their individual effects on performance, capabilities may work together to boost or dampen firm performance. Empirical studies that examined the two-way interaction between different capabilities provide mixed results. This discrepancy in the findings motivates our investigation of the relationship between the capabilities' interactions and Innov-Perf.

A) The Interaction between Marketing and Technological Capabilities:

A firm with intensive TCAPs would generate numerous innovation ideas, and to be effective, it has to focus on a few qualified projects to optimize its investments. In this case, being well-informed about market trends and customer preferences, through high MCAPs, supports the firm in picking the projects that are more likely to succeed in the market (Narasimhan, Rajiv, & Dutta, 2006). Also, the continuous market sensing and competitors monitoring of firms with high MCAPs offer a complementary source of innovation ideas for firms with strong absorptive capacity and allow them to extract new insights and exploit their current technologies in developing various products to satisfy diverse market segments.

Further, high MCAPs also mean the ability to collect high-quality customer feedback on the new product. Such feedback is valuable input that a firm with strong TCAPs would utilize to make radical changes to existing products (Dutta et al., 1999). Additionally, a firm with high MCAPs would not overlook customer needs as a major source of innovation ideas. Instead, both of its scientists' breakthrough ideas might go hand in hand with those derived from customer needs and wants (Danneels, 2002). By doing so, the firm will gain the value of satisfying current customer needs and the lead in introducing cutting-edge products to the market. Thus, we postulate that:

H4: Ceteris Paribus, MCAPs positively moderate the relationship between TCAPs and Innov-Perf, such that high MCAPs would: (a) enhance the benefits of TCAPs and (b) offset the negative effects of strong TCAPs on Innov-Perf.

B) The Interaction between Marketing and Operations Capabilities:

Unlike the complementarity between MCAPs and TCAPs, MCAPs might reduce the benefits of OCAPs and enlarge their costs. A firm with high MCAPs is sensitive to customer needs and market trends and is willing to satisfy as many of these needs as possible before rivals (Day,1994; Krasnikov & Jayachandran, 2008). Depending on its strong OCAPs, the firm would engage in several innovation projects to satisfy the diverse needs of customers. That is because the firm (a) trusts its competence in developing new products in a shorter time thanks to its efficient operations (Nath et al., 2010), and (b) has saved financial resources through its cost-reduction and waste-elimination systems that it can invest in funding the development projects (Sarkees & Hulland, 2009). However, this would frustrate the innovation efforts of the firm over several products rather than investing its scarce resources in a few qualified projects.

Also, strong OCAPs mean that the firm is adopting a cost-reduction philosophy (Tan et al., 2007). When such a firm also embraces a competitor orientation, as part of its MCAPs, it might lean toward imitating competitors to save the costs of initiating development projects (Lukas & Ferrell, 2000). Similarly, having a strong customer orientation, the firm might depend heavily on its customers as a source of innovative ideas and underestimate the investment in its technological resources. Moreover, a firm with high MCAPs would have developed strong relationships with its business partners and vendors (Saboo et al., 2017). When such a firm has strong OCAPs and advocates its best practices, it would retain the incumbent suppliers and lose acquiring potential novel knowledge that would come from exploring new partners. Therefore, we propose that:

H5: Ceteris Paribus, MCAPs negatively moderate the relationship between OCAPs and Innov-Perf, such that strong MCAPs would (a) reduce the benefits of OCAPs, and (b) enhance the negative effects of strong OCAPs on Innov-Perf.

C) The Interaction between Technological and Operations Capabilities:

High TCAPs enable firms to innovate new production processes. This would enhance the cost-efficiency philosophy of a firm with intensive OCAPs because the new processes might cut production costs and allow the firm to offer new products at lower prices (Dutta et al., 1999). Further, when a firm possesses strong OCAPs, it would frequently engage its suppliers early in the product development process (Lizarelli et al., 2021). Having a strong absorptive capacity would allow the firm to acquire and integrate knowledge from those suppliers effectively. Also, possessing high TCAPs imply that a firm is frequently involved in acquiring new technologies and developing novel processes (Krasnikov & Jayachandran, 2008). Such a firm may uncover more efficient processes and promote change, protecting itself from being caught up in its best practices and competency trap. Thus, we suggest that:

H6: Ceteris Paribus, TCAPs positively moderate the relationship between OCAPs and Innov-Perf, such that high TCAPs would: (a) enhance the benefits of OCAPs and (b) offset the negative effects of strong OCAPs on Innov-Perf.

3.3.5. The Moderating Role of International PDCs:

Previous studies (e.g., Clausen 2014; Martínez-Noya & Narula, 2018) draw on the institutional theory to explain the differences between international and domestic collaborations. The institutional theory contends that the structures, goals, and means of firms are shaped by the institutional environments (e.g., social beliefs and norms, educational systems, regulatory structures and laws, and governmental requirements) of their societies. Each country has a "differentiated and specialized" set of institutions with which a firm must comply to gain legitimacy, support, and access to country-specific resources (Scott, 1987).

Grounding on this perspective, researchers argued that international, compared to domestic, collaborations provide better opportunities for learning and innovation (Tower et al., 2021). International PDCs allow a firm to access not only the technological capabilities of its partner but also the stock of knowledge of the partner's country and its network resources (Kim & Inkpen, 2005). Thus, international partners are more likely to offer unique capabilities and diverse resources than domestic partners who might offer redundant knowledge (Colombo et al., 2009; Lucena, 2016; Tower et al., 2021). Combining the distinctive resources and technologies of the two cross-national partners would stimulate new solutions and accelerate innovation, protecting the firm from falling into a competency trap (Lavie & Miller, 2008).

However, international PDCs impose unique challenges. They require higher coordination costs and a more complex process to develop interfirm routines (Colombo et al., 2009). Also, the cultural differences between the partners and their distinct institutional environments might hinder effective communication and challenge building trust between them. This might make it more difficult for the firm to learn from the foreign partner and absorb its knowledge (Lavie & Miller, 2008; Martínez-Noya & Narula, 2018).

As discussed earlier, the extant studies (e.g., Lucena, 2016; Harmancioglu, Griffith, & Yilmaz, 2019; Tower et al., 2021) demonstrated disagreement on the superiority of international PDCs over domestic ones in enhancing firm performance. In this study, we argue that the effect may be contingent on the type and magnitude of functional capabilities of the focal firm. While we consider forming a PDC as a dynamic capability that would enable the firm to reconfigure its functional capabilities and transform its internal processes to integrate the knowledge and technologies of its partners and thus protect against competency traps, we argue that international versus domestic PDCs might interact differently with the three functional capabilities to impact Innov-Perf.

First, forming PDCs mean that the firm is involved in R&D activities and would complement the innovation ideas collected through market orientation with its scientific-based breakthroughs. This might alleviate the downsides of strong MCAPs. Yet, the challenge remains in directing the R&D activities toward satisfying "familiar" market needs instead of winning the fruits of exploring emerging markets (Atuahene-Gima et al., 2005). This issue is less likely to occur in international, versus domestic, PDCs since foreign firms have diverse market knowledge and commercialization expertise (Lucena, 2016). Collaborating with international partners gives the firm higher exposure to the foreign market's distinctive patterns of demand, purchase behaviors, and customer requirements. Having access to such diverse market knowledge and expertise complements the marketing resources of the firm, motivating it to explore new markets and protecting it from the competency trap of its strong MCAPs.

Second, strong TCAPs might promote the focus on exploiting existing technologies rather than exploring new ones, driving a firm into a competency trap (Kaleka & Morgan, 2019). Yet, participating in PDCs might protect firms from falling into such traps by exposing them to new knowledge and technologies of their partners. Having access to such technological knowledge might also enhance the benefits of a firm's TCAPs by enabling it to acquire and internalize the knowledge and utilize it in developing new products. However, as the firm intensifies its TCAPs, the costs of integrating new knowledge and restructuring the current knowledge base of the firm would significantly increase, especially when the acquired knowledge is distant (Zhou & Wu, 2010). These costs are more significant in international, versus domestic, PDCs since foreign partners offer more diverse knowledge and operate in a distinct institutional environment (Colombo et al., 2009; Martínez-Noya & Narula, 2018). These costs might hinder the firm's motive to acquire additional external knowledge (Zhou & Wu, 2010), driving its technologies to become obsolete as new technologies emerge in the market and hurting its Innov-Perf.

Third, when a firm intensifies its OCAPs, it might develop rigid organizational routines, promote its best practices, and advocate a strict waste elimination strategy. In such circumstances, the OCAPs might turn into core rigidities, driving the firm into a competency trap that supports the status quo, hinders change, and calls off further learning and innovation activities (Prajogo & Sohal, 2001; Wang et al., 2015). However, these negative effects of strong OCAPs might be nullified when a firm establishes a PDC. Not only collaborating to develop new products supports the efficiency perspective of the firm by allowing it to share the costs of the R&D activities with its partners, but it also gives the firm an opportunity to learn new techniques and adjust its processes and working routines to work effectively with them. The adjustments to a firm's organizational routines and internal processes might be more pronounced in international PDCs where the international partners have distinctive institutional environments shaping their unique organizational structures, operating systems, and practices. Establishing interfirm routines is more involved in international than domestic PDCs (Colombo et al., 2009), inducing more prominent changes to the firm's internal processes and practices to incorporate those acquired from its distinct partners and thus protecting against competency traps of strong OCAPs. Based on the above arguments, we hypothesize that:

H7: Ceteris Paribus, international – compared to domestic – PDCs would have: (a) a more positive moderate effect on the relationship between MCAPs and Innov-Perf, (b) a less positive moderate effect on the relationship between TCAPs and Innov-Perf, and (c) a more positive moderate effect on the relationship between OCAPs and Innov-Perf.

3.4. Research Methods:

3.4.1. Data and Variables:

To measure our variables, we collected data from several archival databases. First, using the SDC Platinum database, we identified an initial sample of 428 PDCs formed between OEMs and suppliers in multiple high-tech industries between the period of 1985 and 2016. Next, for firms in this sample, we collected data to estimate capabilities from several databanks (e.g., Compustat, Thomson one, Factiva, and Mergent online) and the companies' annual reports. Finally, since we are using multiple indicators for Innov-Perf, we collected the required data from the United States Patent and Trademark Office (USPTO) and ABI/Inform databases.

Our efforts resulted in a complete dataset for a final sample of 202 dyads. Around 30% of the alliances are international and 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.

(a) Dependent Variable:

Innovation performance: we used three indicators to measure Innov-Perf following prior studies (e.g., Hagedoorn & Cloodt, 2003; Zhang et al., 2010). (a) *patent counts*, we totaled the number of patents filed by each OEM within one year from establishing the PDC. This indicates the *quantity* of technological inventions of the firm. (b) *patent citations*, we counted the number of citations each of these patents received from the following patents. This indicates the *quality* of the firm's inventions.; and (c) *new product announcements*, we counted the number of new product launches announced by each OEM within four years[7] from forming the PDC. This indicates the firm's success in converting its inventions into commercializable products. Table (3.2) summarizes the measures and data sources of our variables.

Table (3.2): Measurements of Research Variables

Variable	Abbreviation/ Symbol	Measurement/ Indicators	Reference(s)	Data Sources
Innovation performance	Innov-Perf/ P_i	*Patent* counts; patent c*itations*; and new product announcements (*NPAs*).	Hagedoorn & Cloodt, (2003); Zhang et al. (2010)	USPTO & ABI/Inform
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.)		
Operations capabilities	$Ocap_i$	An SF model for Cost of production = f (output, cost of capital, labor cost)		

[7] 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. Sampson (2004) utilized the four-year window to measure innovation performance of high-tech companies in a similar context.

Variable	Abbreviation/ Symbol	Measurement/ Indicators	Reference(s)	Data Sources
International PDC	INT_i	A binary variable of whether a PDC's partners have different nationalities.		SDC Platinum
Control Variables:	$Controls_i$			SDC Platinum
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) ; Estrada et al. (2016)	
US_OEM	$usoem_i$	A binary variable of whether the headquarter of an OEM is in US.	Lee (2011)	
Collaboration scope	$scope_i$	A binary variable of whether a PDC was limited to R&D activities or included additional activities like marketing and/or manufacturing.	Sampson (2004b); Cui & O'Connor (2012)	
OEM's age	age_i	The number of years between an OEM's foundation date and its PDC's formation date.	Bouncken et al., (2016)	SDC Platinum, Compustat, & or Factiva.
Supplier patents	$suppat_i$	A count variable of the total number of patents of an OEM's supplier.	(Sampson, 2007)	USPTO database
Control function:	CF	A first-stage residual was used to correct for potential endogeneity in the international PDC variable.	Terza et al. (2008); Wooldridge (2015)	Calculated based on a logit estimation
Control function for equation 3	$CF(INT)_i$	Residual of a logit model of international PDC on all the other regressors of equation (3).		

(b) Independent and Moderating Variables:

Functional capabilities: we followed previous marketing studies (e.g., Dutta et al., 1999; Feng et al., 2017; Narasimhan et al., 2006; Saboo et al., 2017) in measuring firm capabilities using an input-output Stochastic Frontier (SF) estimation.

For marketing capabilities, we used sales revenue as an output and the following figures as inputs: current year ad expenditures, ad stock, current year marketing expenditures, stock of marketing expenditures, investments in customer relationships, and installed customer base. We added industry dummies and year dummies to control for the effect of industry factors and changes in the business cycle over the years, respectively. To account for the idea that most marketing investments (e.g., ad expenditures) have a long-term impact on sales, and that recent investments would have a higher impact than earlier ones, we used Koyck-lag structure with 0.5

weight to estimate each of ad stock, stock of marketing exp., accumulated customer relationships, and installed base (see Dutta et al. (1999) for more details)[8]. Our SF model is:

$$ln(sales_i) = \beta_0^m + \beta_1^m ln(ad_i) + \beta_2^m ln(adstock_i) + \beta_3^m ln(SGA_i) + \beta_4^m ln(mrktgstock_i)$$
$$+ \beta_5^m ln(A/R_i) + \beta_6^m ln(rec_i) + \beta_7^m ln(installedbase_i) + \beta_k^m \Sigma_{k=1}^{k=5} ind_{\,k}$$
$$+ \beta_t^m \Sigma_{t=1}^{t=5} years_t + \epsilon_i^m$$

Where $sales_i$ is the total sales revenue of OEM (i) in the year of establishing the collaboration (that year henceforth); ad_i is the ad expenses of OEM (i) in that year; $adstock_i$ is stock of ad expenses of OEM (i) over three years before that year; SGA_i total Selling, General, & Administrative (SG&A) expenditures of OEM (i) in that year; $mrktgstock_i$ is stock of SG&A expenditures as a proxy for marketing expenditures of OEM (i) over three years before that year; A/R_i total accounts receivables as a proxy for investments in customer relationships of OEM (i) in that year; rec_i accounts receivables over three years before that year as a proxy of accumulated customer relationships of OEM(i); $installedbase_i$ total sales revenues of OEM (i) over three years before that year; $ind_{\,k}$ industry dummies; $years_t$ dummies for years grouped into five eras; and ϵ_i^m is the composed error term ($\epsilon_i^m = \nu_i + u_i$) where ν_i is the measurement and specification error and u_i is the inefficiency error term. Table (3.3) presents the results of the SF model of marketing capabilities.

[8] $adstock_t = \sum_{k=1}^{k=t} W^{t-k} * ad\ exp_k$, $mrktgstock_t = \sum_{k=1}^{k=t} W^{t-k} * SGA_k$, $rec_t = \sum_{k=1}^{k=t} W^{t-k} * A/R_k$ $installedbase_t = \sum_{k=1}^{k=t} W^{t-k} * sales_k$, where: W= 0.5 and t= 3

Table (3.3): Parameter Estimates of Marketing Capabilities

lnsales	Coef.	Robust Std.Err.	z	P>z	[95%Conf.	Interval]
Frontier						
lninstalledbase	0.942	0.034	27.540	0.000	0.875	1.009
lnmrkgstock	-0.590	0.086	-6.890	0.000	-0.757	-0.422
lnsga	0.624	0.082	7.600	0.000	0.463	0.785
lnadstock	-0.035	0.019	-1.830	0.067	-0.073	0.003
lnad	0.051	0.022	2.300	0.021	0.008	0.094
lnrec	-0.271	0.072	-3.750	0.000	-0.412	-0.129
lnA/R	0.275	0.075	3.670	0.000	0.128	0.422
years						
2	0.048	0.021	2.280	0.023	0.007	0.090
3	0.027	0.033	0.820	0.414	-0.038	0.092
4	0.184	0.089	2.060	0.039	0.009	0.358
5	-0.002	0.042	-0.060	0.955	-0.085	0.081
industry						
2	-0.001	0.044	-0.020	0.985	-0.087	0.086
3	-0.007	0.023	-0.320	0.748	-0.052	0.037
4	-0.036	0.038	-0.950	0.342	-0.111	0.039
5	-0.034	0.033	-1.030	0.305	-0.098	0.031
_cons	0.161	0.084	1.910	0.056	-0.004	0.326
Usigma						
_cons	-6.761	2.348	-2.880	0.004	-11.363	-2.158
Vsigma						
_cons	-4.791	0.444	-10.790	0.000	-5.662	-3.920
sigma_u	0.034	0.040	0.850	0.394	0.003	0.340
sigma_v	0.091	0.020	4.500	0.000	0.059	0.141
lambda	0.374	0.058	6.480	0.000	0.261	0.486
No. obs.=202			Prob > chi2 = 0.0000			

We directly estimated MCAPs using Battese & Coelli (BC: 1988) method that uses maximum likelihood to estimate technical efficiency by estimating $E\{\exp(-u_i|\epsilon_i^m)\}$. Similar to previous studies, we rescaled our variable to range from 0 (lowest capability) and 10 (highest capability).

For technological capabilities, we follow previous marketing studies (e.g., Feng et al., 2015; Saboo et al., 2017) in considering patent counts as a technological output and the inputs to include patent stock, current R&D expense, and accumulated R&D expenses from previous years. We also used the Koyck-lag structure with 0.4 weight to estimate each of the patent and

R&D stocks (Dutta et al., 1999)[9]. We estimated the following SF model for TCAPs similar to our estimation of MCAPs.

$$ln(patent_i) = \beta_0^t + \beta_1^t ln(patstock_i) + \beta_2^t ln(rd_i) + \beta_3^t ln(accumrd_i) + \beta_k^t \Sigma_{k=1}^{k=5} ind_k + \beta_t^t \Sigma_{t=1}^{t=5} years_t + \epsilon_i^t$$

Where $patent_i$ is the number of patents filed by OEM (i) in that year; $patstock_i$ total number of patents filed by OEM (i) over three years before that year; rd_i total R&D exp. of OEM (i) in that year; and $accumrd_i$ total R&D exp. of OEM (i) over three years before that year. Table (3.4) presents the results of the SF model of technological capabilities.

Table (3.4): Parameter Estimates of Technological Capabilities

lnpatent	Coef.	Robust Std.Err.	z	P>z	[95%Conf.	Interval]
Frontier						
lnpatentstock	0.833	0.051	16.370	0.000	0.733	0.932
lnaccumrd	-0.354	0.230	-1.540	0.124	-0.804	0.096
lnrd	0.467	0.237	1.970	0.049	0.002	0.931
years						
2	0.100	0.100	1.000	0.317	-0.096	0.295
3	0.213	0.140	1.520	0.127	-0.061	0.487
4	-0.089	0.310	-0.290	0.773	-0.697	0.518
5	0.229	0.338	0.680	0.497	-0.432	0.891
industry						
2	0.148	0.135	1.100	0.272	-0.116	0.412
3	0.106	0.088	1.210	0.225	-0.065	0.278
4	-0.140	0.180	-0.780	0.437	-0.493	0.213
5	-0.187	0.127	-1.470	0.142	-0.436	0.062
_cons	0.200	0.222	0.900	0.369	-0.236	0.635
Usigma						
_cons	-2.708	0.513	-5.280	0.000	-3.713	-1.703
Vsigma						
_cons	-2.339	0.388	-6.030	0.000	-3.099	-1.578
sigma_u	0.258	0.066	3.900	0.000	0.156	0.427
sigma_v	0.311	0.060	5.160	0.000	0.212	0.454
lambda	0.831	0.107	7.760	0.000	0.621	1.041
No. Obs.=189	Prob > chi2 = 0.0000					

[9] $patstock_t = \sum_{k=1}^{k=t} G^{t-k} * patent_k$ & $accumrd_t = \sum_{k=1}^{k=t} G^{t-k} * rd\ exp_k$, where G= 0.4 and t=3.

For operations capabilities, we estimated a *cost function* to minimize the Cost of Goods Sold (COGS) as the output using three inputs: output, cost of labor, and cost of capital. Our SF model is:

$$ln(COGS_i) = \beta_0^o + \beta_1^o ln(output_i) + \beta_2^o ln(labcost_i) + \beta_3^o ln(cocap_i) + \beta_k^o \Sigma_{k=1}^{k=5} ind_k + \beta_t^o \Sigma_{t=1}^{t=5} years_t + \epsilon_i^o$$

Where, $COGS_i$ is the cost of goods sold by OEM (i) in that year; $output_i$ the dollar amount of the output of OEM (i) in that year; $labcost_i$ the per-employee wages and benefits of OEM (i) at that year; and $cocap_i$ cost of capital (i.e. the average long-term interest rate) of OEM (i) at that year. Table (3.5) presents the results of the SF model of operations capabilities.

Table (3.5): Parameter Estimates of Operations Capabilities

lncogs	Coef.	Robust Std.Err.	z	P>z	[95%Conf.	Interval]
Frontier						
lnoutput	0.599	0.067	9.000	0.000	0.468	0.729
lnlabcost	-0.035	0.089	-0.390	0.696	-0.209	0.140
lncocap	0.338	0.064	5.310	0.000	0.213	0.463
years						
2	0.075	0.077	0.960	0.335	-0.077	0.227
3	0.361	0.193	1.870	0.062	-0.018	0.739
4	-0.185	0.452	-0.410	0.682	-1.072	0.701
5	1.295	0.379	3.420	0.001	0.554	2.037
ind						
2	0.309	0.236	1.310	0.191	-0.154	0.772
3	0.002	0.170	0.010	0.991	-0.332	0.335
4	-0.954	0.203	-4.700	0.000	-1.352	-0.556
5	-0.161	0.302	-0.530	0.594	-0.753	0.431
_cons	2.965	0.285	10.380	0.000	2.405	3.524
Usigma						
_cons	-2.253	0.639	-3.520	0.000	-3.506	-1.000
Vsigma						
_cons	-1.203	0.408	-2.950	0.003	-2.003	-0.402
sigma_u	0.324	0.104	3.130	0.002	0.173	0.607
sigma_v	0.548	0.112	4.900	0.000	0.367	0.818
lambda	0.592	0.188	3.150	0.002	0.223	0.960
No. obs.=202			Prob > chi2 = 0.0000			

International PDC: we sorted the collaboration between an OEM and its supplier to be either *domestic* if the two partners share the same nationality or *international* if their headquarters are located in different countries.

(c) Control Variables:

We controlled for various OEM-specific, supplier-related, and PDC-related variables that might have an impact on Innov-Perf. Specifically, *the year* in which the PDC was established; the *high-tech industry* in which the OEM operates, the *age* of the OEM on the date of partnering and its *quadratic* term; the *nationality* of the OEM; *supplier's patents* as a proxy of the supplier's innovativeness; and the *collaboration scope*, whether the activities of a PDC was limited to R&D or included marketing and/or manufacturing as well.

Table (3.6) presents 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 patents and citations of 52 and 1053; respectively. The medical equipment sector had the lowest average number of NPAs of just 2.

Also, the computer hardware and software companies had the highest MCAPs of 8.5 and TCAPs of 8.3 on average and they are one of the three sectors (the others being electronics and biotech) that had the highest average OCAPs of 7.8. Both the telecommunications and medical equipment companies had the lowest average MCAPs of 8.1. The medical equipment sector also had the lowest OCAPs at an average of 7.1. The biotech sector had the lowest TCAPs at an average of 7.5. The electronics sector had the highest percentage of international PDCs with 46.3% of the electronic firms collaborated with foreign suppliers. While only 15% of the telecommunications companies had international collaborations, representing the lowest sector in our dataset.

Table (3.6): Variables Correlation and Sample Characteristics

Panel (a): Correlation Matrix and Descriptive Statistics

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Patents	1.000												
(2) Citations	0.528*	1.000											
(3) NPAs	0.022	0.072	1.000										
(4) MCAPs	0.092	0.154*	0.155*	1.000									
(5) TCAPs	0.160*	0.259*	0.109	-0.086	1.000								
(6) OCAPs	-0.034	0.004	-0.094	-0.031	-0.207*	1.000							
(7) International	0.048	0.008	-0.066	-0.011	-0.006	0.005	1.000						
(8) Years	0.244*	0.104	0.070	-0.079	-0.177*	-0.097	0.208*	1.000					
(9) Industry	-0.023	-0.099	-0.048	-0.049	-0.067	-0.073	-0.081	0.098	1.000				
(10) OEM's age	0.342*	0.482*	-0.141*	0.147*	0.099	0.133	0.092	0.109	0.043	1.000			
(11) US_OEM	-0.040	0.018	0.090	-0.018	0.011	-0.156**	-0.370*	-0.102	0.135	-0.259*	1.000		
(12) Supplier's patent	0.066	0.112	0.025	0.022	0.105	-0.140**	0.198*	0.173*	-0.095	0.042	-0.057	1.000	
(13) PDC Scope	-0.014	0.022	0.080	-0.111	0.039	0.107	0.043	-0.051	0.100	0.051	-0.028	0.020	1.000
No. Obs.	202	202	202	202	189	202	202	202	202	202	202	202	202
Mean	667.8	18378.3	38.5	8.3	8.1	7.7	0.3	2.1	2.8	50.6	0.89	133.7	0.61
Std. Dev.	1786.8	26391.7	57.3	1.02	1.57	1.43	0.46	0.82	1.2	30.1	0.3	333	0.48
Min	0	0	0	0	0	0	0	1	1	6	0	0	0
Max	21125	158418	285	10	10	10	1	5	5	109	1	1917	1

* Significant at 95%

Panel (b): Indicators of Innovation Performance by High-tech Sector:

Sector	Obs.	Patents				Citations				NPAs			
		Mean	s.d.	Min.	Max.	Mean	s.d.	Min.	Max.	Mean	s.d.	Min.	Max.
1. Electronics	**41**	441.195	485.087	0	1911	15220.098	21353.177	0	114131	22.024	29.800	0	160
2. Telecommunications	**20**	471.55	583.193	0	1512	18157.95	22506.697	0	67193	31.9	37.422	1	140
3. Computer h/ware & s/ware	**102**	1011.578	2431.103	0	21125	25610.235	30788.468	0	158418	60.088	69.478	0	285
4. Biotech & Pharmaceutical	**19**	52.053	80.463	0	306	1052.895	1472.319	0	5091	3.158	3.452	0	12
5. Medical equipment	**20**	160.9	280.984	0	948	4648.75	7746.842	0	23768	2	1.947	0	5

Panel (c): Capabilities & PDCs by High-tech Sector:

Sector	MCAPs					TCAPs					OCAPs					Domestic PDCs		International PDCs	
	Obs.	Mean	s.d.	Min.	Max.	Obs.	Mean	s.d.	Min.	Max.	Obs.	Mean	s.d.	Min.	Max.	N	%	N	%
1. Electronics	**41**	8.4	0.67	6.4	9.4	**39**	8.2	1.8	0	9.5	**41**	7.8	1.4	5.4	9.4	22	53.7	19	46.3
2. Telecomm.	**20**	8.1	2.1	0	9.6	**17**	8.1	1.4	5.12	10	**20**	7.6	2	1.8	9.3	17	85	3	15
3. Computer h/ware & s/ware	**102**	8.5	0.61	6.2	9.5	**99**	8.3	1.2	1.1	10	**102**	7.8	1.6	0	10	75	73.5	27	26.5
4. Biotech & Pharm.	**19**	8.3	0.93	5.38	10	**16**	7.5	2.4	1.7	9.9	**19**	7.8	1.1	5.1	9.6	12	63.2	7	36.8
5. Medical equip.	**20**	8.1	1.7	3.5	9.6	**18**	7.8	1.9	3.5	10	**20**	7.1	2.5	1.1	9.5	14	70	6	30

3.4.2. Model Specification and Estimation:

We test our hypotheses over three steps. First, we estimate the relationships between capabilities and Innov-Perf. Second, we test the interactions among the three capabilities and their relationships with Innov-Perf. Third, we estimate the moderating effect of international PDCs in the relationships between capabilities and Innov-Perf. Specifically, we estimate the following three equations.

$$\boldsymbol{P_i} = \beta_0 + \beta_1 Mcap_i + \beta_2 Tcap_i + \beta_3 Ocap_i + \beta_4 Mcap_i^2 + \beta_5 Tcap_i^2 + \beta_6 Ocap_i^2 + (\beta_7{:}\beta_{13}) Controls_i + \epsilon_{i1} \qquad \textbf{(1)}$$

$$\boldsymbol{P_i} = \delta_0 + \delta_1 Mcap_i + \delta_2 Tcap_i + \delta_3 Ocap_i + \delta_4 Mcap_i^2 + \delta_5 Tcap_i^2 + \delta_6 Ocap_i^2 + \delta_7 Mcap_i * Tcap_i + \delta_8 Mcap_i * Ocap_i + \delta_9 Tcap_i * Ocap_i + \delta_{10} Tcap_i^2 * Mcap_i + \delta_{11} Ocap_i^2 * Mcap_i + \delta_{12} Ocap_i^2 * Tcap_i + (\delta_{13}{:}\delta_{19}) Controls_i + \epsilon_{i2} \qquad \textbf{(2)}$$

$$\boldsymbol{P_i} = \theta_0 + \theta_1 INT_i + \theta_2 Mcap_i + \theta_3 Tcap_i + \theta_4 Ocap_i + \theta_5 Mcap_i^2 + \theta_6 Tcap_i^2 + \theta_7 Ocap_i^2 + \theta_8 INT_i * Mcap_i + \theta_9 INT_i * Tcap_i + \theta_{10} INT_i * Ocap_i + \theta_{11} INT_i * Mcap_i^2 + \theta_{12} INT_i * Tcap_i^2 + \theta_{12} INT_i * Ocap_i^2 + (\theta_{13}{:}\theta_{19}) Controls_i + \epsilon_{i3} \qquad \textbf{(3)}$$

where P_i is the innovation performance indicator (i.e., patents, citations, and NPAs, and thus, we ran each of the above models three times using one performance indicator each time), $Mcap_i$ marketing capabilities of OEM (i), $Tcap_i$ technological capabilities of OEM (i), $Ocap_i$ operations capabilities of OEM (i), $Mcap_i^2$ the quadratic term of marketing capabilities of OME (i), $Tcap_i^2$ the quadratic term of technological capabilities of OME (i), $Ocap_i^2$ the quadratic term of operations capabilities of OME (i), INT_i international versus domestic PDC established by OEM (i). $Controls_i$ are control variables, and $\epsilon_{i(.)}$ are the random error terms. The complete list of variables is in Table (3.2).

(a) Our Count Data Analysis Approach:

Our dependent variable *innovation performance* is measured using three indicators, all of which are *count data*. Count variables are a special kind of discrete variables that are nonnegative integers or counts with frequent zeros and small values (Greene, 2018, p. 885). One approach to deal with the nature of our dependent variables is to log-transform data and then use simple linear regression (OLS) to run the model. The aim of transforming data is to normalize the error; however, this process may not solve the linearity problem. Also, there might be a significant loss of data resulting from the failure to log-transform observations with zero counts. Additionally, the regression of log-transformed data can result in "impossible predictions, such as negative numbers of individuals" (O'Hara & Kotze, 2010). Another approach is to use the models designed specifically to account for the special aspects of count data (Greene, 2018, p. 885).

Since count variables follow the Poisson distribution, it is natural to consider the Poisson regression model for our analysis. One main assumption of the Poisson models, though, is that the variance of the error equals its mean. To test whether our data satisfies this condition, we ran an overdispersion test as suggested by (Cameron & Trivedi, 2010, p. 575). Our results revealed the existence of the overdispersion issue in our data. To accommodate this feature in our data, we depend on negative binomial regressions to run our models. A negative binomial model is an extension of the Poisson model that doesn't require equality between the mean and the variance (Greene, 2018, p. 889). Negative binomial regression uses Maximum Likelihood (ML) methods to estimate the following model:

$$pr(Performance = p) = \frac{(e^{-\lambda}\lambda^{p})}{p!}, \qquad p = 0,1,2..$$

Whereas $\lambda = exp(X'\beta)$, X is a vector of independent variables and β is a vector of parameters to be estimated. We are using the *Generalized Linear Models (GLMs)* to run the negative binomial models using Stata software. GLMs are introduced by Nelder & Wedderburn (1972) to generalize the linear regression to models with non-normally distributed error terms (e.g., negative binomial models). They use link functions (e.g., log, logit, identity) to relate the linear model to the dependent variable. Even though both GLMs and negative binomial regressions give the same results, GLMs are providing additional diagnostic statistics. Additionally, GLM estimators are "*consistent provided only that the conditional mean function is correctly specified*." (Cameron & Trivedi, 2010, p. 327-332; Hardin & Hilbe, 2018, p. 34).

(b) Clustered Standard Errors:

Our sample covered the period 1985-2016 and an OEM may have multiple PDCs 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).

(c) Collinearity between Quadratic Terms:

To reduce "nonessential" collinearity in our models between capabilities and their quadratic terms, we centered the three capabilities around the mid-point of their scale (i.e., at 5). We similarly centered the continuous control variables (Dalal & Zickar, 2012).

(d) Endogeneity: Two-Stage Residual Inclusion

Our international PDC variable might be endogenous due to omitted variable bias. Unobserved variables (e.g., having R&D employees/scientists with foreign links) could simultaneously impact the choice of collaborating with international partners and Innov-Perf, leading to the error term being correlated with the international PDC variable. Since this potentially endogenous variable is binary, we used the *Two-Stage Residual Inclusion (2SRI)* method (Terza et al., 2008). This is a Control Function (CF) method that uses instrumental variables (Wooldridge, 2015).

We used two Instrumental Variables (IVs) to estimate the first-stage multinomial logit model: the region of the supplier and the differences in productivity per hour between the OEM's country and the supplier's country. First, the geographical region of a supplier might drive an OEM's choice of partnering with that supplier, but it is less likely to affect the innovation performance of the OEM. Second, an OEM that locates in a highly productive country is more likely to face strong competition. This home competition might encourage the OEM to seek foreign partnerships to gain competitive advantage. At the same time, the differences in productivity between the two countries is less likely to affect the innovation performance of the OEM.

To implement the 2SRI method, we (a) ran a first-stage multinomial logit model for international PDC using the two instruments along with all other regressors appearing in the right-hand side of Equation (3), (b) estimated the predicted probabilities of this model and subtracted the observed values form it to get the residuals, (c) we added the computed residual as an additional regressor to Equation (3) and estimated model (4) below. Results of the first-stage multinomial logit models are shown in Table (3.7).

$$\boldsymbol{P_i} = \pi_0 + \pi_1 INT_i + \pi_2 Mcap_i + \pi_3 Tcap_i + \pi_4 Ocap_i + \pi_5 Mcap_i^2 + \pi_6 Tcap_i^2 + \pi_7 Ocap_i^2 + \pi_8 INT_i * Mcap_i + \pi_9 INT_i * Tcap_i + \pi_{10} INT_i * Ocap_i + \pi_{11} INT_i * Mcap_i^2 + \pi_{12} INT_i * Tcap_i^2 + \pi_{12} INT_i * Ocap_i^2 + (\pi_{13}{:}\pi_{19}) Controls_i + \pi_{20}\, CFINT_i + \epsilon_{i4} \qquad \textbf{(4)}$$

We also measured innovation performance *after one year* of the collaboration, while all other regressors including capabilities and international PDC are measured *in the year* of collaboration. This rules out potential *reverse causalities* in the models.

Table (3.7): First-stage Multinomial Logistic Regression for International PDC

International PDC	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Productivity difference	.136	.066	2.07	.038	.008	.265	**
Supplier's Region			Baseline Category				
Supp. Reg. 2	1.81	2.398	0.75	.45	-2.89	6.511	
Supp. Reg. 3	4.268	1.653	2.58	.01	1.028	7.507	***
MCAP	.386	.574	0.67	.501	-.738	1.511	
TCAP	.035	.376	0.09	.925	-.701	.772	
OCAP	-.205	.222	-0.92	.357	-.64	.231	
MCAP2	-.094	.114	-0.82	.41	-.316	.129	
TCAP2	-.003	.078	-0.04	.969	-.156	.15	
OCAP2	-.072	.067	-1.07	.284	-.204	.06	
Years:							
2	-.259	.463	-0.56	.576	-1.167	.649	
3	.35	.748	0.47	.64	-1.117	1.817	
4	-4.553	3.873	-1.18	.24	-12.144	3.038	
5	2.808	1.285	2.19	.029	.289	5.328	**
Industry:							
2	1.249	.895	1.40	.163	-.505	3.002	
3	-.063	.682	-0.09	.927	-1.399	1.274	
4	-.81	1.233	-0.66	.511	-3.226	1.606	
5	-.187	.833	-0.22	.822	-1.819	1.445	
Age	-.001	.011	-0.11	.916	-.024	.021	
Age2	0	0	-0.66	.506	-.001	.001	
OEM_US	-7.807	2.093	-3.73	0	-11.909	-3.705	***
Supplier patents	.14	.174	0.81	.42	-.2	.48	
PDC Scope	.522	.52	1.01	.315	-.496	1.541	
Constant	5.472	2.175	2.52	.012	1.209	9.736	**

Mean dependent var	0.307	SD dependent var	0.462
Pseudo r-squared	0.623	Number of obs	189
Chi-square	102.462	Prob > chi2	0.000
Akaike crit. (AIC)	133.965	Bayesian crit. (BIC)	208.525

**** p<.01, ** p<.05, * p<.1*

3.5. Results:

We present our estimations and results in three steps. First, we test the inverted U-shaped relationship between capabilities and Innov-Perf by estimating equation (1) for each of the indicators of Innov-Perf using the three capabilities and their quadratic forms along with the control variables. Second, we estimate equation (2) with the interaction between the three capabilities and their quadratic forms. Third, we test the interaction between the capabilities and international PDC by estimating a baseline GLM model without endogeneity correction for equation (3), and an adjusted GLM model with endogeneity correction for equation (4).

3.5.1. Results of Capabilities Relationships with Innov-Perf:

The results of our first estimation offer evidence of the existence of the competency trap effect on Innov-Perf. The results in Model (1) in Table (3.8) indicate that MCAP is positively and significantly associated with patents, citations, and NPAs; and $MCAP^2$ is negatively and significantly associated with patents and citations. Similarly, TCAP is positively and significantly associated with patents, citations, and NPAs; and $TCAP^2$ is negatively and significantly associated with NPAs. Likewise, OCAP is positively and significantly associated with NPAs; and $OCAP^2$ is negatively and significantly associated with patents and citations.

Table (3.8): The Relationships between Capabilities and their Interactions and Innovation Performance:

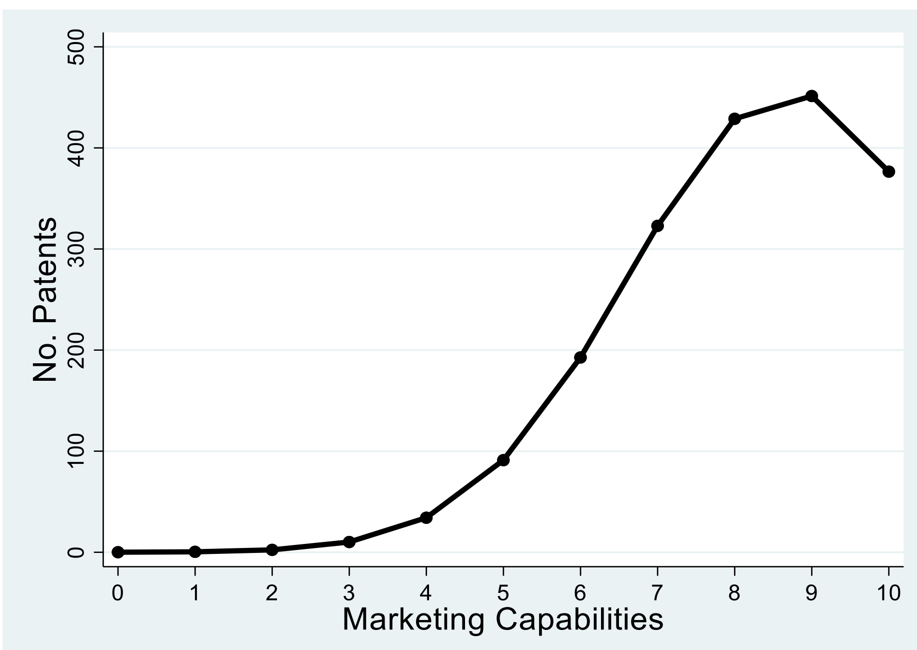
`	Model (1): Individual Capabilities			Model (2): Capabilities Interactions		
	(1a) Patents	**(1b) Citations**	**(1c) NPAs**	**(2a) Patents**	**(2b) Citations**	**(2c) NPAs**
MCAP	.865***	.859***	.233**	.34	.245	.207
	(.101)	(.111)	(.108)	(.516)	(.666)	(.563)
TCAP	.65***	.532***	.269**	1.246***	1.537***	1.83***
	(.11)	(.098)	(.125)	(.244)	(.289)	(.68)
OCAP	.015	.078	.176*	-.196	-.053	1.077
	(.067)	(.08)	(.092)	(.481)	(.573)	(.895)
MCAP2	-.116***	-.098***	.016	-.046	-.075	.04
	(.029)	(.037)	(.034)	(.067)	(.08)	(.057)
TCAP2	-.02	.012	-.042*	-.262**	-.341**	-.398***
	(.024)	(.022)	(.025)	(.112)	(.14)	(.11)
OCAP2	-.034*	-.06**	-.032	.131	-.082	-.15
	(.019)	(.028)	(.027)	(.08)	(.11)	(.147)
TCAP X MCAP				-.179**	-.312***	-.371***
				(.077)	(.076)	(.125)
OCAP X MCAP				-.092	-.129	-.246
				(.097)	(.123)	(.266)
OCAP X TCAP				.246***	.269***	.048
				(.055)	(.053)	(.121)
TCAP2 X MCAP				.071**	.101**	.098***
				(.032)	(.039)	(.032)
OCAP2 X MCAP				-.094***	-.065*	-.036
				(.028)	(.038)	(.035)
OCAP2 X TCAP				.027	.05**	.058
				(.019)	(.021)	(.045)
Controls:						
Years:						
Years2	.413**	.44**	.978***	.394**	.506**	.98***
	(.186)	(.196)	(.202)	(.198)	(.205)	(.217)
Years3	.986***	1.183***	.867***	1.076***	1.315***	.937***
	(.311)	(.341)	(.315)	(.31)	(.326)	(.302)
Years4	.811	.314	2.502***	.871*	.299	2.289***
	(.515)	(.585)	(.853)	(.516)	(.561)	(.755)
Years5	2.68***	.344	1.464**	3.231***	1.209	1.98**
	(.716)	(.784)	(.613)	(.924)	(.948)	(.917)
High-tech industry:						
Ind2	-.134	-.079	.26	-.172	-.188	.335
	(.365)	(.366)	(.295)	(.366)	(.373)	(.298)
Ind3	.304	.241	.718**	.2	.105	.733**
	(.217)	(.253)	(.288)	(.253)	(.274)	(.336)
Ind4	-1.583***	-1.973***	-1.526***	-1.79***	-2.347***	-1.731***
	(.42)	(.424)	(.541)	(.397)	(.392)	(.58)
Ind5	-.993***	-1.208***	-1.946***	-.985***	-1.382***	-2.072***
	(.348)	(.382)	(.355)	(.38)	(.457)	(.44)
OEM_age	.038***	.03***	-.009	.038***	.029***	-.01
	(.004)	(.004)	(.007)	(.003)	(.004)	(.008)
OEM_age2	-.001***	-.001***	-.0002	-.001***	-.001***	-.0002
	(.0001)	(.0001)	(.0002)	(.0001)	(.0001)	(.0002)
US_OEM	-.439	-.083	-.023	-.401	.041	.078
	(.272)	(.316)	(.388)	(.248)	(.289)	(.409)
Supplier patent	.013	.125	.073	-.006	.094	.093
	(.078)	(.107)	(.076)	(.08)	(.106)	(.078)

`	Model (1): Individual Capabilities			Model (2): Capabilities Interactions		
	(1a) Patents	(1b) Citations	(1c) NPAs	(2a) Patents	(2b) Citations	(2c) NPAs
Collaboration scope	.145	.036	.147	.126	.074	.167
	(.146)	(.146)	(.127)	(.155)	(.15)	(.13)
_cons	2.711***	5.966***	.827	3.47**	7.715***	-.501
	(.613)	(.748)	(.777)	(1.607)	(1.799)	(2.394)
Observations	189	189	189	189	189	189
Chi2	915.927	726.426	307.027	1640.312	2124.134	381.297
Prob > Chi2	0.000	0.000	0.000	0.000	0.000	0.000
Akaike Crit. (AIC)	2474.661	3817.135	1637.245	2470.881	3804.561	1635.600

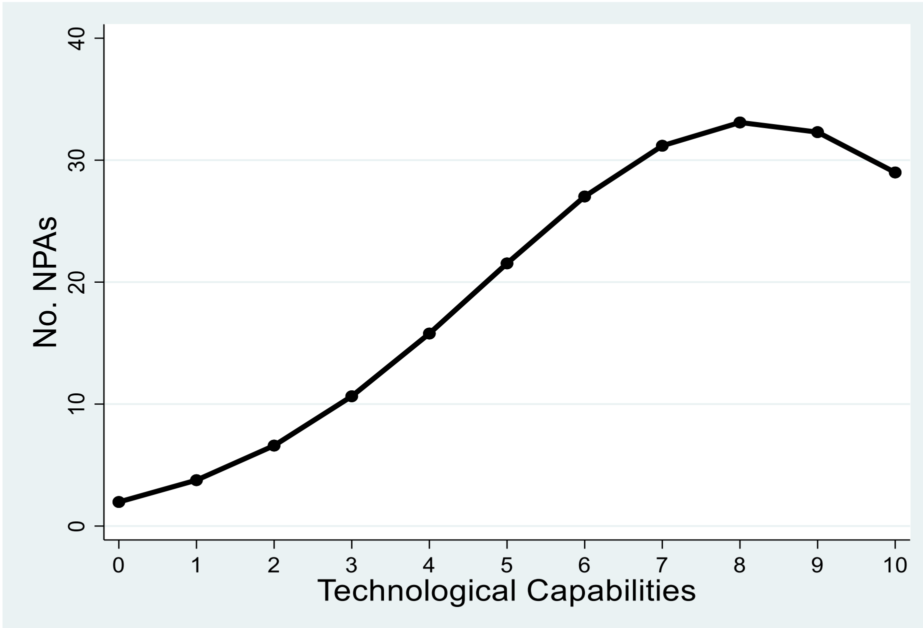
Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

These relationships are visually illustrated in Panels (A1-A3) of Figure (3.3). The three figures show, with varying slopes, that as capabilities increase, the Innov-Perf increases at a decreasing rate until it reaches a peak point after which the Innov-perf starts to decline. These figures demonstrate a curvilinear relationship between each of the three capabilities and Innov-Perf.

Panel (A1): MCAP Relationship with Innov-Perf



Panel (A2): TCAP Relationship with Innov-Perf



Panel (A3): OCAP Relationship with Innov-Perf

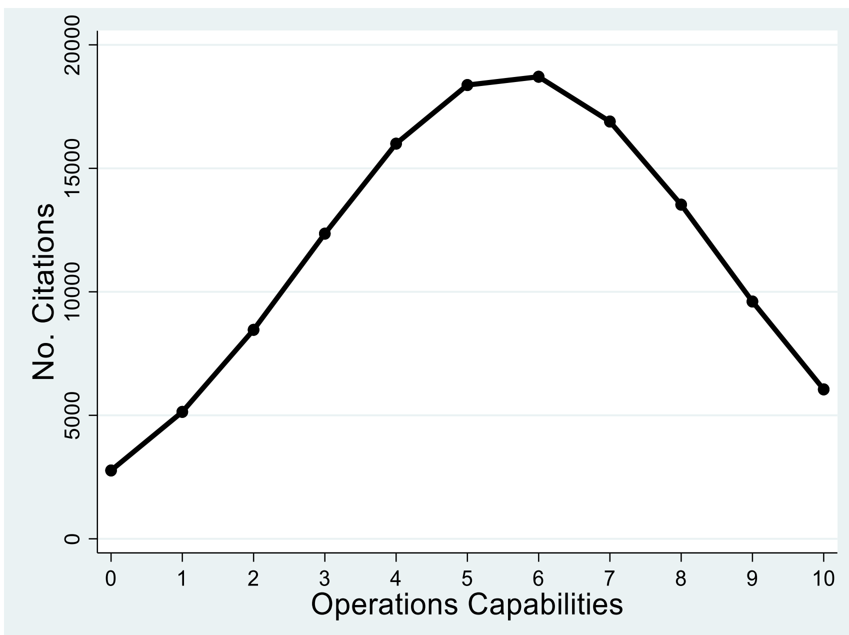


Figure (3.3): The Relationships between Capabilities and Innovation Performance

We formally tested whether these relationships are significant inverse U-shapes. Panels (B1-B3) of Table (3.9) present the results of the U tests and the peak points for each capability.

As shown in Panel (B1), MCAP has a significant inverted U-shaped relationship with patents with a peak at 8.7. It also has a similar but not significant relationship with citations. The results in Panel (B2) demonstrate that there is an inverted U-shaped relationship between TCAP and NPAs, but this relationship is not significant. In Panel (B3), OCAP has a significant inverted U-shaped relationship with each of the patents with a peak of 5.2, and citations with a peak of 5.6. These results are in support of H1 and H3, but they fail to fully support H2.

Table (3.9): Inverted U-Shape Tests

Panel (B1): Peak Points and U Test Results for MCAP			
	Patents	**Citations**	**NPAs**
Peak point of MCAPs	8.7***	9.4***	-12.2
Lower bound slope	2.02***	1.8***	0.07
Upper bound slope	-0.3*	-0.12	0.4
Inverted U overall test	p-value= 0.1	p-value = 0.34	N/A
Panel (B2): Peak Points and U Test Results for TCAP			
	Patents	**Citations**	**NPAs**
Peak point of TCAPs	21.76	- 26.6	8.2**
Lower bound slope	0.85	0.41	0.68**
Upper bound slope	0.45	0.65	-0.14
Inverted U overall test	N/A	N/A	p-value = 0.19
Panel (B3): Peak Points and U Test Results for OCAP			
	Patents	**Citations**	**NPAs**
Peak point of OCAPs	5.21	5.6	7.7
Lower bound slope	0.36**	0.68**	0.49**
Upper bound slope	-0.33**	-0.52**	-0.14
Inverted U overall test	p-value = .04	p-value = .03	p-value = .31

**** p<.01, ** p<.05, * p<.1*

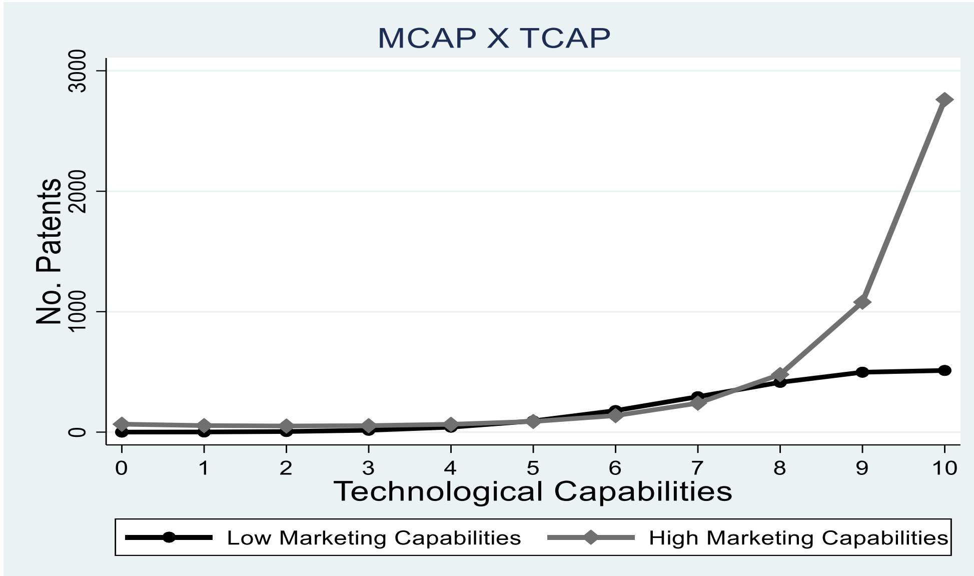
3.5.2. Results of the Relationships between Capabilities Interactions and Innov-Perf:

Next, we estimate equation (2) to test H4-H6. Model (2) of Table (3.8) presents the results of the relationships among the capabilities interactions and Innov-Perf. The interaction between $TCAP^2$ and MCAP is positively and significantly associated with patents, citations, and NPAs. These results indicate that MCAP positively moderates the relationship between TCAP and Innov-Perf, supporting H4. Figure (3.4) – Panel (C1) illustrates this relationship. At high levels of TCAPs, high MCAPs are associated with higher Innov-Perf than low MCAPs. Conversely, the interaction between $OCAP^2$ and MCAP is negatively and significantly associated with patents and citations. These results indicate that MCAP negatively moderates the relationship between OCAP and Innov-Perf, supporting H5. This relationship is depicted in Panel (C2) of Figure (3.4). At all levels of OCAP, high MCAP is associated with lower Innov-Perf than low levels of MCAP.

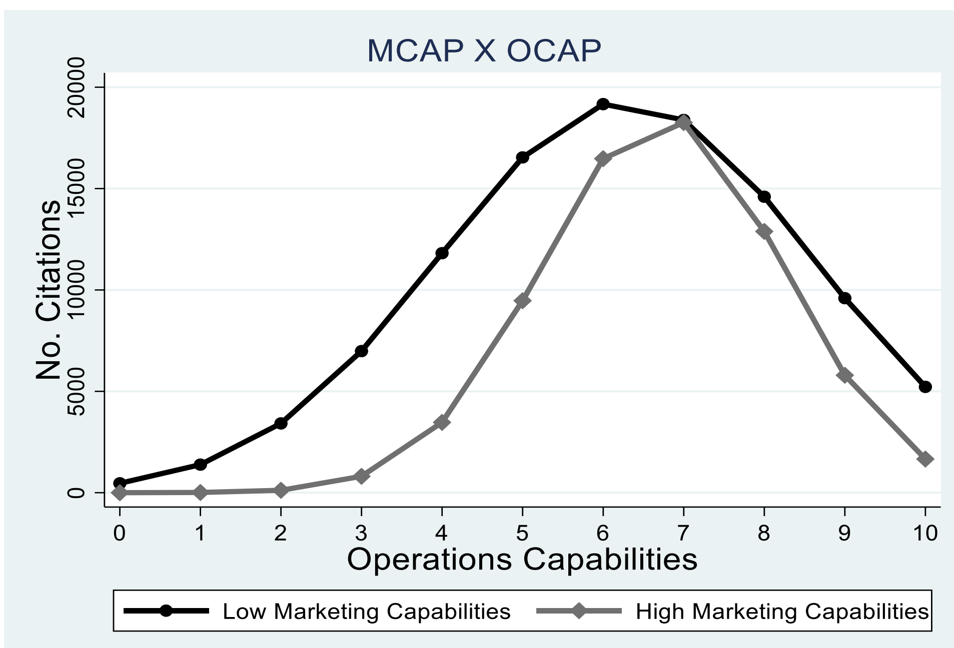
Consistent with H6, we found that the interaction between $OCAP^2$ and TCAP is positively and significantly associated with citations, indicating a positive moderation of TCAP in the relationship between OCAP and Innov-Perf. This relationship is demonstrated in Panel (C3) of Figure (3.4). At all levels of OCAP, high TCAP is associated with more Innov-Perf than low levels of TCAP.

In addition to the interaction effects, Model (2) in Table (3.8) also estimates the simple effects of the individual capabilities. The results of MCAP and OCAP are not significant, but TCAP is positively and significantly associated with patents, citations, and NPAs. And $TCAP^2$ is negatively and significantly associated with them all. The U test shows a significant inverse U-shaped relationship between TCAP and each of the citations and NPAs, supporting H2.

Panel (C1): MCAP X TCAP & Innov-Perf



Panel (C2): MCAP X OCAP & Innov-Perf



Panel (C3): TCAP X OCAP & Innov-Perf

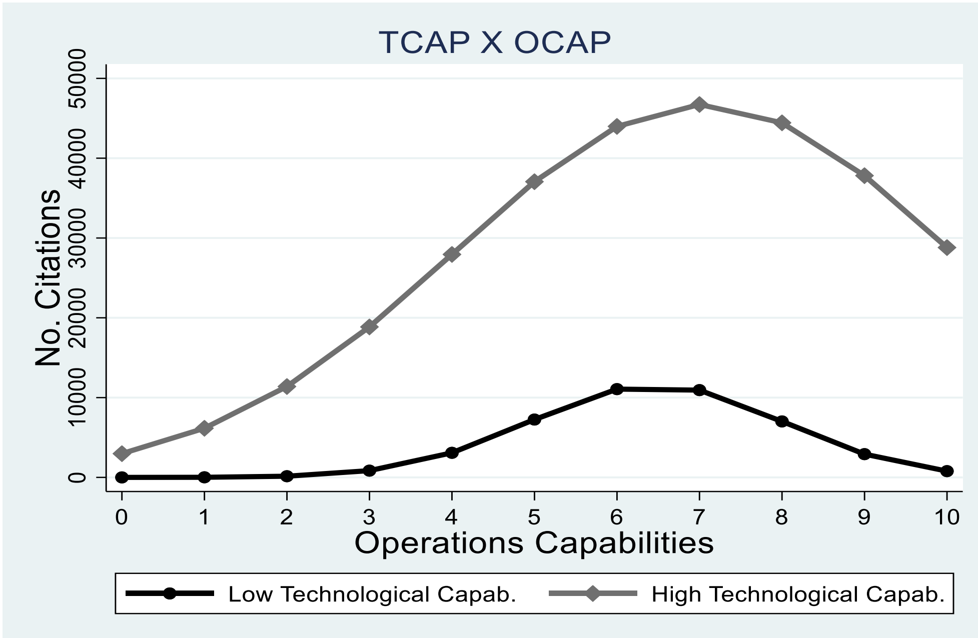


Figure (3.4): Illustrations of the Effects of Capabilities Interactions

3.5.3. Results of the Moderating Role of International PDC:

Finally, we test H7 about the moderating effect of international PDC in the relationship between capabilities and Innov-Perf. We first estimate a baseline model (Model 3 in Table 3.10) without correcting for endogeneity. In Model (4), we correct for endogeneity using a Control Function (CF) method by including the calculated residual from the first-stage logistic regression as an additional regressor. However, the coefficients of the CF variable are not significant for all three models (4a, 4b, and 4c), suggesting that endogeneity is not a serious problem in our models. Hence, we proceed by interpreting the results of the baseline Model (3) of Table (3.10).

The interaction between $MCAP^2$ and international, compared to domestic, PDC is associated with higher citations. These relationships are depicted in Panel (D1) of Figure (3.5). At high levels of MCAPs, international PDC is associated with higher Innov-Perf than domestic alliances. These results indicate that international PDC has a more positive moderation effect on the relationship between MCAP and Innov-Perf, supporting H7a.

Also, consistent with H7b, we found that the interaction between $TCAP^2$ and international, compared to domestic, collaborations is associated with fewer citations. Figure (3.5) – Panel (D2) shows this relationship by demonstrating that at high levels of TCAP, international collaborations are associated with lower Innov-Perf than domestic ones.

In contrast, we found that the interaction between $OCAP^2$ and international, compared to domestic, PDCs is associated with higher NPAs. This result indicates that international PDC has a more positive moderation effect on the relationship between OCAP and Innov-Perf, supporting H7c. Panel (D3) in Figure (3.5) illustrates that at high levels of OCAP, international PDCs are associated with higher Innov-Perf than domestic alliances.

In addition to the moderating effects, Model (3) also estimates the simple effects of capabilities. MCAP is negatively and significantly associated with citations and the U test confirmed the existence of a significant inverted U-shape relationship between MCAP and citations, further supporting H1. Similarly, OCAP is negatively and significantly associated with patents, citations, and NPAs, and the U test confirmed the existence of significant inverted U-shape relationships between OCAP and all three of them, further supporting H3. However, the results for TCAP are not significant in this model.

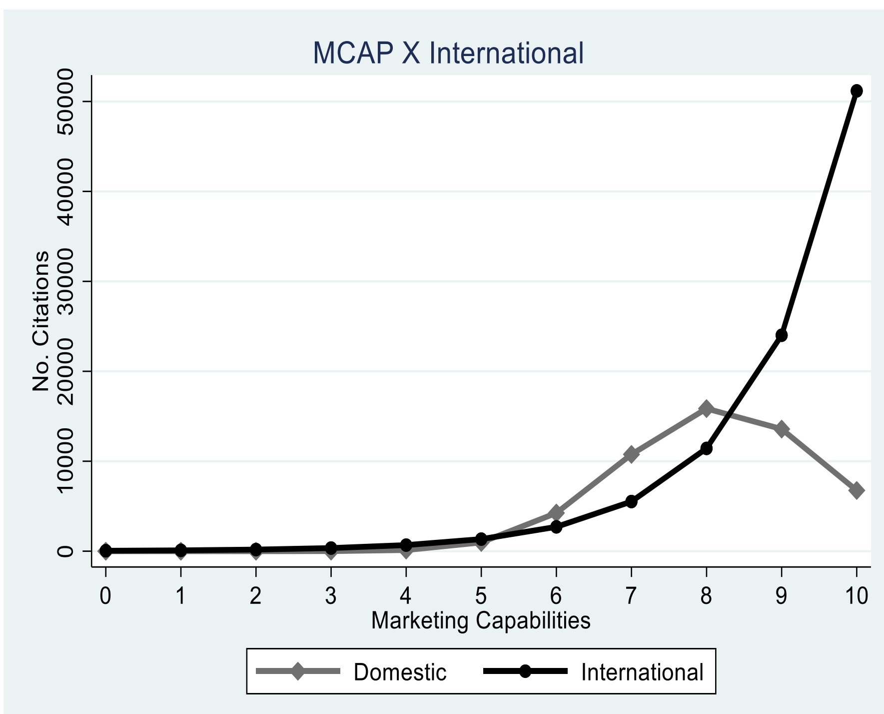
Table (3.10): The Moderating Role of International PDCs in the Relationships between Capabilities and Innov-Perf

	Model (3): Baseline GLM			Model (4): Adjusted GLM		
	(3a) Patents	(3b) Citations	(3c) NPAs	(4a) Patents	(4b) Citations	(4c) NPAs
MCAP	.499	1.742**	-.522	.501	1.773**	-.548
	(.715)	(.855)	(.85)	(.714)	(.848)	(.84)
TCAP	.647***	.471***	.099	.648***	.48***	.099
	(.086)	(.12)	(.14)	(.085)	(.119)	(.139)
OCAP	.011	.075	.953**	.009	.07	.98**
	(.082)	(.093)	(.412)	(.083)	(.095)	(.412)
MCAP2	-.083	-.271*	.107	-.083	-.274*	.113
	(.118)	(.144)	(.139)	(.118)	(.142)	(.137)
TCAP2	-.014	.039	-.011	-.015	.036	-.012
	(.027)	(.033)	(.032)	(.026)	(.033)	(.031)
OCAP2	-.059**	-.08**	-.236**	-.059**	-.079**	-.243**
	(.028)	(.035)	(.093)	(.028)	(.035)	(.095)
International (INT)	-2.042	-.091	-2.81**	-1.986	.109	-2.626*
	(1.503)	(1.75)	(1.407)	(1.547)	(1.799)	(1.457)
INT X MCAP	.257	-1.045	.662	.26	-1.061	.705
	(.676)	(.809)	(.846)	(.673)	(.797)	(.835)
INT X TCAP	-.053	.143	.203	-.055	.127	.187
	(.119)	(.102)	(.124)	(.121)	(.104)	(.123)
INT X OCAP	.041	.11	-.795*	.043	.115	-.822*
	(.167)	(.19)	(.437)	(.168)	(.195)	(.439)
INT X MCAP2	.075	.274*	.018	.072	.271*	.001
	(.121)	(.14)	(.133)	(.122)	(.139)	(.133)
INT X TCAP2	-.026	-.08**	-.038	-.026	-.077*	-.034
	(.042)	(.039)	(.038)	(.042)	(.04)	(.038)
INT X OCAP2	.043	.027	.253***	.044	.027	.264***
	(.038)	(.039)	(.092)	(.038)	(.039)	(.095)
Controls:						
Years:						
Years2	.432**	.475**	.983***	.433**	.484**	.994***
	(.208)	(.212)	(.212)	(.208)	(.211)	(.217)
Years3	.986***	1.19***	.658**	.987***	1.196***	.662**
	(.335)	(.351)	(.291)	(.336)	(.352)	(.289)
Years4	1.297**	1.21	2.458***	1.271**	1.19	2.336***
	(.595)	(.775)	(.683)	(.632)	(.81)	(.752)
Years5	2.575***	.302	1.309***	2.542***	.23	1.204***
	(.611)	(.527)	(.474)	(.613)	(.534)	(.436)
High-tech industry:						
Ind2	-.126	-.131	.493*	-.122	-.121	.509*
	(.371)	(.372)	(.295)	(.372)	(.372)	(.298)
Ind3	.217	.124	.748**	.221	.131	.756**
	(.256)	(.284)	(.295)	(.26)	(.287)	(.295)
Ind4	-1.632***	-2.153***	-1.51***	-1.625***	-2.144***	-1.51***
	(.409)	(.422)	(.572)	(.41)	(.423)	(.575)
Ind5	-1.162***	-1.324***	-2.03***	-1.161***	-1.32***	-2.036***
	(.398)	(.421)	(.376)	(.399)	(.419)	(.378)
OEM_age	.038***	.03***	-.007	.038***	.03***	-.007
	(.004)	(.004)	(.007)	(.004)	(.004)	(.007)
OEM_age2	-.001***	-.001***	-.0003	-.001***	-.001***	-.0003
	(.0001)	(.0001)	(.0002)	(.0001)	(.0001)	(.0002)

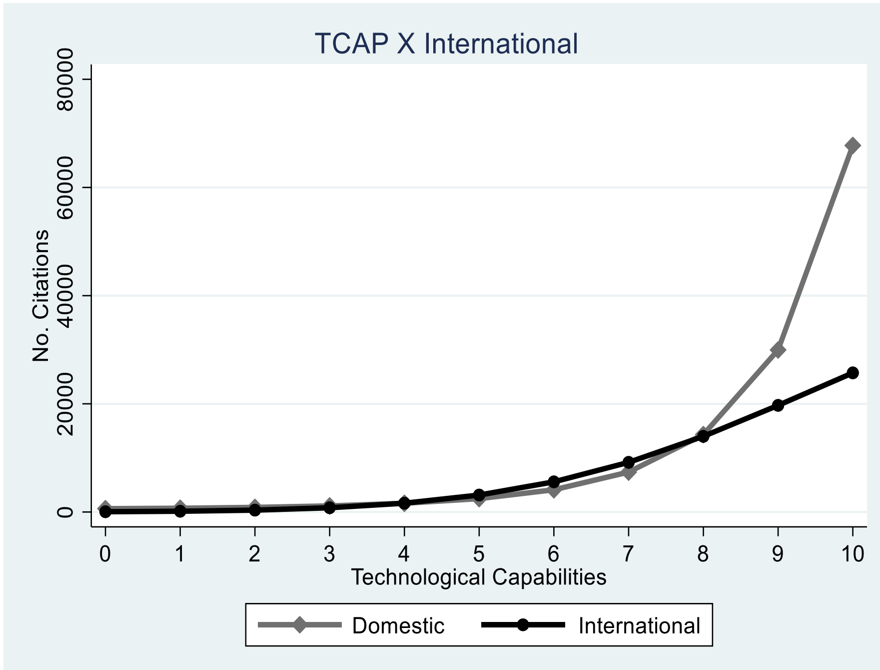
	Model (3): Baseline GLM			Model (4): Adjusted GLM		
	(3a) Patents	(3b) Citations	(3c) NPAs	(4a) Patents	(4b) Citations	(4c) NPAs
US_OEM	-.408	-.04	.034	-.395	-.018	.104
	(.297)	(.36)	(.356)	(.292)	(.355)	(.384)
Supplier patent	.075	.17	.103	.072	.16	.091
	(.084)	(.11)	(.067)	(.086)	(.11)	(.069)
Collaboration scope	.232	.151	.179	.224	.128	.155
	(.153)	(.155)	(.15)	(.158)	(.16)	(.156)
CF(INT)				-.088	-.246	-.341
				(.289)	(.343)	(.381)
_cons	3.781***	5.157***	2.089*	3.761***	5.072***	2.005
	(1.331)	(1.538)	(1.261)	(1.341)	(1.554)	(1.277)
Observations	189	189	189	189	189	189
Chi2	2466.992	1224.086	433.090	2620.617	1199.560	425.973
Prob > Chi2	0.000	0.000	0.000	0.000	0.000	0.000
Akaike Crit. (AIC)	2479.642	3819.238	1635.846	2481.598	3820.901	1637.250

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

Panel (D1): MCAP X International PDC & Innov-Perf



Panel (D2): TCAP X International PDC & Innov-Perf



Panel (D3): OCAP X International PDC & Innov-Perf

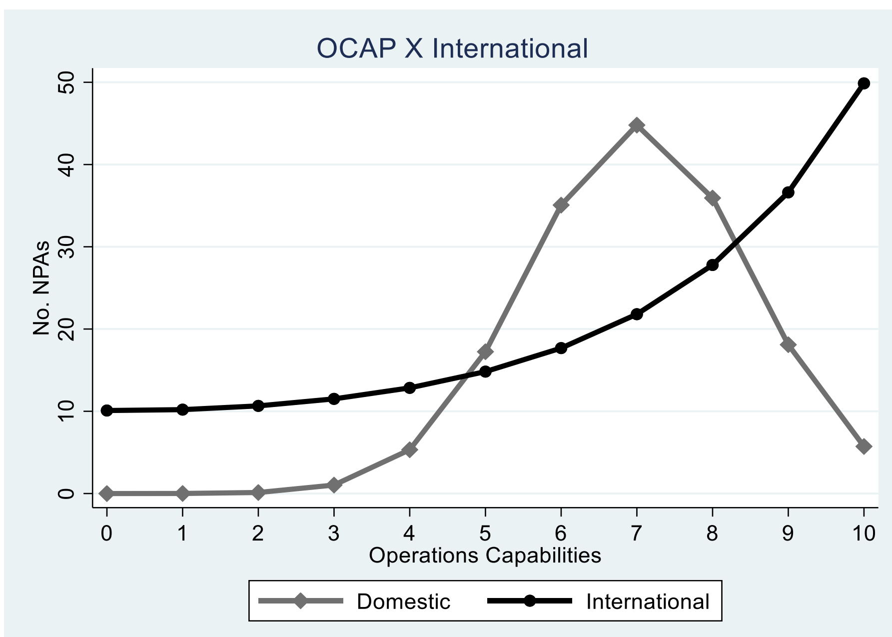


Figure (3.5): Illustrations of the Moderating Effects of International PDCs

3.6. Discussions:

As market competition intensifies in the present time, firms are resorting to building competitive advantages to survive. Many consider core capabilities as a good source of competitive advantage that would enhance a firm's performance and allow it to earn abnormal returns. However, developing a capability is not a simple task as it takes time and requires investments in valuable resources. Because of these investments, a firm may want to exploit its existing capability to get the most out of it. This may promote organizational inertia toward the status quo and discourage change, transforming the core capability into core rigidity and driving the firm into its own competency trap.

Although the competency trap is a well-known phenomenon in the literature since the 1980s (*cf.* Levitt & March, 1988), prior marketing studies did not empirically investigate the downsides of firm capabilities. We contribute to the existing literature by demonstrating the competency trap effect of the three functional capabilities (marketing, technological, and operations) on innovation performance. Our empirical results indicate that all three capabilities are associated positively with innovation performance until they reach a peak point after which their downsides outweigh their benefits and their relationship with innovation performance turns to be negative. In other words, our paper is the first marketing study to empirically show the competency trap of the three functional capabilities simultaneously.

Having illustrated the inverted U-shaped relationship between individual capabilities and innovation performance, it is not seldom that firms develop more than one capability to further enhance their performance. The challenge faced by such firms is that capabilities would interact with each other differently to impact performance. While some would enhance each other's advantages and/or diminish their drawbacks, others would amplify the negative side of each other. Thus, firms have to be careful in allocating their scarce resources to build the "right" set of capabilities.

Although several studies (e.g., Dutta et al., 1999; Feng et al., 2017; Moorman & Slotegraaf, 1999) considered the complementarity versus substitutability characteristic of different capabilities, none investigated the interactions between "strong" capabilities. Our study extends the scope of the current studies by investigating the non-linear two-way interactions among the three capabilities. Our results add to the existing literature by demonstrating how a particular capability moderates the relationship between another strong capability and innovation performance. For instance, we find that marketing capabilities would positively (negatively) moderate the relationship between strong technological (operations) capabilities and innovation performance. Also, our findings indicate that technological capabilities positively interact with strong operations capabilities to enhance innovation performance.

While we provide empirical evidence that the competency trap is an actual problem that can hurt firm performance, the dynamic capabilities approach argues that possessing a dynamic capability may save the firm from falling into competency traps (Teece, 2014). We empirically tested this argument by examining the moderating role of forming PDCs with domestic versus international partners in the relationship between capabilities and innovation performance. This is one of the major contributions of our study to the extant marketing studies that understudied the role of external resources in the capabilities-performance relationship.

Our results also contribute to the innovation collaboration literature by highlighting that the type and level of internal firm capabilities must be considered when choosing between foreign and domestic partners that are equally qualified. For instance, we find that international, as compared to domestic, partners are associated with higher (less) innovation performance when the firm possesses strong marketing or operations (technological) capabilities.

3.7. Managerial Implications:

Our study offers four key insights for practitioners. *First*, firms with core capabilities need to be careful when allocating their resources to build capabilities because intensifying investments in areas where they have high capabilities might drive them into a competency trap. Our study particularly found that intensive marketing, technological, or operations capabilities have drawbacks that outweigh their benefits, turning their relationship with innovation performance to be negative. However, moderate levels of marketing, technological, or operations capabilities are associated with superior innovation performance, as compared to low and high levels for firms in innovation collaborations.

Second, our results provide guidelines for managers on how to avoid the competency trap effect of strong capabilities on innovation performance. *One way* to do this is to build capabilities that complement each other. Particularly, as our findings indicate, complementing strong technological (operations) capabilities with marketing (technological) capabilities would help the firm avoid falling into the competency trap and enhance its innovation performance. Nonetheless, investing in marketing capabilities might amplify the downside effect of strong operations capabilities and further hurt innovation. *Another way* is to deploy a dynamic capability such as forming an innovation collaboration. Our results demonstrate that innovation collaborations – both international and domestic – positively moderate the relationships between the three capabilities and innovation performance, even though international collaboration might have more (less) positive effects in the cases of marketing and operations (technological) capabilities.

Third, we present a guide for managers tasked with forming innovation collaborations. We found that considering the type and level of existing firm capabilities is important when choosing between foreign and domestic partners. Firms with strong marketing or operations capabilities might select foreign, over domestic, partners. While firms with strong technological capabilities might benefit more from domestic partners.

Last but not the least, our results are relevant to a key consideration for effective marketing strategy – avoiding marketing myopia (Levitt, 1960). Both constructs, marketing myopia and competency trap, can be seen as similar in their impact on negative competitive and business outcomes in the future. However, despite similarities they are quite distinct, and it is important for managers to understand these differences for they have very different prescriptions in terms of undertaking mitigation efforts. We summarize these key differences in Table (3.11). The key message is both marketing myopia and competency trap hinges on the manner in which the firm deploys its resources. That said, sometimes, leadership changes can be an effective immediate response to address marketing myopia, while competency trap is more insidious and such a leadership change may not be as effective in the short run.

Table (3.11): Marketing Myopia versus Competency Trap

	Marketing Myopia	Competency Trap
Definition	- Means a narrow definition of a firm's business in terms of the product being offered. - The firm is product-oriented and short-term focused.	- Denotes too much focus on exploiting existing capabilities and marginalizing investments in building new capabilities. - Core capabilities turn into core rigidities over time.
Root cause	- Distortion in the strategic vision of the top management. - The firm is blinded by its focus on short-term goals of selling the product they have, rather than fulfilling customers' needs and wants.	- Ineffective deployment of a firm's strategic resources by directing them to reinforce existing capabilities rather than building new ones. - The firm is blinded by its best practices and success.
Evolution	- An immediate implication of the top-management's decision to define the business narrowly	- A long process of reinvesting in the existing capabilities intensively.
Marketing concept	- The firm overlooks its role as a satisfier of customers' needs and wants. It underestimates the importance of the marketing function since it does not adopt a customer orientation.	- The firm may be overemphasizing its focus on satisfying customers' needs and wants. - The firm may possess excessive marketing capabilities that generate several costs, leading the firm into the competency trap.
Unit of analysis	- Can be seen as both firm as well as manager-level construct.	- A firm-level construct.
Mitigation mechanism	- May be mitigated by change of leadership.	- Can be mitigated by building a dynamic capability.
Similarities	- Both result from mistaken strategic decisions made by the top management: • The myopia is a mistake of not defining the business in a broader term based on the value it offers to customers. • The trap is a mistake of not switching in the right time to build the "right" capability to exploit emerging market trends. - Both can result in negative outcomes and business failure.	

3.8. Limitations and Further Research:

While we demonstrate the competency trap effect of strong functional capabilities, our data was limited to firms in innovation collaborations. We call for future research on this phenomenon in different contexts. Also, while we study firms in innovation collaborations, we focused on the OEM side. Even though we controlled for supplier innovativeness, future studies may consider supplier capabilities in their models. Finally, our study did not consider different collaboration forms. We call for further studies on the moderating effects of collaboration governance modes (e.g., joint ventures vs. R&D agreements) in the capabilities-performance relationship.

4. Collaborating to Innovate: Balancing Strategy Dividend and Transactional Efficiencies

Abstract

When a firm collaborates with its suppliers, it expands its access to external knowhow, and thus, can enhance its innovation outcomes. However, such partnerships also expose it to various hazards of opportunism including knowledge spillovers and 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 that buyer-supplier perceptions of these collaborations do not align on the key issues of governance, strategy, and value generation. There are also calls for specific collaboration forms to navigate periods of economic downturns.

We study product 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 product 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 to navigate lean economic times may be misdirected.

Keywords: Governance value analysis; product development contracts; Innovation performance; Marketing capabilities, Technological capabilities; Operations capabilities; Differentiation; Cost-leadership

4.1. 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). While such partnerships are common, and industry reports indicate up to 85% of firms believe they are effective means of innovation (Tevelson et al., 2013), they have gained new significance in current times. As both supply and demand-side slowdowns happen, increasingly more firms are focussing on innovation to emerge stronger out of the COVID-19 pandemic (Manly et al., 2021); and some experts are calling for more collaborations as a means. These calls are not without merit. Historically, such alliances increase during slowdowns and accelerate during recovery (Bamford et al., 2020). Suppliers specialize in cognate technologies, have ongoing relations with other firms, and are often independently engaged in technology development. So, partnering with suppliers expand a firm's access to external knowhow, and thus, can shorten learning cycles, accelerate product development, reduce R&D costs, and enhance innovation performance overall (Ozdemir et al., 2017).

However, these also expose the firms to risks of partner opportunism, e.g., knowledge spillovers, appropriations, and renegotiations, raising the spectre that misaligned partnerships will bleed value (Carson & John, 2013; Heide & John, 1990). So, the focal firms need to balance the trade-offs that pit value from the expanded access to external knowledge against the costs that might result. These trade-offs are also framed by whether the firm has the right strategic resources and momentum to effectively leverage the collaboration.

These are complex issues, and not surprisingly, the verdict on supplier alliances is noisy. Evidence from the 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.

Most marketing papers focus on the trade-offs firms face in the dichotomous choice between formal and relational arrangements (e.g., Bouncken et al., 2016; Noordhoff et al., 2011; Tracey et al., 2014). Yet, as the payoffs and the transaction costs of collaborations pull in different directions, firms face a more granular set of contractual choices. *Product Development Collaborations (PDCs)* are 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). PDC contracts with suppliers can be organized in different ways (Keil et al., 2008). 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 mode, Network Equipment Technologies granted Interphase Co. a *license contract* to use its AATM interface technology in developing ATM adapter cards.

The right choice of the PDC 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 et al., 1996; 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 PDC contracts, from more arms-length agreements and licensing to more integrated joint ventures.

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 delivering innovative products as indicated by its patent counts, patent citations, and new product announcements*.

The extant literature is also quite limited in its treatment of marketing strategy. Many of the marketing studies that examine PDC effectiveness, do so independent of the role of marketing strategy (e.g., Bouncken et al., 2016; Coviello, & Joseph, 2012; 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 PDCs with its suppliers. Drawing inferences without considering strategy may lead to erroneous inferences about the effectiveness of PDCs. Interestingly, there is indeed disagreement on the efficacy of governance modes among such studies (Sampson, 2004a). We hope to address this by explicitly incorporating firm strategic positioning 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; Song, Benedetto, & Zhao, 2008).

Yet, efforts to incorporate strategy comes with challenges. Conceptually, the Resource-Based View (RBV) points to different strategic functional capabilities – marketing, technological, and operations – as key to sustainable competitive advantage. While some papers study the impact of individual capabilities on firm innovation performance (*cf*. Wu, 2014), to the best of our knowledge, none consider how these capabilities may work together to amplify or mute each other's effects in determining innovation outcomes. Yet, research indicates the roles of the three capabilities are not mutually exclusive (*cf*. Krasnikov & Jayachandran, 2008). So, a limited approach constrains the evidence-base for managers interested in developing strategic capabilities for innovation. In this paper, we address this by considering the three capabilities simultaneously.

Governance efficacy is often pegged to transactional efficiency. Yet, a narrow focus on efficiency could underplay how PDCs create and share value in the channel. This is critical given the premise that PDCs are key strategic decisions in the best of times, but even more so in an economic downturn. 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 PDCs is determined by the fit among the spectrum of contractual arrangements, firm capabilities, and the firm's relevant positioning strategy.

Our empirical study uses a database of 202 PDCs 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 et al., 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 PDC forms, result in superior innovation performance. We also find that the different strategic capabilities interact differently with different PDCs to moderate the latter's effects on a firm's innovation outcomes.

In this, 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 PDC contracts; (b) we include all three strategic capabilities, marketing, technological, and operations, in our model – to the best of our knowledge, our paper would be the first to illustrate how they operate jointly to impact innovation; (c) we include marketing 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 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 PDC literature, we present our theory, and empirical efforts, and discuss our results.

4.2. Literature Review:

Firms usually participate in PDCs 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), and thus, suffer from a high failure rate estimated to be as much as 70% (Noordhoff et al., 2011; Sivadas & Dwyer, 2000). 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 PDCs and there is a large body of scholarly literature in the domain across multiple disciplines. In

Appendix (C) we list a select group of papers in marketing to summarize the general contribution of our paper in that spectrum.

Three governance modes are commonly ascribed to PDCs (*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; (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. These forms have been studied in both horizontal (*cf.* Eng & Ozdemir, 2014; Lambe et al., 2002) and vertical collaborations (*cf.* Boyd & Spekman, 2008; Rindfleisch & Moorman, 2001). Our paper falls within the latter body of work, with a specific focus on *upstream* collaborations between suppliers and original equipment manufacturers (OEM) – a topic that has received relatively less attention.

Despite the interest in both horizontal and vertical collaborations, there is much heterogeneity in the scope of governance modes studied. The trade-offs between different governance modes are often not the topic of research in most papers focused on horizontal collaborations. At the same time, most papers studying vertical relationships (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 PDC arrangements faced by firms. Yet other papers study heterogeneity within governance modes. For example, 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, this paper explicitly considers all three governance modes.

Our focus on the three “top-tier” PDC 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 (4.1). We believe, not accounting for the granularity of these diverse contractual arrangements in studying PDCs is a critical gap in the literature. This gap leaves a big part of the implications of PDCs unaddressed, and limits inferences that can be drawn from research results.

Table (4.1): Comparison between Formal Governance Modes of PDCs:

	Joint Ventures (JVs)	**Joint Development Agreements (Agreements)**	**Technology Licensing Contracts (Licenses)**	**References**
Definition	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.	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. This form is basically a project-based arrangement that resembles a pure hybrid form of organization.	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.	Hagedoorn & Hesen (2007); Oxley (1999).
Duration	Long-term/ on-going relationship (sometimes its duration is not determined a priori)/ Relational continuity is expected.	Fixed and relatively longer duration than licenses but less than JVs.	Fixed and relatively short-term duration.	Houston & Johnson (2000)
Initiation and negotiation costs	Relatively very costly.	Relatively more costly than licenses and less than JVs.	Relatively less costly.	Sampson (2004b).
Monitoring, & adaptation costs	Relatively low.	Relatively less than licenses but higher than JVs	Relatively high.	Oxley (1999).
Termination costs	Relatively very high.	Relatively higher than licenses but less than JVs.	Relatively low.	Oxley (1999).
Bureaucracy level	Relatively high	Relatively low	Relatively low	Sampson (2004b).

	Joint Ventures (JVs)	Joint Development Agreements (Agreements)	Technology Licensing Contracts (Licenses)	References
Learning opportunities	Relatively very high; interactive learning	Relatively high; interactive learning	Relatively low; passive learning	Lane & Lubatkin (1998).
Knowledge/ Technology Flow	Bilateral transfer of knowledge, technology, and resources.	Bilateral transfer of knowledge, technology, and resources.	Unilateral transfer of technology and resources from licensor to licensee.	Oxley (1997).
Decision Making	Consensus/centralized.	Decentralized process.	Decentralized process.	Sampson (2004b).
Adaptability provided	Relatively very high	Relatively higher than licenses but less than JVs	Relatively low	Sampson (2004a).
Flexibility to terminate the partnership	Relatively less flexible; Costly and complicated process.	Relatively less flexible than licenses but more flexible than JVs; relatively easier and less costly than JVs but higher than licenses.	Relatively flexible; relatively easy and less costly.	Mayer & Salomon (2006)
Administrative control	Relatively very high; managed by a board of directors comprising members from all parties.	Relatively higher than licenses but less than JVs; partners exchange hostages.	Relatively very low; parties are working independently.	Oxely (1997); Sampson (2004a).
Control Scheme	Aligned incentives through shared ownership.	Aligned incentives through sharing the outcomes of the alliance.	Formal contract.	Oxely (1997).
Idiosyncratic investments	Mutual investments; parties are motivated to make specific investments.	Mutual investments; parties are inclined to make specific investments.	Mainly specific investments are made by the customer firm (licensee).	Hagedoorn & Hensen (2007).
Level of safeguarding provided	Relatively very high protection against opportunism and knowledge-leakage.	Relatively high protection against opportunism and knowledge-leakage.	Relatively low protection against opportunism and knowledge-leakage.	Oxley (1999); Houston & Johnson (2000).
Incentives to utilize technology and resources	Lower-powered/ attenuated incentives; mainly utilized to satisfy the purposes of the JVs.	Basically, aimed at completing the project at hand.	Higher-powered incentives; open to exploring all possible areas.	Oxley (1999).

Indeed, results in the literature on the impact of PDCs on firm performance are mixed. Several marketing papers study the relationship between PDCs and firm performance, including market value (e.g., Boyd & Spekman, 2008; Fang et al., 2015), financial performance (e.g., Luo et al., 2007; Ozdemir et al., 2017), and innovativeness (e.g., Bouncken et al., 2016; Fang, 2008). However, the results are mixed, with positive, negative, curvilinear, and no relationship was reported between PDCs and performance. For instance, Knudsen (2007) examined the impact of different types of PDCs on Innov-Perf and found that development collaborations, in general, have no significant impact on Innov-Perf. Estrada et al. (2016) also reported that horizontal PDCs per se have no impact. In contrast, Wu (2014) found that competitor collaborations have an inverted U-shaped relationship with product Innov-Perf.

Most of these studies ignore the different PDC governance modes, leaving open the possibility that variation in the results may be resolved with a more granular governance model. Ideas that peg performance to the governance structure that a firm chooses for its PDC are not isolated (Sampson, 2004b). Drawing on *Transaction Cost Economics (TCE)*, several non-marketing studies (e.g., Hagedoorn et al., 2005; Sampson, 2004a) examined the conditions under which a firm would prefer one governance mode over others to form a PDC.

In the context of mixed results in the PDC – performance relationship in the literature, it is 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 PDCs (see Fang et al., 2015 as one notable exception). Even this thin slate of studies focuses on either technological or marketing capabilities (e.g., Lee & Chang, 2014), and no paper accounts for all three capabilities simultaneously – which we do in this paper. We believe not accounting for all the capabilities leaves key parts of the variation in Innov-Perf unexplained, limiting our inferences.

The absence of explicit treatment of the firm's marketing strategy in studies of PDCs 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 strategies of *cost-leadership* and *product differentiation* (Porter, 1980) have had the "greatest" impact on studies of firms' product strategy in marketing, since they explicitly address the basic pillars of competition related to products themselves. Other strategy frameworks concentrated more on environmental factors (Swink & Hegarty, 1998).

4.3. Theory and Hypotheses:

Firms collaborating to improve their Innov-Perf are forced to reckon with a trade-off: access to external knowhow 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 operations capabilities may be useful for lowering costs by routinizing its processes, and thus suitable for firms focused on generating a cost-leadership advantage in the market. More integrated supplier collaborations like JVs internalize the costs of adaptations and thus, ease routinization, relative to more arms-length contracts such as licensing which would call for more flexibility, for which high operations capabilities would be unsuited. Thus, misalignment between the firm's capabilities, 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 Governance Value Analysis (GVA) framework by Ghosh & John (1999; 2005) 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 on strategy, resources, and governance (Nickerson, Hamilton, & Wada, 2001).

We build our hypotheses on GVA. Figure (4.1) 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) the governance mode is jointly determined by both the firm's strategy and capabilities; (3) investments in the firm's capabilities are jointly determined by its strategy and governance modes; (4) innovation performance emerges as a net of strategy dividend and transaction costs. [10]

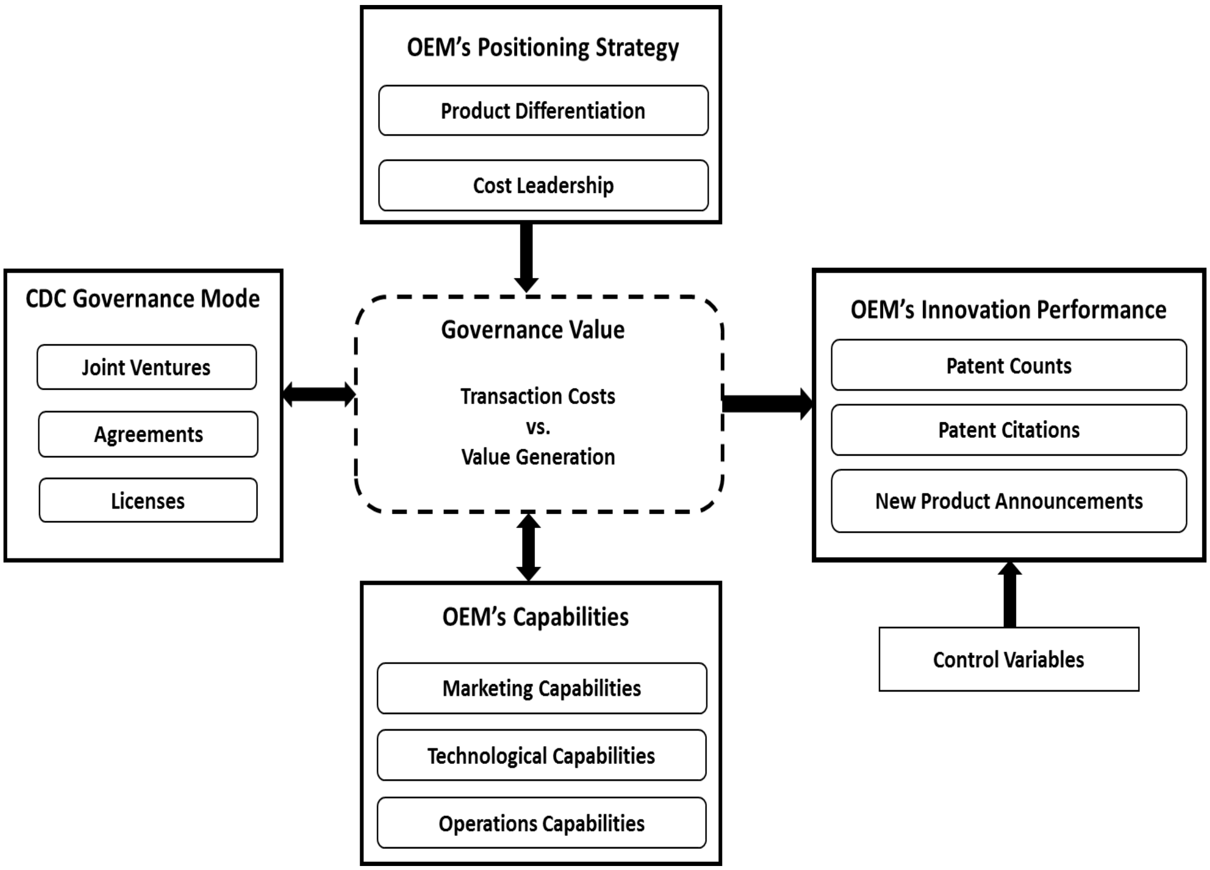


Figure (4.1): Conceptual Framework for Innovation Performance

4.3.1. 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

[10] In this framework, positioning strategy is considered exogenous. While an argument can be made that strategy is endogenous to firm capabilities, in our subsequent empirical analyses we argue that firms in our sample make relatively longer-term commitment to strategy and are not prone to frequent adjustments.

transaction costs of crafting and monitoring; firms opt for crafting incomplete licensing contracts (Helm et al., 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, forming a JV would provide greater protection against partner opportunism (Oxley & Sampson, 2004), which would 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 *establishing a JV will lead to greater Innov-Perf of an OEM than an agreement or license.*

On the other hand, initiating a JV is very costly and comes with high bureaucracy, which can frustrate innovative activities (Sampson, 2004a). Besides, developing high-tech products also entails high technical complexity and frequent changes that require flexibility that cannot be achieved in JVs (Lee et al., 2009). In contrast, agreements have less negotiation and initiation costs and offer more flexibility to firms because they 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 the unfettered flow of knowledge between partners, greater learning, and enhanced innovation (Lane & Lubatkin, 1998). Hence, one would expect, *collaborating through an agreement will lead to greater Innov-Perf of an OEM than a JV or license with its suppliers.* In view of the competing explanations, we do not pose an explicit hypothesis of the aggregate impact of governance mode and consider it an empirical issue.

4.3.2. Functional Capabilities & Innovation Performance:

a) Marketing Capabilities (MCAPs):

MCAPs refer to the ability of a firm to understand and satisfy customer needs and wants ahead of its competitors; and to develop and maintain relationships with customers, channel members, and suppliers (Day, 1994; Krasnikov & Jayachandran, 2008). These capabilities help firms identify the potential needs of new markets and direct their innovation to satisfy them ahead of rivals (Ngo and O'Cass, 2012). MCAPs denote a firm's skills at transferring its available resources into innovative outputs based on its marketing mix strategies (Nath et al., 2010). They also enable firms to forecast the potential returns to their investments in innovation projects and thus allocate resources effectively among them (Zang & Li, 2017). Additionally, having built strong relationships with customers and channel members, firms with high MCAPs can benefit from pioneer entry to the market and effectively commercialize their innovative products (Su et al., 2009). Previous marketing studies (e.g., Mariadoss et al., 2011; Moorman & Slotegraaf, 1999) concluded that MCAPs have a positive and significant influence on product development performance. Considering the prior studies' findings, we postulate that:

H1: Ceteris paribus, MCAPs are positively associated with Innov-Perf.

b) Technological Capabilities (TCAPs):

TCAPs are defined as a firm's ability to convert its resources into innovation (Narasimhan et al., 2006) by investing in its internal R&D to establish a stock of knowledge (Berchicci, 2013). They enhance the ability of a firm to evaluate external knowledge, acquire, assimilate, and integrate it into its existing knowledge base; and then utilize this knowledge base in developing innovative products and services. Therefore, TCAPs are a key factor 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 (Dutta et al., 1999). A firm with superior TCAPs can innovate and introduce new products more frequently, faster, and cheaper than rivals (Sarkees et al., 2014). Prior empirical studies (e.g., Moorman & Slotegraaf, 1999; Zhou & Wu, 2010) have supported the positive impact of TCAPs on innovation and product development performance. Thus, we suggest that:

H2: Ceteris paribus, TCAPs are positively associated with Innov-Perf.

c) Operations Capabilities (OCAPs):

OCAPs indicate a firm's ability to coordinate a complex set of activities to enhance its output through the most efficient use of its production processes, technologies, and flow of materials (Nath et al., 2010). These capabilities enable firms to process the available resources efficiently and flexibly to manufacture new products (Cousins et al., 2011). Thus, they are critical to the success of converting innovations into viable commercial products (Narasimhan et al., 2006). Firms with strong OCAPs can effectively manage their innovation and new product development processes. They implement cost-reduction and waste-elimination systems such as just-in-time, total quality management, and six sigma (Tan et al., 2007). These systems would free-up valuable resources and generate returns that can be reinvested in innovating new products (Sarkees & Hulland, 2009). They would also significantly reduce product development time thanks to their emphasis on critical factors such as concurrent engineering, waste elimination, standardization, flexibility, and setup time reduction (Tan et al., 2007).

Moreover, firms with high OCAPs frequently involve their suppliers early in the product development process (Lizarelli et al., 2021). Such interaction with suppliers would bring in new knowledge that the firm would integrate into its innovation activities. In addition, OCAPs enable firms to flexibly and quickly react to modifications in product designs, responding to market changes and feedback (Saboo et al., 2017). Therefore, OCAPs can contribute to the success of developing new products that satisfy diverse customer needs in a short time. Hence, we posit that:

H3: Ceteris paribus, OCAPs are positively associated with Innov-Perf.

4.3.3. Governance Mechanisms, Functional Capabilities & Innovation Performance:

Their capabilities are key to the firms' sustainable competitive advantage. So, in structuring any PDC, a key consideration would be protection from opportunistic appropriation by the partner. Hierarchical forms like JVs would reduce such appropriability hazards, whereas agreements would offer little protection depending critically on establishing bilateral norms, and licenses would be too costly to identify with any acceptable degree of protection. However, the capabilities differ in their inherent appropriability and ex-post value creation. We now discuss how these moderate the outcomes.

a) Marketing capabilities (MCAPs), Governance Mechanisms & Innov-Perf:

Strong MCAPs enable firms to identify opportunities for successful innovation (Su et al., 2009). However, effective exploitation of this capability involves sharing unique knowledge and resources with business partners, which can be opportunistically appropriated in the absence of appropriate safeguards – the magnitude of the hazard increasing with greater MCAPs. For firms more vulnerable to partner opportunism, TCE indicates the need for a more hierarchical mechanism, like JVs, as such a safeguard. So, faced with greater appropriability hazards, a firm will be more motivated to engage with its partners to leverage its MCAPs, under a JV arrangement, compared to the non-equity modes of licenses and agreements (Sampson, 2004a). The intense direct interactions with its JV's partner, afford the firm a better opportunity to learn from the partner (Keil et al., 2008), further improving the odds of successful innovation for firms with stronger MCAPs. Thus, we postulate that JVs enhance the Innov-Perf for firms with stronger MCAPs, more than the other governance forms.

H4: Ceteris paribus, JVs are associated with higher Innov-Perf for OEMs with strong marketing capabilities as compared to licenses and agreements.

b) Technological capabilities (TCAPs), Governance Mechanisms & Innov-Perf:

Firms with strong TCAPs would have strong bargaining power in negotiating agreements because of their technological knowledge stocks and innovation expertise (Veugelers, 1997). The favorable agreements that result, would offset the need for monitoring to prevent opportunistic appropriation. High levels of TCAPs also enhance a firm's absorptive capacity (Berchicci, 2013), supporting enhanced organizational learning and knowledge development, even outside of organizing internally like JVs.

Further, strong TCAPs enable firms to better evaluate and select appropriate partners for the PDC (Berchicci, 2013), which can work as a proactive control against opportunism. For firms with strong TCAPs, these offset the appropriability-oriented benefits of JVs (*cf.* Houston & Johnson, 2000) in favor of agreements. Agreements would also enhance Innov-Perf more than licenses as they allow more interaction and knowledge sharing between partners. Besides, firms that utilize licenses might depend on their licensors' technologies and refrain from developing their own competencies, hurting their own abilities to innovate (Eng & Wong, 2006). Thus, we posit that:

H5: Ceteris paribus, agreements are associated with higher Innov-Perf for OEMs with strong technological capabilities as compared to JVs and licenses.

c) Operations Capabilities (OCAPs), Governance Mechanisms & Innov-Perf:

Firms with strong OCAPs can efficiently combine and mix distinct resources and complex systems from different suppliers to manufacture novel products (Dutta et al., 1999). That notwithstanding, as Krasnikov & Jayachandran (2008) illustrate, such production processes are codifiable and can be copied more easily than marketing and R&D knowledge. Thus, OCAPs are more vulnerable to knowledge leakage and appropriability hazards (Oxley, 1999). These compound the appropriability concerns, inflating the desirability of JVs. Thus, the interaction between JVs and OCAPs would enhance the Innov-Perf of a firm.

On one hand, a JV provides the required safeguard for firms to safely share their knowledge and openly interact with their partners. On the other hand, OCAPs enable the firm to operate flexibly and shift quickly from one process to another (Cousins et al., 2011; Krasnikov & Jayachandran, 2008). This manufacturing agility is essential for the firm's quick response to any modifications in product designs (Saboo et al., 2017; Wu et al., 2010), offsetting the delay of the JV's centralized decision-making process and allowing the firm to manufacture the innovative product in a timely manner. Hence:

H6: Ceteris paribus, JVs are associated with higher Innov-Perf for OEMs with strong operations capabilities as compared to agreements and licenses.

4.3.4. 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 investing in different 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 structuring appropriate governance mechanisms to grease efficient transactions and enhance joint performance. We discuss how the fit among strategy, capabilities, and governance might affect Innov-Perf.

a) Positioning Strategy, Governance Mechanism, Capabilities & Innov-Perf:

One of the key decisions that firms need to make is which capabilities to invest in to achieve their goals. That is because there are "distinctive capabilities" that firms need to be "superior" at to attain their strategies (Day, 1994). Porter (1980) identified the "required resources" for implementing a differentiation strategy to include MCAPs and TCAPs. A differentiation strategy is mainly centered on idiosyncratic innovations and unique marketing efforts that are difficult to be imitated (Svendsen et al., 2011). Thus, market knowledge is crucial for its successful implementation. Firms with strong MCAPs have better market sensing allowing them to be ahead of the competition and stay updated (Day, 1994). Collaborations are a key mechanism firms deploy to access that knowledge (Keil et al., 2008).

However, just gathering knowledge is not predictive of the success of differentiation. Differentiation strategies are associated with higher levels of uncertainty as well, partly driven by frequent changes in product designs and attributes in the face of dynamic market conditions

(Harrigan, 1988). These require the firms to be nimble. So, while an internal equity-based organization like a JV may open more channels of information, its higher bureaucracy levels make it difficult for firms to implement a successful differentiation strategy, compared to more loosely organized agreements (Miller, 1986). Further, firms with strong MCAPs tend to preserve strong supplier relationships (McGee, Dowling, & Megginson, 1995). These can offset some appropriability concerns (Poppo & Zenger, 2002). Also, as agreements offer more chances of direct interaction and knowledge sharing than licenses, we postulate that:

H7: Ceteris paribus, differentiation-oriented OEMs with strong MCAPs will have superior Innov-Perf if they set agreements with suppliers than if they form JVs or craft licenses.

A differentiation strategy also requires strong TCAPs that enable firms to develop innovative products (Porter, 1980). Implementing a differentiation strategy entails deploying more flexible technology to produce a broader range of more “specialized” products. It also requires access to more diverse knowledge since creating differentiated products involves a relatively high degree of knowledge specificity (Svendsen et al., 2011).

To this end, TCAPs enhance firms’ abilities to acquire and assimilate external knowledge and effectively utilize it to develop novel products more frequently and rapidly (Berchicci, 2013; Dutta et al., 1999). While TCAPs enable the firm to adapt quickly, the internal administration costs of a hierarchical arrangement like JV could weigh it down and make more arms-length arrangements like agreements and licenses preferred.

In general, because licenses are costly to craft given the difficulty of identifying appropriate terms and conditions, agreements might be preferred since they give more flexibility and have lesser internal costs than JVs. However, if deployed wrongly, an agreement can snare the partners into opportunistic ex-post renegotiations and disputes. Thus, licenses would be preferred over agreements when it is possible to delineate the terms of the licenses more crisply. To this end, a firm that possesses strong TCAPs is well-informed about industry trends and emerging technologies in the market, and can better identify the terms of a license, obviating the need for incurring the likelihood of higher ex-post costs of renegotiations and disputes that come with agreements. Thus, considerations of diverse knowledge requirements, frequent adjustments, and better ability to identify terms and conditions, make these firms prefer more market-type arrangements like licenses, over the more normative arrangements like agreements, or more hierarchical JVs for differentiation-oriented firms (Harrigan, 1988).

Strong TCAPs, allow firms to overcome the hold-up problem of making specific investments under arms-length licensing, by identifying several potential uses for their assets (McGee et al., 1995). Further, arms-length licensing under a differentiation strategy motivates a firm to build its own technological competencies by investing in its own research, product design, and patents (Banker et al., 2014), which improves its competitive advantage, especially when stronger TCAP allows it to identify the appropriate technological competencies to focus on. Hence:

H8: Ceteris paribus, differentiation-oriented OEMs with strong TCAPs will have superior Innov-Perf if they craft licenses than if they form JVs or utilize agreements.

b) Cost-Leadership Strategy, Governance Mechanism, Capabilities & Innov-Perf:

Cost-leadership strategy requires strong TCAPs and OCAPs (Porter, 1980). Firms with strong TCAPs are efficient at process innovation, lowering costs of coordination between different activities in the production processes (Harrigan, 1988). This might allow firms to introduce products similar to rivals but at lower prices. On the other hand, firms with strong OCAPs can, efficiently and flexibly, combine distinct parts from diverse sources to manufacture new products at the lowest possible cost without jeopardizing product quality (Dutta et al., 1999). Indeed, empirical evidence suggests OCAPs contribute more to firm performance under a low-cost strategy than a differentiation strategy (Vickery, Droge, & Markland, 1993).

This focus on cost-leadership strategy imposes competing demands on firms as they structure their PDCs with their suppliers. Low-cost strategies impose an incentive to look for economies in scope and share costs, which is simpler in more hierarchical arrangements like equity-based JVs which pool resources (Merchant, 2014). Low-cost strategies also push firms towards commodity-like products, which come with two underlying incentives – prioritizing stability over flexibility in collaborative relationships (Harrigan, 1988), and investing in specific assets to achieve production efficiencies by leveraging this stability (Nickerson et al., 2001). Notice that these pit the desirability of JVs (less negotiations, cost sharing, stability, lower hazards of appropriation) against the disadvantages (higher administrative costs, lack of flexibility to switch to lower-cost suppliers – which can be mitigated in more arms-length collaborations like licenses and agreements), to achieve the goals of a low-cost strategy. This is where stronger TCAPs and OCAPs complement the advantages and offset some of the costs of JVs vis-à-vis licenses and agreements.

Strong TCAPs boost firms' ability to quickly learn processes and efficient working routines from direct interaction with their JV partners and exploit this knowledge to develop new products faster than competitors and at lower costs (McGee et al., 1995). Similarly, strong OCAPs endow firms with overall flexibility in responding to unexpected changes in development and production processes, thus offsetting some of the advantages that come with the ability to switch partners (Sampson, 2004b; Wu et al., 2010). Therefore, we posit that:

H9: Ceteris paribus, cost-oriented OEMs with strong TCAPs will have superior Innov-Perf if they form JVs with suppliers than if they set agreements or craft licenses.

H10: Ceteris paribus, cost-oriented OEMs with strong OCAPs will have superior Innov-Perf if they form JVs with suppliers than if they set agreements or craft licenses.

4.4. Methods:

4.4.1. Data and Variables:

We build our database from several archival sources. We started with the Thomson Financial SDC Platinum database to identify high-tech OEMs that formed PDCs with high-tech suppliers between 1985 and 2016, focusing only on dyadic relationships, resulting in an initial sample of 428 dyads. From this, we extracted measures for PDC governance and several control variables. Next, for firms in this sample, we searched other databases (Compustat, Thomson one, Factiva, and Mergent online) and consulted their annual reports to collect data on firm-specific strategic factors. Finally, 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 is international PDCs, 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.

(a) Dependent Variable:

***Innovation performance* (Innov-Perf):** following previous studies (e.g., Hagedoorn & Cloodt, 2003; Zhang et al., 2010), we used multiple indicators for measuring Innov-Perf: (a) *patent counts*, we counted the number of patents filed by each OEM within one year from establishing the PDC; (b) *patent citations*, we counted the number of citations each of these patents received from following patents; and (c) *new product announcements*, we totaled the number of new product launches announced by each OEM within four years[11] from forming the PDC. Table (4.2) summarizes the measures and data sources for our variables.

Table (4.2): Measurements of Research Variables

Variable	Abbreviation/ Symbol	Measurement/ Indicators	Reference(s)	Data Sources
Innovation performance	Innov-Perf/ P_i	*Patent* counts; patent c*itations*; and new product announcements (*NPAs*).	Hagedoorn & Cloodt, (2003); Zhang et al. (2010)	USPTO & ABI/Inform
Governance mechanism	Gov_i	A categorical variable valued 0 if the PDC 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.)		
Operations capabilities	$Ocap_i$	An SF model for: Cost of production = f (output, cost of capital, labor cost)		
Differentiation strategy	$Diff_i$	A factor score of: (SGA exp./Sales); (R&D exp./Sales); & (Sales/COGS) ratios.	Banker et al. (2014).	
Cost-leadership strategy	$Cost_i$	A factor score of: (Sales/Capital exp.); & (Sales/Total Assets) ratios.		

[11] 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. Sampson (2004b) utilized the four-year window to measure innovation performance of high-tech companies in a similar context.

Variable	Abbreviation/ Symbol	Measurement/ Indicators	Reference(s)	Data Sources
Control Variables:	$Controls_i$			SDC Platinum
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); Estrada et al. (2016)	
Nationality	$usoem_i$	A dummy variable of whether the headquarter of an OEM is in the US.	Lee (2011)	
Prior experience	$exper_i$	A dummy variable of whether an OEM had formed PDCs before the focal one.	Oxley (1997); Sampson (2005)	
Scope of PDC	$scope_i$	A dummy variable of whether a PDC was limited to R&D activities, or included additional activities like marketing and/or manufacturing.	Sampson (2004b); Cui & O'Connor (2012)	
Domestic PDC	dom_i	A dummy variable of whether a PDC's partners have the same nationality.	Sampson (2004b)	
OEM's age	age_i	The number of years between an OEM's foundation date and its PDC'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)	
Supplier 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 are generated using an instrument-free method to correct for potential endogeneity in continuous variables.	Park & Gupta (2012); Papadopoulos (2022)	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).		

(b) Independent Variables:

Governance mechanism: we categorized the PDCs 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; Saboo et al., 2017). Details of our estimation procedures and results are presented in chapter three. *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 expenses, and accumulated R&D expenses from previous years. *For OCAPs*, we estimated a cost function to minimize the cost of goods sold as the output using three inputs: cost of labor, output, and cost of capital. We added industry dummies and year dummies, to each of the three SF models, to control for the effect of industry factors and changes in the business cycle over the years, respectively. We rescaled our variables to range from 0 (lowest capability) and 100 (highest capability).

Product positioning strategy: we borrowed a measurement from the accounting literature (see Balsam, Fernando, & Tripathy, 2011; Banker et al., 2014) that builds on classic papers in the strategy literature (e.g., Hambric, 1983). This measure estimates the strategic orientation of the firm using financial ratios. Firm strategy affects how it allocates resources among its activities. For instance, a differentiation-oriented firm might increase its investments in R&D,

product design, and marketing activities. Such investment decisions will be captured by the financial statements of the firm. From these financial figures, we might be able to deduce the "realized" strategy of the firm (Banker et al., 2014).

Differentiation strategy: similar to previous studies (e.g., Balsam et al., 2011; Banker et al., 2014), we used the following three financial ratios as indicators of a differentiation strategy: (a) *SGA exp./Sales* ratio captures a firm's investments in marketing-related activities (e.g., ad., promotions, customer services) to differentiate its offerings from competitors. A higher ratio indicates a differentiation strategy; (b) *R&D exp./Sales* ratio captures the firm's investments in developing unique innovative products. A higher R&D exp/Sales ratio indicates a differentiation strategy; (c) *Sales/COGS* ratio, firms with unique offerings can command premium prices and increase their profitability. Thus, the margin between their sales and COGS will be higher. In this case, this higher ratio would indicate a differentiation strategy. However, some studies used this ratio as an efficiency indicator. Efficient firms might aim at reducing their COGS relative to their sales to increase their margins. In this case, the higher ratio would be associated with a cost-leadership strategy. We conduct factor analysis to see whether this ratio is loading among differentiation factors or cost-leadership factors.

Cost-leadership strategy: following previous scholars (e.g., Banker et al., 2014; David et al., 2002), we used the following two financial ratios as indicators of cost strategy: (a) *Sales/Total Assets* ratio, which indicates a firm's efficiency in utilizing its capital investments to generate value (i.e., sales revenue). A high ratio is associated with a cost-leadership strategy; (b) *Sales/Capital exp.* ratio, where capital exp. captures investments in acquiring fixed assets such as plant, property, and equipment. This ratio is known as assets parsimony or capital intensity indicator. It indicates the assets used up in making the product or providing the service. Low-cost firms would aim at using as few assets as possible per unit of output. A high "sales/capital exp." ratio indicates a cost-leadership strategy.

For each of the above five ratios, we took its mean over five years to capture the long-term nature of the strategic orientation of an OEM. For instance, to estimate the strategy of each OEM in our sample at the year of establishing the PDC, we computed the average of each financial ratio using data of the previous five years to the PDC. For example, if an OEM had signed a licensing contract with its supplier in 2010, we computed its "R&D/Sales" ratio, for instance, by taking the mean of this ratio for that OEM over years from 2005-2009. We applied the same process to compute the five ratios for all OEMs in our sample.

We conducted an Exploratory Factor Analysis (EFA) for the five ratios to examine if our empirical data coincide with the theory. The results, displayed in Panel (A) of Table (4.3), show that our ratios load on two factors. Each of "SGA/Sales", "R&D/Sales", and "Sales/COGS" ratios have loaded on one factor which we called *differentiation*. And the other two ratios have loaded (as theorized) on the second factor which we labeled *low-cost.* We used the factor loadings of each of these ratios to compute a factor score for each factor (i.e., strategy) for each OEM in our sample and used the standardized factor scores as our measure for differentiation and cost-leadership strategies, similar to the work of Balsam et al., (2011) and Banker et al., (2014).

Also, following their procedures, we ran a Confirmatory Factor Analysis (CFA) to test the validity of our measures. The results of the CFA, shown in Panel (B) of Table (4.3), confirm the results of the EFA. The first three ratios have significantly loaded on the differentiation factor with large and significant scores (all above the cut-off of 0.4). Similarly, the other two ratios have loaded on the low-cost factor with large and significant scores. The CFA model showed a good overall fit to the data. Chi-Square has p-value of 0.398 > 0.05. The Root Mean Square Error of Approximation (RMSEA= 0.008) is less than the cut-off value of 0.08. Both Comparative Fit Index (CFI = 1.000 > 0.90) and the Tucker-Lewis Index (TLI = 0.999 > 0.95) exceeds their recommended thresholds. The coefficient of determination of the model is 97%.

Table (4.3): Factor Analysis to Estimate Strategy Variables

Panel A: Exploratory Factor Analysis

Ratio	***Differentiation factor loading***	***Low-cost factor loading***	***Uniqueness***
SGA/Sales	**0.7774**	-0.2174	0.3484
R&D/Sales	**0.8556**	-0.1484	0.2459
Sales/COGS	**0.8486**	-0.0884	0.2720
Sales/TA	-0.0428	**0.8920**	0.2026
Sales/Capital Exp	-0.2787	**0.8094**	0.2673

Panel B: Confirmatory Factor Analysis

<table>
<tr><th>Ratio</th><th>Differentiation factor loading</th><th>Low-cost factor loading</th><th>Composite reliability</th><th>Average variance extracted (AVE)</th></tr>
<tr><td>SGA/Sales</td><td>0.6916***</td><td rowspan="3"></td><td rowspan="3">0.80</td><td rowspan="3">0.572</td></tr>
<tr><td>R&D/Sales</td><td>0.8192***</td></tr>
<tr><td>Sales/COGS</td><td>0.7518***</td></tr>
<tr><td>Sales/TA</td><td rowspan="2"></td><td>0.9219***</td><td rowspan="2">0.72</td><td rowspan="2">0.575</td></tr>
<tr><td>Sales/Capital Exp</td><td>0.5475***</td></tr>
</table>

*** Significance at 1% level.

(c) 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 PDC was formed; the *high-tech industry* in which the OEM operates, the *nationality* of the OEM; the *age* of the OEM on the date of partnering; whether the OEM had prior *experience* with similar collaborations; the *scope of the PDC* (i.e., whether the PDC was limited to R&D or also included marketing and/or manufacturing as well); whether the PDC was a *domestic alliance* or it included cross-border partners; *supplier's patents* as a proxy of the supplier's innovativeness; and the *market overlap* between partners.

Table (4.4) presents the descriptive statistics and correlations between our variables. Table (4.5) summarizes the descriptive statistics of our main variables by the high-tech sector. 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 (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, more biotech firms adopted the differentiation strategy than others. While more medical equipment firms implemented the cost-leadership strategy than others.

Table (4.4): 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) patent	1.00																	
(2) citation	0.53*	1.00																
(3) NPA	0.02	0.07	1.00															
(4) Gov	0.04	0.05	0.00	1.00														
(5) MCAP	0.09	0.15*	0.16*	-0.05	1.00													
(6) TCAP	0.16*	0.26*	0.11	0.16*	-0.09	1.00												
(7) OCAP	-0.03	0.00	-0.09	-0.08	-0.03	-0.21*	1.00											
(8) diff	-0.06	-0.07	-0.06	0.18*	-0.03	0.00	0.16*	1.00										
(9) cost	-0.05	-0.19*	0.08	0.00	-0.30*	0.08	-0.26*	-0.19*	1.00									
(10) years	0.24*	0.10	0.07	-0.17*	-0.08	-0.18*	-0.10	0.09	0.15*	1.00								
(11) ind	-0.02	-0.10	-0.05	0.02	-0.05	-0.07	-0.07	0.19*	0.23*	0.10	1.00							
(12) usoem	-0.04	0.02	0.09	0.10	-0.02	0.01	-0.16*	0.12	-0.04	-0.10	0.14	1.00						
(13) exper	0.26*	0.49*	0.43*	0.08	0.13	0.15*	0.08	-0.07	-0.22*	-0.02	-0.12	0.03	1.00					
(14) scope	-0.01	0.02	0.08	0.09	-0.11	0.04	0.11	0.11	0.13	-0.05	0.10	-0.03	-0.12	1.00				
(15) domestic	-0.05	0.00	0.06	0.24*	0.01	0.00	0.00	0.12	-0.09	-0.21*	0.08	0.34*	0.12	-0.03	1.00			
(16) age	0.34*	0.48*	-0.14*	-0.09	0.15*	0.10	0.13	-0.24*	-0.08	0.11	0.04	-0.26*	0.21*	0.05	-0.08	1.00		
(17) sameind	0.01	0.10	-0.07	-0.17*	0.04	-0.15*	0.02	0.08	-0.01	0.25*	0.01	0.05	-0.10	0.01	-0.11	0.04	1.00	
(18) suppat	0.07	0.11	0.03	0.00	0.02	0.11	-0.14*	-0.05	-0.01	0.17*	-0.09	-0.06	0.08	0.02	-0.20*	0.04	0.15*	1.00
No. Obs.	202	202	202	202	202	189	202	202	202	202	202	202	202	202	202	202	202	202
Mean	667.8	18378.2	38.5	1.2	83.8	81.4	77.1	0	0	2.114	2.787	.886	.564	.614	.698	50.609	.455	133.7
Std. Dev.	1786.8	26391.7	57.3	0.61	10.2	15.7	14.3	1	1	.824	1.167	.318	.497	.488	.46	30.141	.499	333
Min	0	0	0	0	0	0	0	-1.014	-1.003	1	1	0	0	0	0	6	0	0
Max	21125	158418	285	2	100	100	100	8.633	6.361	5	5	1	1	1	1	109	1	1917

**** Significant at 95%***

Table (4.5): Sample Characteristics by the High-Tech Sectors

(a) Indicators of Innovation Performance 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**	441.195	485.087	0	1911	15220.098	21353.177	0	114131	22.024	29.800	0	160
2. Telecommunications	**20**	471.55	583.193	0	1512	18157.95	22506.697	0	67193	31.9	37.422	1	140
3. Computer h/ware & s/ware	**102**	1011.578	2431.103	0	21125	25610.235	30788.468	0	158418	60.088	69.478	0	285
4. Biotech & Pharmaceutical	**19**	52.053	80.463	0	306	1052.895	1472.319	0	5091	3.158	3.452	0	12
5. Medical equipment	**20**	160.9	280.984	0	948	4648.75	7746.842	0	23768	2	1.947	0	5

(b) Governance Mechanisms and Strategy by Sector:

Sector	Obs	*Governance Mechanisms*						*Strategy*							
		JVs		Agreements		Licenses		Differentiation				Cost-leadership			
		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	-.394	0.360	-.91	.438	-.2	0.665	-.956	2.554
2. Telecomm.	**20**	1	5	11	55	8	40	-.204	0.413	-.671	.704	.023	0.934	-.674	2.935
3. Computer h/ware & s/ware	**102**	5	4.9	69	67.6	28	27.5	.016	0.495	-1.013	2.118	-.115	0.893	-.973	6.195
4. Biotech & Pharm	**19**	4	21	6	31.6	9	47.4	1.521	2.432	-.169	8.633	.098	0.668	-1.003	1.848
5. Medical equip	**20**	7	35	7	35	6	30	-.513	0.506	-1.014	1.037	.879	1.772	-.772	6.361

(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**	84.539	6.721	63.953	93.639	**39**	81.783	17.677	0	95.352	**41**	77.76	11.464	53.931	94.002
2. Telecomm.	**20**	80.568	20.514	0	95.628	**17**	80.798	13.962	51.156	99.922	**20**	75.625	19.628	1.953	92.734
3. Computer h/ware & s/ware	**102**	84.885	6.143	62.031	95.429	**99**	82.807	12.454	8.97	100	**102**	78.23	11.588	0	100
4. Biotech & Pharm	**19**	82.653	9.274	53.839	100	**16**	75.193	23.966	2.571	98.813	**19**	77.877	11.194	50.874	96.321
5. Medical equip	**20**	81.256	16.852	21.4	96.075	**18**	78.462	19.358	25.159	99.657	**20**	71.196	25.186	8.543	95.089

4.4.2. 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 innovation performance. We take a stepwise approach to this by estimating the following four equations:

$$\boldsymbol{P_i} = \beta_0 + \beta_1 Gov_i + (\beta_2 \colon \beta_{10}) Controls_i + \epsilon_{i1} \qquad \textbf{(1)}$$

$$\boldsymbol{P_i} = \gamma_0 + \gamma_1 Mcap_i + \gamma_2 Tcap_i + \gamma_3 Ocap_i + (\gamma_4 \colon \gamma_{12}) Controls_i + \epsilon_{i2} \qquad \textbf{(2)}$$

$$\boldsymbol{P_i} = \delta_0 + \delta_1 Gov_i + \delta_2 Mcap_i + \delta_3 Tcap_i + \delta_4 Ocap_i + \delta_5 Gov_i * Mcap_i + \delta_6 Gov_i * Tcap_i + \delta_7 Gov_i * Ocap_i + (\delta_8 \colon \delta_{16}) Controls_i + \epsilon_{i3} \qquad \textbf{(3)}$$

$$\boldsymbol{P_i} = \theta_0 + \theta_1 Gov_i + \theta_2 Mcap_i + \theta_3 Tcap_i + \theta_4 Ocap_i + \theta_5 Diff_i + \theta_6 Cost_i + \theta_7 Gov_i * Mcap_i + \theta_8 Gov_i * Tcap_i + \theta_9 Gov_i * Ocap_i + \theta_{10} Gov_i * Mcap_i * Diff_i + \theta_{11} Gov_i * Tcap_i * Diff_i + \theta_{12} Gov_i * Ocap_i * Diff_i + \theta_{13} Gov_i * Mcap_i * Cost_i + \theta_{14} Gov_i * Tcap_i * Cost_i + \theta_{15} Gov_i * Ocap_i * Cost_i + (\theta_{16} \colon \theta_{24}) Controls_i + \epsilon_{i4} \qquad \textbf{(4)}$$

where P_i is the innovation performance indicator (i.e., patents, citations, and NPAs, and thus, we ran each of these four models three times using one performance indicator each time), Gov_i is the governance mechanism implemented by OEM (i), $Mcap_i$ marketing capabilities of OEM (i), $Tcap_i$ technological capabilities of OEM (i), $Ocap_i$ operations capabilities of OEM (i), $Diff_i$ differentiation strategy for OEM(i), $Cost_i$ cost-leadership 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 (4.2).

(e) 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).

(f) Clustered standard errors:

Our sample covered the period 1985-2016 and an OEM may have multiple PDCs 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).

(g) Endogeneity: Mixed approach - Gaussian Copula and Two-Stage Residual Inclusion

One of the regressors that may be endogenous is the firm's positioning strategy. Unobserved factors that may determine a firm's innovation outcomes may also constrain its choice of marketing strategy. A firm could also adjust its strategy, based on the observed outcomes. Nevertheless, a firm's positioning strategy is a long-term commitment to 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 the positioning strategy using data over the five years *before* the collaboration year, ruling out any potential contemporaneous impact. Similarly, we also measured innovation performance after one year of the collaboration, while all other regressors including governance and firm capabilities are measured in the year of collaboration. This rules out potential reverse causality between the regressors and the dependent variable.

Nevertheless, it is difficult to rule out all sources of endogeneity, especially for governance and capabilities. In particular, several unobserved variables (e.g., management competency, idiosyncratic local market conditions) could simultaneously impact the choice of governance, investment in capabilities, and innovation performance. Given the different types of these potentially endogenous variables, we used mixed methods (i.e., the Gaussian Copula and two-stage residual inclusion methods) to correct for such endogeneity.

First, we utilized the instrument-free *Gaussian Copula method* to correct for the potential endogeneity in the continuous variables (i.e., the three functional capabilities). Park & Gupta (2012) introduced a semi-parametric Copula method to handle the endogeneity problem without using exogenous instrumental variables. This instrument-free method constructs the joint distribution of the endogenous variable and the error term from the individual marginal distributions. For the model to be identified, this method assumes that the structural error term is normally distributed[12] and 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, displayed in Table (4.6), confirm that none of the three firm capabilities is normally distributed.

Table (4.6): Shapiro-Wilk Test

Capabilities	**Obs.**	**W**	**V**	**Z**	**Prob>Z**
MCAP	202	0.665	50.435	9.025	0.000
TCAP	189	0.733	37.985	8.345	0.000
OCAP	202	0.764	35.474	8.215	0.000

Following Carson & Ghosh (2019), we estimated Copula terms for each of our endogenous capabilities variables using the following formula:

$$C_v = \Phi^{-1}(H(X)),$$

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 X is the endogenous regressor. Then, we added these terms as control variables to our models (3) and (4). The Control Function[13] (CF) approach for endogeneity correction was also recommended by Rutz & Watson (2019) as an alternative to the simultaneous estimation of non-linear models.

[12] Park and Gupta (2012) initially assumed the normal distribution of the error terms, however, their simulations demonstrated that the Gaussian Copulas are robust against the misspecifications in the true distribution of the error term. This was also supported by a simulation done by Papadopoulos (2022). This result indicates the validity of utilizing the Gaussian Copula method in non-linear models.

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

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 reviewed in Wooldridge (2015) as a CF approach. As indicated by Wooldridge (2015, p.421) this approach "*parsimoniously handles fairly complicated models that are nonlinear in endogenous explanatory variables*." This approach 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: supply agreement and Coefficient of Variation in OEMs size. The first IV, *supply agreement*, is a binary variable indicating whether a PDC's deal included an agreement between partners that the supplier would supply the components and materials required for developing the new product. This additional clause to the PDC's deal would affect the choice of the governance mechanism, but it would have no impact on the innovation performance of an OEM. Our second IV *is* the *Coefficient of Variation in OEMs size* (CV(size)) as indicated by their total assets. Greater dispersion from other firms in an industry might motivate a firm to utilize a particular collaboration form (e.g., smaller firms might prefer to form JVs to gain more assets and be competitive in their markets), but this dispersion would not affect the innovation performance of the firm.

To implement the 2SRI method, we (a) ran a first-stage multinomial logit model for governance using our two instruments along with all other regressors appearing on the right-hand side of Equation (3) and the three copula terms controlling for endogeneity in functional capabilities, (b) estimated the predicted probabilities of this model and subtracted the observed values form it to get the residuals, (c) added the computed residual as an additional regressor to Equation (3), and (d) repeated steps (a), (b), and (c) for the three-way interaction model in Equation (4). Results of the first-stage multinomial logit models are shown in Tables (4.7) and (4.8).

Table (4.7): First-Stage Multinomial Logistic Regression for the Two-Way Model

Governance mode	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
JVs				***Base Category***			
Agreements:							
IV1: Supply agreement	3.931	1.81	2.17	.03	.385	7.478	**
IV2: CV(size)	-4.13	1.501	-2.75	.006	-7.071	-1.188	***
2.years	.083	1.571	0.05	.958	-2.997	3.162	
3.years	2.089	2.138	0.98	.329	-2.102	6.279	
4.years	-5.251	2.606	-2.01	.044	-10.359	-.142	**
5.years	-1.353	2.425	-0.56	.577	-6.106	3.4	
2.ind	-2.145	1.766	-1.21	.225	-5.607	1.317	
3.ind	-1.828	1.669	-1.10	.274	-5.099	1.444	
4.ind	-4.551	2.054	-2.22	.027	-8.578	-.525	**
experience	1.05	.922	1.14	.255	-.757	2.856	
scope	-1.4	.662	-2.12	.034	-2.697	-.103	**
domestic	.326	1.608	0.20	.839	-2.825	3.476	
age	-.034	.015	-2.19	.028	-.064	-.004	**
sameind	-2.414	.981	-2.46	.014	-4.337	-.492	**
suppat	0	.001	0.21	.832	-.002	.002	
usoem	.151	1.427	0.11	.916	-2.645	2.948	
MCAP	-.296	.122	-2.44	.015	-.535	-.058	**
TCAP	.103	.057	1.81	.07	-.008	.214	*
OCAP	.01	.058	0.17	.867	-.103	.122	
Cmcap	1.606	.775	2.07	.038	.087	3.124	**
Ctcap	-.274	.675	-0.41	.685	-1.597	1.049	
Cocap	-.683	1.207	-0.57	.571	-3.049	1.682	
Constant	28.941	12.914	2.24	.025	3.631	54.251	**
Licenses:							
IV1: Supply agreement	4.498	1.92	2.34	.019	.736	8.261	**
IV2: CV(size)	-2.507	1.854	-1.35	.176	-6.14	1.127	
2.years	-1.395	1.7	-0.82	.412	-4.727	1.938	
3.years	.6	2.306	0.26	.795	-3.92	5.12	
4.years	-8.25	2.878	-2.87	.004	-13.89	-2.609	***
5.years	-16.591	4.167	-3.98	0	-24.759	-8.423	***
2.ind	-1.132	1.713	-0.66	.509	-4.49	2.227	
3.ind	-.307	1.971	-0.16	.876	-4.17	3.556	
4.ind	-1.637	2.028	-0.81	.42	-5.611	2.337	
experience	1.319	1.005	1.31	.19	-.652	3.289	
scope	-1.425	.794	-1.79	.073	-2.982	.132	*
domestic	1.972	1.885	1.05	.296	-1.723	5.667	
age	-.03	.015	-2.01	.045	-.06	-.001	**
sameind	-2.16	.989	-2.18	.029	-4.099	-.22	**
suppat	.001	.001	0.57	.566	-.002	.003	
usoem	-.826	1.443	-0.57	.567	-3.654	2.002	
MCAP	-.379	.127	-2.98	.003	-.628	-.13	***
TCAP	.007	.065	0.11	.911	-.121	.135	
OCAP	.079	.068	1.17	.241	-.053	.212	
Cmcap	2.116	.802	2.64	.008	.545	3.688	***
Ctcap	.628	.754	0.83	.405	-.85	2.105	
Cocap	-1.882	1.397	-1.35	.178	-4.619	.855	
Constant	34.101	14.278	2.39	.017	6.116	62.086	**

Mean dependent var	1.187	SD dependent var	0.589
Pseudo r-squared	0.323	Number of obs	187
Chi-square	1961.694	Prob > chi2	0.000
Akaike crit. (AIC)	314.677	Bayesian crit. (BIC)	463.308

**** p<.01, ** p<.05, * p<.1*

Table (4.8): First-Stage Multinomial Logistic Regression for the Three-Way Model

Governance mode	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
JVs				***Base Category***			
Agreements:							
IV1: supply agreement	3.871	1.744	2.22	.026	.454	7.289	**
IV2: CV(size)	-4.035	1.446	-2.79	.005	-6.869	-1.201	***
2.years	.008	1.708	0.00	.996	-3.339	3.355	
3.years	1.962	2.04	0.96	.336	-2.035	5.96	
4.years	-5.337	2.789	-1.91	.056	-10.802	.129	*
5.years	-1.377	2.364	-0.58	.56	-6.01	3.257	
2.ind	-2.099	1.602	-1.31	.19	-5.239	1.042	
3.ind	-1.749	1.79	-0.98	.329	-5.257	1.759	
4.ind	-4.226	1.676	-2.52	.012	-7.512	-.941	**
experience	1.057	1.025	1.03	.302	-.951	3.065	
scope	-1.375	.663	-2.07	.038	-2.674	-.075	**
domestic	.311	1.557	0.20	.842	-2.74	3.361	
age	-.035	.021	-1.68	.093	-.075	.006	*
sameind	-2.378	.986	-2.41	.016	-4.311	-.446	**
suppat	0	.001	0.20	.844	-.002	.002	
usoem	.157	1.37	0.11	.909	-2.529	2.842	
MCAP	-.293	.115	-2.54	.011	-.519	-.067	**
TCAP	.099	.059	1.69	.092	-.016	.214	*
OCAP	.005	.051	0.10	.92	-.095	.105	
diff	-.139	.964	-0.14	.885	-2.029	1.75	
cost	-.119	.705	-0.17	.866	-1.5	1.263	
Cmcap	1.58	.761	2.08	.038	.088	3.073	**
Ctcap	-.221	.757	-0.29	.77	-1.705	1.262	
Cocap	-.615	1.093	-0.56	.574	-2.757	1.527	
Constant	29.204	11.885	2.46	.014	5.909	52.498	**
Licenses:							
IV1: supply agreement	4.436	1.878	2.36	.018	.755	8.117	**
IV2: CV(size)	-2.449	1.833	-1.34	.181	-6.041	1.143	
2.years	-1.515	1.826	-0.83	.407	-5.093	2.064	
3.years	.357	2.22	0.16	.872	-3.994	4.708	
4.years	-8.334	3.126	-2.67	.008	-14.461	-2.206	***
5.years	-17.707	4.182	-4.23	0	-25.904	-9.51	***
2.ind	-1.108	1.535	-0.72	.471	-4.117	1.902	
3.ind	-.339	2.153	-0.16	.875	-4.558	3.881	
4.ind	-1.828	1.703	-1.07	.283	-5.167	1.511	
experience	1.318	1.117	1.18	.238	-.871	3.508	
scope	-1.392	.787	-1.77	.077	-2.935	.151	*
domestic	1.888	1.803	1.05	.295	-1.646	5.423	
age	-.029	.02	-1.42	.157	-.069	.011	
sameind	-2.15	.993	-2.17	.03	-4.096	-.204	**
suppat	.001	.001	0.54	.588	-.002	.003	
usoem	-.886	1.316	-0.67	.501	-3.467	1.694	
MCAP	-.386	.124	-3.11	.002	-.629	-.143	***
TCAP	.007	.069	0.10	.923	-.129	.142	
OCAP	.071	.062	1.15	.251	-.05	.191	
diff	.135	.97	0.14	.889	-1.765	2.036	
cost	-.108	.809	-0.13	.894	-1.695	1.478	
Cmcap	2.161	.802	2.70	.007	.59	3.732	***
Ctcap	.594	.846	0.70	.482	-1.064	2.252	
Cocap	-1.839	1.294	-1.42	.155	-4.375	.696	
Constant	35.479	13.888	2.55	.011	8.259	62.699	**

Mean dependent var	1.187	SD dependent var	0.589
Pseudo r-squared	0.325	Number of obs	187
Chi-square	2898.988	Prob > chi2	0.000
Akaike crit. (AIC)	321.817	Bayesian crit. (BIC)	483.373

*** $p<.01$, ** $p<.05$, * $p<.1$

After adding Copula terms and CFs, our adjusted Models (3) and (4) are:

$$\boldsymbol{P_i} = \omega_0 + \omega_1 Gov_i + \omega_2 Mcap_i + \omega_3 Tcap_i + \omega_4 Ocap_i + \omega_5 Gov_i * Mcap_i + \omega_6 Gov_i * Tcap_i + \omega_7 Gov_i * Ocap_i + (\omega_8 : \omega_{16})\ Controls_i + \omega_{17} C_{Mcap\ i} + \omega_{18} C_{Tcap\ i} + \omega_{19} C_{Ocap\ i} + \omega_{20} Govhatcap_i + \epsilon_{i5} \quad (5)$$

$$\boldsymbol{P_i} = \eta_0 + \eta_1 Gov_i + \eta_2 Mcap_i + \eta_3 Tcap_i + \eta_4 Ocap_i + \eta_5 Diff_i + \eta_6 Cost_i + \eta_7 Gov_i * Mcap_i + \eta_8 Gov_i * Tcap_i + \eta_9 Gov_i * Ocap_i + \eta_{10} Gov_i * Mcap_i * Diff_i + \eta_{11} Gov_i * Tcap_i * Diff_i + \eta_{12} Gov_i * Ocap_i * Diff_i + \eta_{13} Gov_i * Mcap_i * Cost_i + \eta_{14} Gov_i * Tcap_i * Cost_i + \eta_{15} Gov_i * Ocap_i * Cost_i + (\eta_{16} : \eta_{24})\ Controls_i + \eta_{25} C_{Mcap\ i} + \eta_{26} C_{Tcap\ i} + \eta_{27} C_{Ocap\ i} + \eta_{28} Govhatst_i + \epsilon_{i6} \quad (6)$$

Whereas P_i is the innovation performance indicator (i.e., patent counts, citation counts, and new product announcements). This means that we run each of these four models three times using one performance indicator each time. Gov_i is the governance mode implemented by OEM (i), $Mcap_i$ marketing capabilities of OEM (i), $Tcap_i$ technological capabilities of OEM (i), $Ocap_i$ operations capabilities of OEM (i), $Diff_i$ differentiation strategy for OEM(i), $Cost_i$ cost leadership strategy for OEM (i), $Controls_i$ are control variables, $C_{Mcap\ i}$ Copula term for marketing capabilities, $C_{Tcap\ i}$ Copula term for technological capabilities, $C_{Ocap\ i}$ Copula term for operations capabilities, $Govhatcap_i$ CF for the two-way model, $Govhatst_i$ CF for the three-way model, and $\epsilon_{i(.)}$ are the random error terms.

4.5. Results:

We present our estimations and results in four steps. First, we estimate equation (1) for each of the three Innov-Perf indicators, including only the governance modes as regressors in addition to the control variables. Second, we estimate equation (2), including only the three 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 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. Our results are presented in Tables (4.9), (4.10), and (4.11).

4.5.1. Results of Direct Impact of PDC Governance Modes:

The results of our first estimation offer evidence for the aggregate impact of governance modes. The results are presented in Table (4.9), panels (a) and (b). Notice that the marginal impacts of all governance modes are significantly positive. For example, JVs, agreements, and licenses would increase the number of patents by about 145, 242 and 228, respectively as shown in Table (4.9), panel (b). Panel (a) of Table (4.9) allows us to compare if the marginal impacts are significantly different. We find agreements, are associated with the highest Innov-Perf. For instance, the number of citations associated with agreements is 71% higher than those for JVs. Likewise, agreements are associated with 30% New Product Announcements (NPAs) higher than licenses.

Table (4.9): Impact of Governance and Capabilities on Innovation Performance

	(a) Governance Model			**(b) Marginal Impacts of Governance**			**(c) Capabilities Model**		
	Dependent Variables			Dependent Variables			Dependent Variables		
	(1a) **Patents**	(2a) **Citations**	(3a) **NPAs**	(1b) **Patents**	(2b) **Citations**	(3b) **NPAs**	(1c) **Patents**	(2c) **Citations**	(3c) **NPAs**
JV	-.508	-.713*	.026	145.38**	4180.45***	22.58***			
	(.421)	(.369)	(.334)	(57.48)	(1576.30)	(7.28)			
Agreement	***(Reference Category)***			241.51***	8526.97***	21.99***			
				(24.14)	(933.19)	(4.07)			
License	-.056	-.138	-.303**	228.32***	7428.52***	16.24***			
	(.257)	(.159)	(.149)	(55.85)	(1304.39)	(2.97)			
MCAP							.038***	.049***	.039***
							(.011)	(.009)	(.013)
TCAP							.062***	.057***	.016**
							(.006)	(.005)	(.007)
OCAP							-.012*	-.01	.006
							(.007)	(.008)	(.01)
Controls:									
2.years	-.462*	-.674**	.321				-.304	-.329	.46*
	(.275)	(.304)	(.27)				(.223)	(.237)	(.248)

	(a) Governance Model			(b) Marginal Impacts of Governance			(c) Capabilities Model		
	Dependent Variables			Dependent Variables			Dependent Variables		
	(1a) **Patents**	(2a) **Citations**	(3a) **NPAs**	(1b) **Patents**	(2b) **Citations**	(3b) **NPAs**	(1c) **Patents**	(2c) **Citations**	(3c) **NPAs**
3.years	.071	-.073	.503				.281	.345	.712**
	(.459)	(.542)	(.335)				(.347)	(.39)	(.314)
4.years	-.028	-.935	1.07***				.068	-.269	1.88***
	(.613)	(.694)	(.408)				(.488)	(.482)	(.48)
5.years	1.753**	-.532	1.691**				2.099***	-.299	1.728**
	(.759)	(.776)	(.829)				(.725)	(.688)	(.76)
2.ind	-.957*	-1.101**	-.061				-.614	-.737*	-.168
	(.56)	(.506)	(.275)				(.468)	(.43)	(.281)
3.ind	-.362	-.641**	.604**				-.289	-.502*	.364
	(.269)	(.323)	(.276)				(.251)	(.285)	(.268)
4.ind	-1.404***	-1.717***	-1.17***				-.979**	-1.482***	-1.237***
	(.531)	(.542)	(.376)				(.466)	(.466)	(.419)
5.ind	-.567	-.717	-1.749***				-.961***	-1.186***	-1.725***
	(.494)	(.481)	(.283)				(.303)	(.342)	(.248)
usoem	-.559	-.18	-.049				-.63**	-.182	.014
	(.369)	(.333)	(.283)				(.281)	(.287)	(.281)
suppat	.0001	.0004	-.0001				-.0003*	.00003	-.00003
	(.0003)	(.0004)	(.0002)				(.0002)	(.0003)	(.0003)
sameind	-.044	.021	-.292**				.03	.022	-.429***
	(.182)	(.203)	(.134)				(.123)	(.2)	(.119)
age	.04***	.031***	-.009				.032***	.025***	-.012**
	(.005)	(.005)	(.006)				(.004)	(.004)	(.006)
scope	.545***	.597***	.37***				.489***	.479***	.355***
	(.178)	(.188)	(.132)				(.134)	(.154)	(.138)
domestic	.124	.178	-.043				.118	.172	-.039
	(.208)	(.222)	(.153)				(.153)	(.159)	(.145)
exper	1.58***	2.002***	1.485***				1.487***	1.665***	1.365***
	(.317)	(.37)	(.234)				(.26)	(.307)	(.206)
_cons	3.343***	7.09***	2.317***				-3.869***	-.895	-2.506
	(.437)	(.391)	(.546)				(1.071)	(.995)	(1.757)
Obs.	202	202	202	202	202	202	189	189	189
Chi2	337.831	283.679	330.774				886.117	1070.448	342.313
Prob>Chi2	0.000	0.000	0.000				0.000	0.000	0.000
Akaike crit. (AIC)	2629.519	4048.174	1678.624				2465.465	3792.186	1598.586

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

Delta-method standard errors are in parenthesis
**** p<.01, ** p<.05, * p<.1*

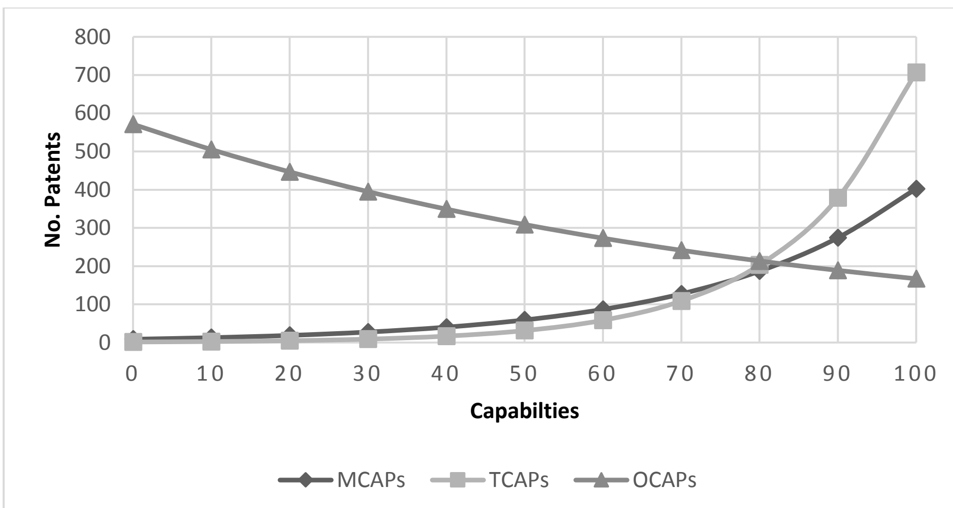
Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

4.5.2. Results of Direct Impact of PDC Governance Modes and Capabilities:

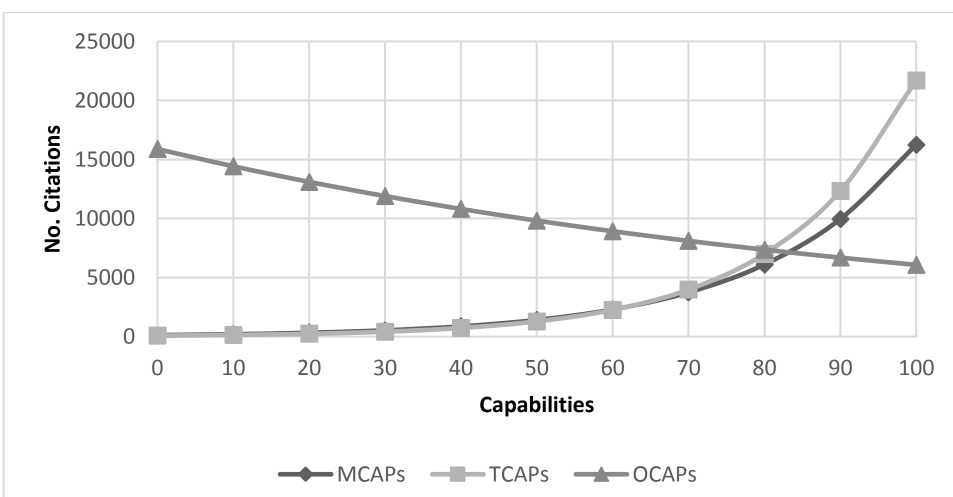
Our second estimation tests the three hypotheses (H1-H3) pertaining to the individual effects of capabilities on Innov-Perf. Our results in panel (c) of Table (4.9) reveal that MCAPs and TCAPs are positively and significantly associated with the three indicators of Innov-Perf, supporting H1 and H2. For instance, we find that a one percent increase in MCAPs is associated with a 3.8%, 4.9%, and 3.9% increase in patents, citations, and NPAs, respectively. Similarly, a one percent increase in TCAPs is associated with a 6.2%, 5.7%, and 1.6 % increase in patents, citations, and NPAs, respectively. On the other hand, the results show that OCAPs have no significant relationships with citations and NPAs, but they are negatively associated with patents, such that, a one percent increase in OCAPs would decrease patents by 1.2%. Note that this is contrary to H3, which predicts an increase.

In Figure (4.2), 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 all three indicators. Patents and Citations are higher for firms with high levels of TCAPs, while NPAs seem to be higher for firms with high levels of MCAPs.

Panel (A1): Capabilities & Patents



Panel (A2): Capabilities & Citations



Panel (A3): Capabilities & NPAs

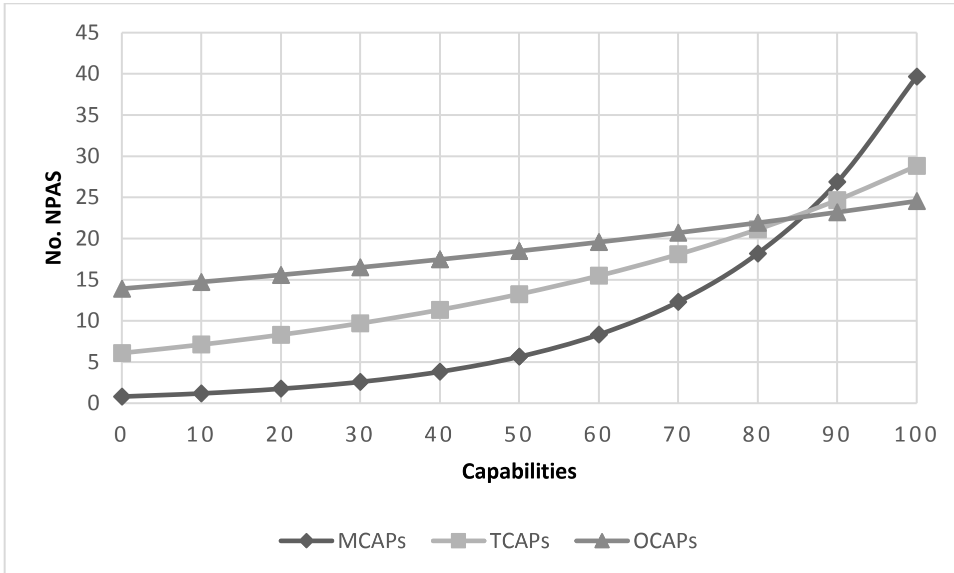


Figure (4.2): The Differential Impact of Capabilities on Innovation Performance

4.5.3. Results of Two-Way Interactions – Capabilities X Governance:

Next, we estimate the simultaneous impact of governance and capabilities on Innov-Perf to test H4-H6 – see Table (4.10). Our baseline model in panel (d) confirms that agreements have the highest impact on Innov-Perf. While there is only partial support for it in the adjusted model in panel (e) which demonstrates that agreements have a higher impact that is only significant in comparison to JVs but not to licenses. We also find support for H1 and H2 once again in both the baseline and adjusted models. Nonetheless, the baseline model shows no significant impact of OCAPs on Innov-Perf. Yet, after correcting for endogeneity, OCAPs have a positive impact on patents and citations, supporting H3. Table (4.10) also illustrates the two-way interaction effects of governance and capabilities.

Consistent with H4, both the baseline and adjusted models confirm that the 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 would increase patents, citations, and NPAs by 9.6%, 7.5%, and 10.2%, respectively, over that of agreements, and NPAs by 9.7% over that of licenses. Likewise, the adjusted model conveys that for JVs, a one percent increase in MCAPs would increase patents, citations, and NPAs by 13.8%, 10.2%, and 9.8%, respectively, over agreements, and patents by 8.7%, over licenses. Whereas the baseline model coefficients are largely not significant for the interactions with TCAPs (H5) and OCAPs (H6), after correcting for endogeneity, the adjusted model returns several significant coefficients. In particular, we find that a one percent increase in TCAPs for agreements would increase patents and citations by 4.5% and 5.4%, respectively, over that of JVs. In comparison, the similar increase in patents for licenses is only 2.7% over JVs and no significant change for citations and NPAs. Thus, we conclude the evidence is consistent with H5, with agreements being associated with higher patents and citations over both JVs and licenses, for firms with stronger TCAPs.

With regards to the interaction with OCAPs, we find that a one percent increase in OCAPs for JVs, would increase patents and citations by 6.1% and 7.8%, respectively, over agreements, and increase citations by 6.9% over licenses. The other interactions are not significant. Thus, we conclude the evidence is consistent with H6, with JVs being associated with higher patents over agreements, and higher citations over both agreements and licenses, for firms with stronger OCAPs.

Table (4.10): The Two-Way Interaction between Governance Modes & Firm Capabilities:

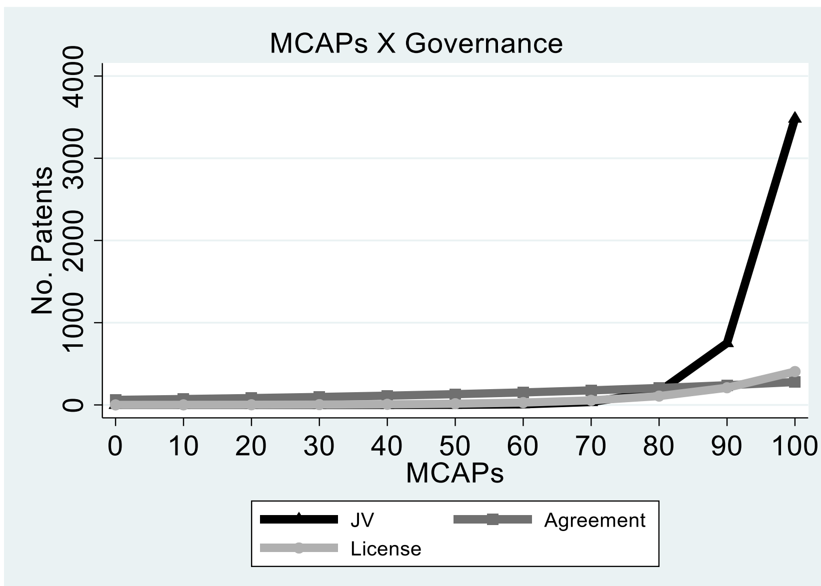
	(d) Baseline GLM			**(e) Adjusted GLM**		
	Dependent Variables			Dependent Variables		
	(1d) **Patents**	(2d) **Citations**	(3d) **NPAs**	(1e) **Patents**	(2e) **Citations**	(3e) **NPAs**
JV			***Reference Category***			
Agreement	8.705**	6.696**	12.037***	12.289***	11.035**	8.518*
	(4.189)	(2.823)	(3.939)	(4.323)	(4.522)	(5.053)
License	4.389	5.273*	11.975***	8.566	10.852*	6.508
	(4.616)	(3.17)	(4.586)	(5.482)	(5.654)	(5.932)
MCAP	.108**	.104***	.128***	.153***	.143***	.115*
	(.043)	(.032)	(.043)	(.051)	(.053)	(.065)
TCAP	.057***	.05***	.032***	.055***	.062***	.047***
	(.015)	(.006)	(.008)	(.01)	(.011)	(.015)
OCAP	-.003	.008	.021	.064*	.104***	.057
	(.029)	(.022)	(.017)	(.038)	(.04)	(.041)
JV*MCAP			***Reference Category***			
Agreement*MCAP	-.096**	-.075**	-.102**	-.138***	-.102***	-.098*
	(.043)	(.032)	(.044)	(.037)	(.037)	(.058)
License*MCAP	-.049	-.047	-.097**	-.087*	-.074	-.083
	(.047)	(.034)	(.048)	(.047)	(.046)	(.064)
JV*TCAP			***Reference Category***			
Agreement*TCAP	.004	.017	-.03	.045***	.054***	-.001

	(d) Baseline GLM			(e) Adjusted GLM		
	Dependent Variables			Dependent Variables		
	(1d)	(2d)	(3d)	(1e)	(2e)	(3e)
	Patents	**Citations**	**NPAs**	**Patents**	**Citations**	**NPAs**
	(.021)	(.021)	(.019)	(.016)	(.019)	(.016)
License *TCAP	.002	.005	-.022*	.027*	.022	-.006
	(.018)	(.015)	(.013)	(.014)	(.014)	(.015)
JV*OCAP	***Reference Category***					
Agreement*OCAP	-.013	-.021	-.017	-.061*	-.078**	-.033
	(.03)	(.022)	(.017)	(.032)	(.033)	(.031)
License *OCAP	-.005	-.02	-.032	-.055	-.069**	-.043
	(.039)	(.031)	(.023)	(.037)	(.033)	(.03)
Controls:						
2.years	-.316	-.347	.393	-.275	-.322	.387
	(.227)	(.246)	(.242)	(.23)	(.3)	(.262)
3.years	.287	.404	.629**	.253	.378	.51
	(.333)	(.398)	(.316)	(.347)	(.456)	(.318)
4.years	-.174	-.684	1.848***	.106	-.767	2.333***
	(.48)	(.507)	(.452)	(.513)	(.636)	(.696)
5.years	1.994**	-.302	1.492**	1.891**	-.402	1.514**
	(.869)	(.815)	(.623)	(.827)	(.858)	(.652)
2.ind	-.53	-.678	-.17	-.415	-.461	-.079
	(.468)	(.458)	(.297)	(.455)	(.398)	(.29)
3.ind	-.235	-.416	.454*	-.137	-.267	.399
	(.279)	(.308)	(.272)	(.281)	(.29)	(.261)
4.ind	-1.001**	-1.522***	-1.423***	-.909*	-1.455***	-1.138**
	(.483)	(.456)	(.403)	(.491)	(.516)	(.472)
5.ind	-1.235***	-1.344***	-1.838***	-.909**	-.896**	-1.431***
	(.292)	(.362)	(.299)	(.37)	(.423)	(.303)
usoem	-.56*	-.13	.017	-.794**	-.406	-.011
	(.298)	(.27)	(.289)	(.322)	(.309)	(.307)
suppat	-.0003	.00003	-.00004	-.0002	.0003	-.00001
	(.0002)	(.0003)	(.0003)	(.0002)	(.0003)	(.0002)
sameind	.004	-.026	-.374***	.011	.019	-.253*
	(.129)	(.199)	(.142)	(.118)	(.172)	(.132)
age	.034***	.028***	-.011*	.035***	.025***	-.012**
	(.004)	(.005)	(.006)	(.005)	(.004)	(.006)
scope	.485***	.52***	.402***	.474***	.476***	.319***
	(.135)	(.169)	(.127)	(.116)	(.137)	(.116)
domestic	.096	.165	-.014	.25	.326*	-.077
	(.166)	(.158)	(.142)	(.17)	(.186)	(.152)
experience	1.465***	1.644***	1.418***	1.35***	1.539***	1.276***
	(.28)	(.32)	(.207)	(.303)	(.358)	(.211)
CF & Copula Terms:						
govhatcap				.443	-.4	1.688**
				(.885)	(.983)	(.859)
Cmcap				-.092	-.237	.076
				(.221)	(.269)	(.198)
Ctcap				-.408**	-.449**	-.538**
				(.191)	(.229)	(.24)
Cocap				-.332	-.712***	-.287
				(.254)	(.261)	(.302)
_cons	-10.155***	-6.627***	-12.33***	-19.133***	-18.639***	-14.602***
	(3.93)	(2.19)	(4.073)	(4.825)	(4.541)	(5.337)
Obs.	189	189	189	187	187	187
Chi2	1238.155	1772.866	612.074	1799.318	2286.934	1015.631
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Akaike crit. (AIC)	2472.849	3801.623	1605.713	2457.205	3765.553	1590.825

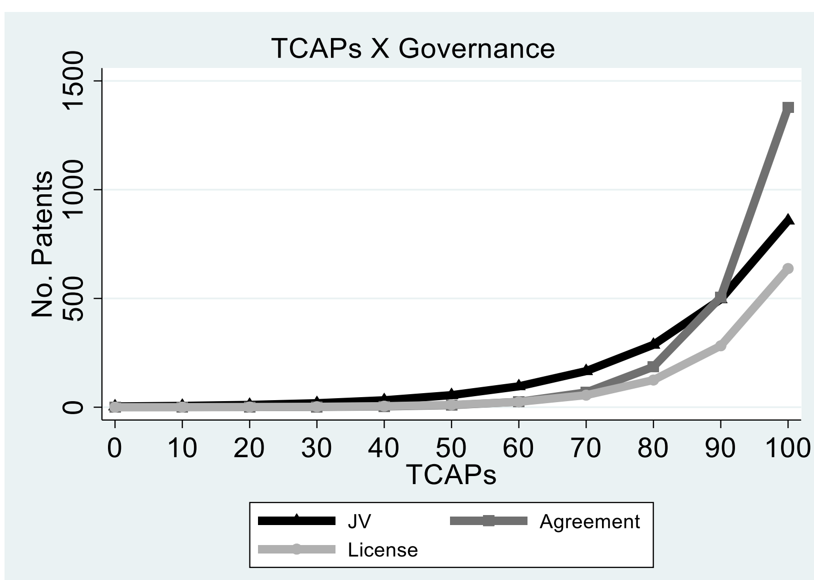
Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

To illustrate the results, in Figure (4.3), we plot the predicted number of patents 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 and OCAPs, JVs generate higher patents than agreements and licenses. In contrast, notice that for firms with higher TCAPs, agreements generate higher patents than other modes.

Panel (B1): The Interaction of MCAP and Governance



Panel (B2): The Interaction of TCAP and Governance



Panel (B3): The Interaction of OCAP and Governance

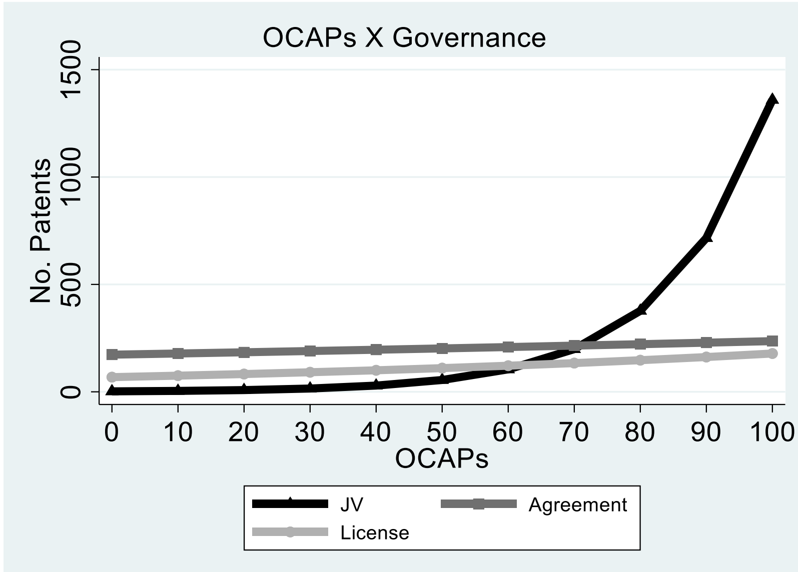


Figure (4.3): Sample Two-Way Interactions

4.5.4. Results of Three-Way Interactions – Capabilities X Governance X Strategy

Finally, we include the three-way interactions of governance, capabilities, and strategy to test H7-H10 – see Table (4.11). Interpretation of the three-way interactions is more involved. In H7, 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 would *decrease* patents, citations, and NPAs by 10.1%, 9.3%, and 9.1%, respectively. In contrast, looking at the coefficients for Agreement x MCAP x Diff, under the same conditions, *for agreements*, it would *increase* citations by 9.6% (and no significant impact on patents and 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 patents and NPAs). The corresponding coefficient in the endogeneity-adjusted model, suggests, it is only for agreements that differentiation will enhance Innov-Perf by increasing citations by 7.6% (no significance for others). We infer that these offer overall strong support for H7.

The results for the three-way interactions involving TCAPs *reject* the hypothesis in H8. In particular, the coefficients for License x TCAP x Diff shows in both the baseline and the endogeneity corrected model, that each unit increase in TCAPs and differentiation would *decrease* both patents (1.9%, 1.5%) and citations (2.3%, 1.8%). So, we speculate that the hold-up problems that accompany innovation under a differentiation strategy, may not be addressed by license in firms with strong TCAPs. Such firms may effectively identify technological competencies for better product differentiation, but the same capability may not be as effective in outlining the hold-up problems that may come paired with the technology portfolio, thereby acting as a drag on Innov-Perf.

H9 proposes that for cost-leadership-oriented firms, JVs will outperform other forms, at higher levels of TCAPs. The results for the three-way interaction JV x TCAP x Cost in the endogeneity-adjusted estimations suggest that this is true for NPAs, where for JVs, a unit increase in TCAPs and cost-leadership orientation results in a 4.4% increase in NPAs. Thus, we get support for H9. Other coefficients involving TCAPs, and cost-leadership, are not significant.

With respect to H10, we hypothesized that for cost-leadership-oriented firms, JVs will outperform other forms, at higher levels of OCAPs. This is largely borne out by the results in both the baseline and the endogeneity-adjusted models. Looking at the JV x OCAP x Cost coefficients, we see that for JVs, a unit increase in OCAPs and cost-leadership orientation results in an *increase* in patents, citations, and NPAs by 28.6%, 21.5%, and 17.8%, respectively in the baseline model, and an *increase* in patents and citations by 17.3% and 17.1%, respectively in the adjusted model. In contrast, agreements are associated with a 1.3% and 1.1% decrease in NPAs in a corresponding situation. Thus, we infer strong support for H10.

Among interactions not hypothesized, we find that for cost-leadership-oriented firms, both JVs and agreements decrease Innov-Perf at higher levels of MCAPs. We also find that for differentiation-oriented firms, JVs outperform both agreements and licenses at higher levels of OCAPs.

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.

The direct impacts of the different capabilities are mostly consistent with our earlier results. While MCAP is significant for patents in the adjusted models, it is not significant for citations and NPAs. Yet it is also significant for citations in the baseline model. Thus, we conclude partial support for H1 even after controlling for the three-way interactions. However, TCAP is not significant at all in the adjusted model, despite the significant coefficients in the baseline model. OCAP is only significant for citations in the adjusted model.

Focusing only on the endogeneity-adjusted results, 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 patents, such that for JVs, a one percent increase in MCAPs would increase patents by 1.24%, over that of agreements, the other results being non-significant. While the relevant interaction terms are not significant in the baseline model, the TCAP interaction terms in the endogeneity-adjusted model show that with increasing TCAPs, agreements outperform JVs for patents and citations. However, the difference is not significant with respect to licenses – partially consistent with H5. The results for the OCAP interactions are largely consistent with H6. This is especially true in the endogeneity-adjusted model, where we find that with increasing OCAP, JVs would generate greater patents and citations compared to both agreements and licenses.

Table (4.11): The Three-Way Interaction of Governance, Firm Capabilities, & Strategy

	(f) Baseline GLM			**(g) Adjusted GLM**		
	Dependent Variables			Dependent Variables		
	(1f) **Patents**	(2f) **Citations**	(3f) **NPAs**	(1g) **Patents**	(2g) **Citations**	(3g) **NPAs**
JV			***Reference Category***			
Agreement	18.454***	17.279**	7.139	8.965	8.373	-12.728
	(5.853)	(6.905)	(8.492)	(7.375)	(8.338)	(10.878)
License	14.718**	10.65	3.434	5.629	2.98	-17.384
	(6.195)	(7.714)	(8.619)	(7.517)	(8.81)	(11.207)
MCAP	.189***	.167***	.045	.133*	.125	-.062
	(.043)	(.051)	(.069)	(.074)	(.083)	(.102)
TCAP	.068***	.065***	.041**	.03	.043	.021
	(.015)	(.017)	(.019)	(.023)	(.033)	(.036)
OCAP	.017	.029	.033	.083	.143***	.017
	(.021)	(.024)	(.029)	(.052)	(.053)	(.047)
diff	-.173	-2.893	1.773	-.579	-3.299	.162
	(2.932)	(3.797)	(2.743)	(2.947)	(3.707)	(3.183)
cost	.901	2.93	1.084	1.552	3.213*	1.272
	(1.934)	(2.43)	(1.644)	(1.662)	(1.901)	(1.364)
JV*MCAP			***Reference Category***			
Agreement*MCAP	-.182***	-.133**	-.016	-.124**	-.076	.089
	(.045)	(.055)	(.067)	(.058)	(.064)	(.093)
License*MCAP	-.144***	-.095	-.001	-.073	-.01	.105
	(.05)	(.058)	(.072)	(.063)	(.07)	(.093)
JV*TCAP			***Reference Category***			
Agreement*TCAP	-.005	.001	-.036	.071***	.081**	.042
	(.02)	(.024)	(.024)	(.027)	(.034)	(.028)
License*TCAP	-.0004	.004	-.022	.056**	.056*	.04
	(.02)	(.033)	(.02)	(.022)	(.033)	(.027)
JV*OCAP			***Reference Category***			
Agreement*OCAP	-.034	-.075**	-.04	-.061**	-.103***	-.019
	(.028)	(.033)	(.03)	(.031)	(.037)	(.037)
License*OCAP	-.03	-.033	-.026	-.063*	-.077*	-.007
	(.032)	(.032)	(.032)	(.037)	(.039)	(.036)
Three-Way Interactions						
JV*MCAP*diff	-.101**	-.093*	-.091*	-.069	-.079	-.047
	(.046)	(.056)	(.05)	(.045)	(.052)	(.046)
Agreement*MCAP*diff	.014	.096**	.014	.014	.076**	.032
	(.03)	(.038)	(.032)	(.031)	(.034)	(.041)
License*MCAP*diff	.047	.078*	.018	.042	.061	.04
	(.03)	(.041)	(.035)	(.034)	(.041)	(.041)
JV*TCAP*diff	.026	.04	.021	-.028	-.019	-.026
	(.033)	(.034)	(.023)	(.035)	(.05)	(.046)
Agreement*TCAP*diff	-.008	-.014	.023	-.018	-.03	.023
	(.028)	(.036)	(.023)	(.025)	(.035)	(.019)
License*TCAP*diff	-.019***	-.023***	-.009	-.015**	-.018**	-.006
	(.007)	(.009)	(.007)	(.007)	(.008)	(.007)
JV*OCAP*diff	.086**	.106***	.066*	.126***	.168***	.103*
	(.035)	(.032)	(.035)	(.037)	(.05)	(.058)
Agreement*OCAP*diff	-.014	-.054**	-.063***	.002	-.012	-.06***
	(.02)	(.028)	(.022)	(.025)	(.032)	(.021)
License*OCAP*diff	-.026	-.021	-.032**	-.02	-.005	-.037**
	(.029)	(.034)	(.015)	(.026)	(.027)	(.017)

	(f) Baseline GLM			(g) Adjusted GLM		
	Dependent Variables			Dependent Variables		
	(1f)	(2f)	(3f)	(1g)	(2g)	(3g)
	Patents	**Citations**	**NPAs**	**Patents**	**Citations**	**NPAs**
JV*MCAP*cost	-.269***	-.24**	-.211*	-.173**	-.205***	-.068
	(.086)	(.105)	(.112)	(.067)	(.068)	(.102)
Agreement*MCAP*cost	-.025***	-.037***	-.002	-.03***	-.042***	-.005
	(.009)	(.012)	(.012)	(.008)	(.01)	(.012)
License*MCAP*cost	-.004	-.002	.004	-.006	-.008	.006
	(.01)	(.016)	(.009)	(.009)	(.014)	(.01)
JV*TCAP*cost	-.025	-.005	.02	-.009	.007	.044**
	(.017)	(.016)	(.021)	(.014)	(.017)	(.021)
Agreement*TCAP*cost	.011	-.004	.001	.009	.0003	.001
	(.017)	(.021)	(.015)	(.015)	(.017)	(.013)
License*TCAP*cost	-.024	-.036	-.009	-.025	-.023	-.008
	(.018)	(.028)	(.016)	(.016)	(.028)	(.013)
JV*OCAP*cost	.286***	.215**	.178*	.173**	.171**	.023
	(.083)	(.098)	(.095)	(.07)	(.071)	(.092)
Agreement*OCAP*cost	-.004	-.004	-.013***	-.005	-.007	-.011**
	(.003)	(.004)	(.004)	(.004)	(.005)	(.005)
License*OCAP*cost	.014	-.001	-.004	.008	-.015	-.012
	(.02)	(.025)	(.02)	(.018)	(.022)	(.018)
Controls:						
2.years	-.131	-.211	.378	-.041	-.064	.404
	(.19)	(.272)	(.241)	(.2)	(.302)	(.253)
3.years	.029	.123	.603*	.102	.203	.554*
	(.265)	(.389)	(.332)	(.276)	(.449)	(.329)
4.years	.232	-.132	1.584**	.415	-.262	2.017**
	(.48)	(.527)	(.77)	(.573)	(.723)	(.796)
5.years	1.264***	-.516	1.103**	1.512***	-.262	1.463***
	(.453)	(.486)	(.562)	(.556)	(.648)	(.483)
2.ind	-.61	-.753*	-.275	-.513	-.568	-.287
	(.406)	(.437)	(.321)	(.362)	(.363)	(.278)
3.ind	.011	-.343	.313	.075	-.239	.155
	(.267)	(.276)	(.227)	(.25)	(.276)	(.208)
4.ind	-.807	-1.167*	-1.475**	-.835	-1.093	-1.364**
	(.552)	(.642)	(.664)	(.597)	(.736)	(.581)
5.ind	-.921**	-.996**	-1.489***	-.54	-.535	-1.185***
	(.38)	(.394)	(.308)	(.475)	(.546)	(.283)
usoem	-.652**	-.385	-.024	-.867**	-.705**	.012
	(.27)	(.268)	(.332)	(.338)	(.314)	(.326)
suppat	-.0003	.0001	-.0001	-.0003	.0002	-.0001
	(.0003)	(.0003)	(.0002)	(.0003)	(.0004)	(.0002)
sameind	.074	.011	-.274**	.095	.081	-.124
	(.139)	(.177)	(.134)	(.128)	(.16)	(.117)
age	.034***	.025***	-.011*	.033***	.023***	-.012*
	(.005)	(.005)	(.007)	(.004)	(.005)	(.006)
experience	1.57***	1.822***	1.553***	1.413***	1.659***	1.41***
	(.259)	(.314)	(.231)	(.272)	(.348)	(.227)
scope	.524***	.554***	.392**	.547***	.567***	.317**
	(.118)	(.164)	(.171)	(.112)	(.171)	(.148)
domestic	.201	.384**	.037	.299	.526***	.002
	(.171)	(.184)	(.173)	(.182)	(.194)	(.159)
CF & Copula Terms:						
govhatst				.389	-.25	2.336***
				(.867)	(.979)	(.869)
Cmcap				-.066	-.239	.041
				(.25)	(.404)	(.291)
Ctcap				-.408**	-.552**	-.729**

	(f) Baseline GLM			**(g) Adjusted GLM**		
	Dependent Variables			Dependent Variables		
	(1f)	(2f)	(3f)	(1g)	(2g)	(3g)
	Patents	**Citations**	**NPAs**	**Patents**	**Citations**	**NPAs**
				(.203)	(.276)	(.321)
Cocap				-.51	-.993**	-.068
				(.416)	(.392)	(.314)
_cons	-20.163***	-15.274**	-7.032	-17.332**	-18.824**	5.805
	(5.408)	(6.456)	(8.75)	(8.398)	(8.692)	(11.223)
Obs.	189	189	189	187	187	187
Chi2	5238.035	4109.493	1266.346	6113.220	5512.345	2491.870
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Akaike crit. (AIC)	2464.265	3794.892	1621.530	2451.142	3757.660	1603.704

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

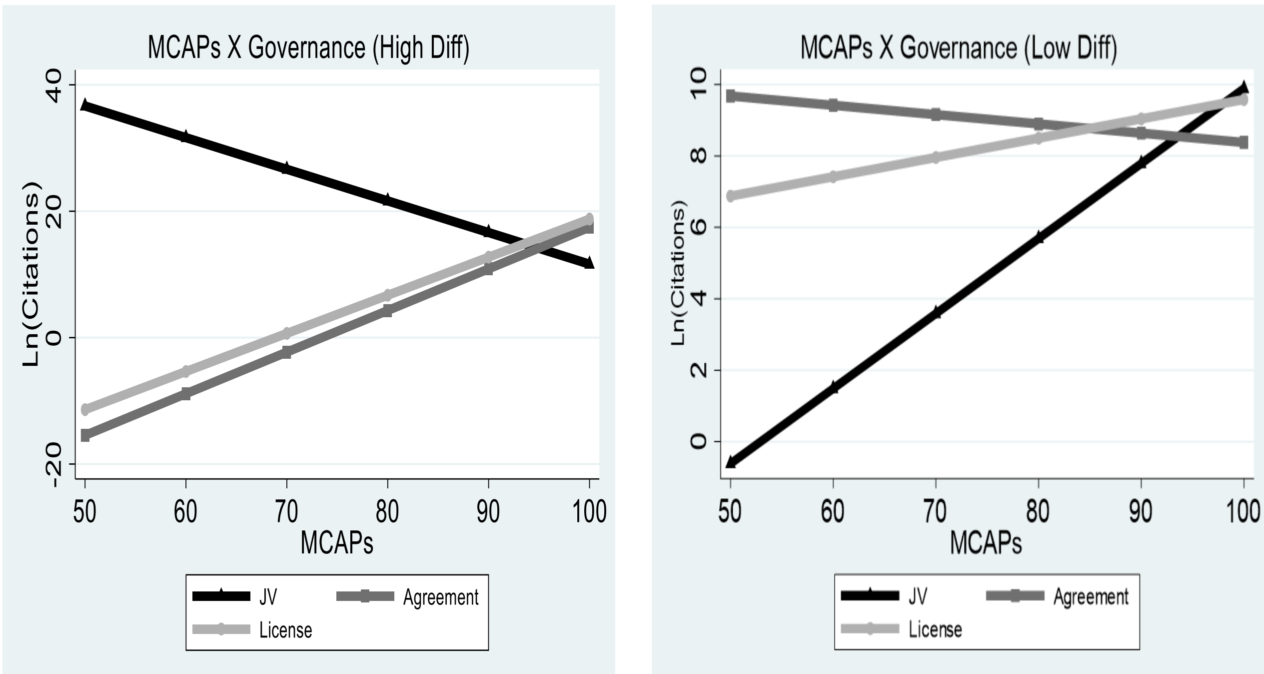
To illustrate the three-way interactions, in Figure (4.4), we plot the predicted Innov-Perf indicator, calculated using the estimated coefficients of equation (6), against the capabilities for each governance mode, once each for high and low values of the firm's positioning strategy (based on a median split of the strategy measures).[14] 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 also lead to higher NPAs for high-cost-leadership-oriented firms at high TCAPs. Notice that the advantage of JVs over the other forms reduces significantly for low-cost-leadership-oriented firms. In the last row, JVs result in higher citations for firms with high levels of cost-leadership strategy with high OCAPs. However, for low-cost-leadership-oriented firms that is no more the case, and JVs are dominated by licenses. While each of these is 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.,

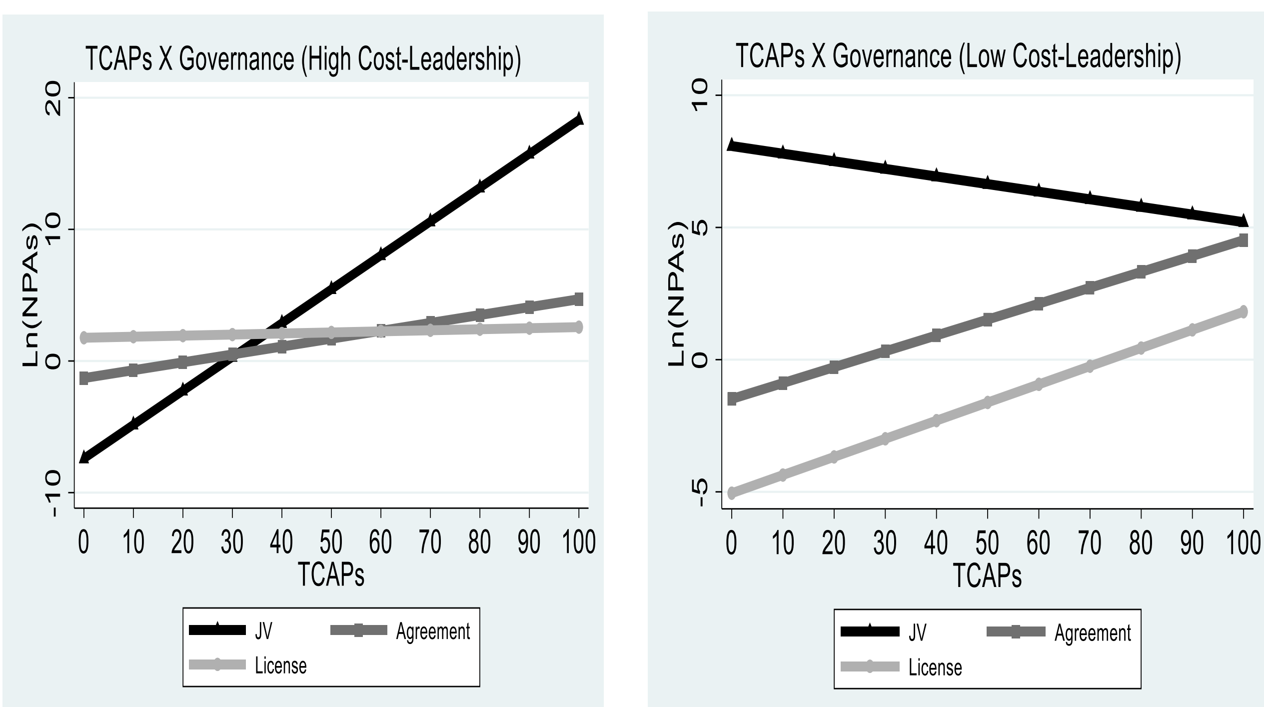
[14] We use the log of the performance indicators to better capture the differences in our plots.

joint ventures, would be secularly more effective, would be wrong. In Table (4.12), we provide a summary of the hypotheses and their results.

Panel (C1): MCAPs X Governance X Differentiation



Panel (C2): TCAPs X Governance X Cost-Leadership



Panel (C3): OCAPs X Governance X Cost-Leadership

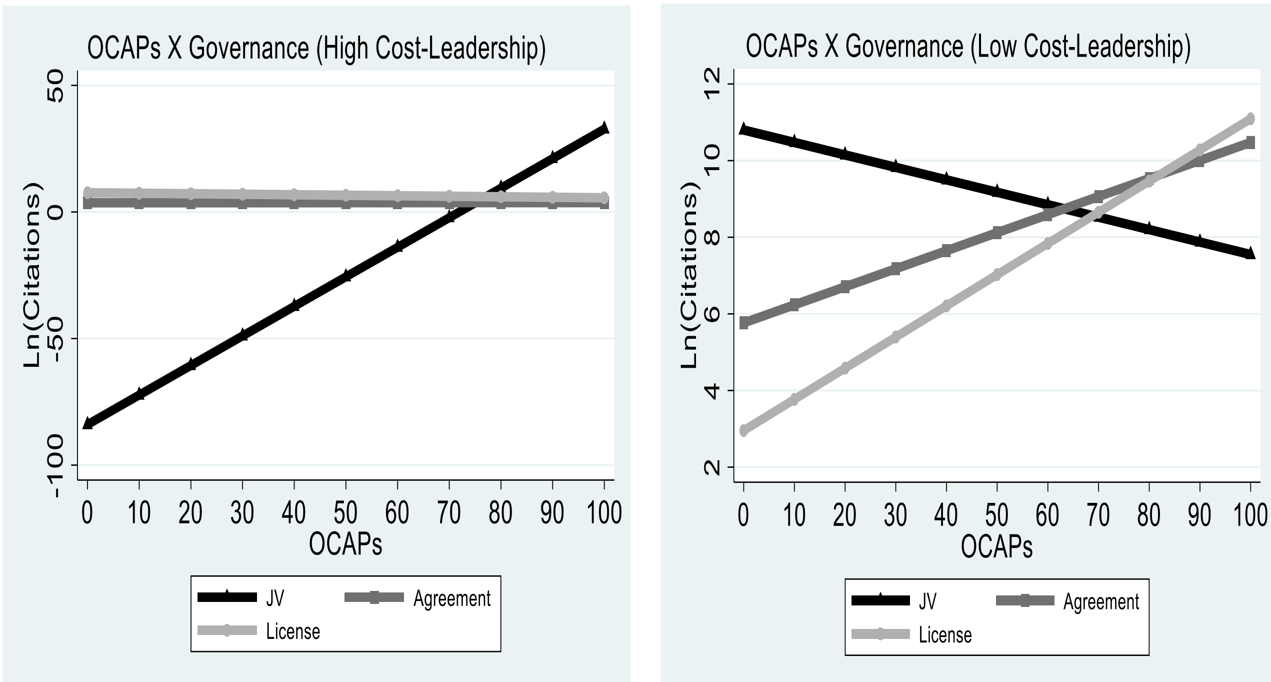


Figure (4.4): Sample Three-Way Effects on Innovation Performance

Table (4.12): Summary of Hypotheses Results

Hypothesis	Governance Model	Capabilities Model	Two-way Base Model	Two-way Adjusted Model	Three-way Base Model	Three-way Adjusted Model
Agreements will have a stronger relationship with Innov-Perf than JVs or licenses.	Supported		Supported	Partially supported	Supported	Not supported
H1: MCAPs are positively associated with Innov-Perf.		Supported	Supported	Supported	Supported	Supported
H2: TCAPs are positively associated with Innov-Perf.		Supported	Supported	Supported	Supported	Not supported
H3: OCAPs are positively associated with Innov-Perf.		Not supported	Not supported	Supported	Not supported	Supported
H4: JVs are associated with higher Innov-Perf for OEMs with strong MCAPs as compared to licenses and agreements.			Supported	Supported	Supported	Partially supported
H5: Agreements are associated with higher Innov-Perf for OEMs with strong TCAPs as compared to JVs and licenses.			Not supported	Supported	Not supported	Partially supported
H6: JVs are associated with higher Innov-Perf for OEMs with strong OCAPs as compared to agreements and licenses.			Not supported	Supported	Partially supported	Supported
H7: Differentiation-oriented OEMs with strong MCAPs will have superior Innov-Perf if they set agreements than JVs or licenses.					Partially supported	Supported
H8: Differentiation-oriented OEMs with strong TCAPs will have superior Innov-Perf if they use licenses than JVs or agreements.					Not supported	Not supported
H9: Cost-leadership oriented OEMs with strong TCAPs will have superior Innov-Perf if they form JVs than agreements or licenses.					Not supported	Supported
H10: Cost-leadership oriented OEMs with strong OCAPs will have superior Innov-Perf if they form JVs than agreements or licenses.					Supported	Supported

4.6. 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. This potential erosion in the strategy dividend is even more important in tight economic times. 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 or operations capabilities. We estimate, for firms with similar cost-leadership orientations, technological capability can boost new products announcement by 4.4% for JVs, but not for licensing and agreements. Similar estimates show operations capabilities can boost successful patent applications by more than 17% for JVs but not for the other modes. On the other hand, estimates show that strong marketing capabilities in the same situation can dampen successful patent applications of JVs by more than 17%. Nevertheless, marketing capabilities seem to be more benign for JVs in differentiation-oriented firms. For such firms, they appear to boost patent citations by 7.6% for 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 a cost-leadership orientation. Thus, one of our central themes is, the idea of fit in product developments collaborations comes with underlying notions of misalignment costs that need to be recognized.

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 collaboration. In a similar vein, we also use all three functional capabilities in our model. While their critical roles in driving firm performance are recognized, they have rarely been studied together in the context of innovation collaborations. 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. For example, contrary to our expectations, we find operations capabilities are negatively associated with successful patent applications. Indeed, if such firms routinize their processes in the quest for operational efficiency, it may discourage novel solutions and engender a "success trap," such that they refrain from further learning and development in favor of reinforcing the routines that brought success, (Wang, Senaratne, & Rafiq, 2015). 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 – joint ventures for high marketing and operations capabilities and agreements for high technological capability.

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 the effectiveness of innovation collaborations. So, by considering the firm's differentiation and cost-leadership positioning strategies, 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. While all our hypothesized effects find support, contrary to our predictions we find licensing hurts innovation outcomes of differentiation-oriented firms with strong technological capabilities. While speculative, it appears that the limited inter-firm interaction in a more arms-length mode may hinder the firm's ability to learn effectively from its partner, neutralizing the high absorptive capacity potential of high technology capability.

4.7. Managerial Implications:

We offer three key managerial takeaways. *First*, our findings identify the appropriate portfolio of contracts given the existing firm capabilities and positioning strategy. This minimizes misalignment costs while easing the process of generating and sharing value – (a) protecting the firm's valuable knowledge and skills from opportunistic appropriation, (b) motivating partners to share knowhow and expertise, (c) facilitating efficient knowledge transfers, and (d) ensuring effective use of its deployed resources. This leads to better innovation outcomes. We summarize these in Table (4.13).

Table (4.13): (Mis)Alignment among Strategy, Capabilities, and Governance and its Impact on Innovation Performance

Strategy Adopted		**Capabilities Built**	**Governance Mode Chosen**	**Impact on Innov-Perf**
Differentiation		Marketing	Agreements & Licenses	More citations
		Technological	Licenses	Fewer patents & citations
		Operations	JVs	More patents, citations, & NPAs
			Agreements & Licenses	Fewer NPAs
Cost Leadership		Marketing	JVs & Agreements	Fewer patents & citations
		Technological	JVs	More NPAs
		Operations	Licenses	Fewer NPAs
			JVs	More patents & citations

Second, our results provide guidance for building the "right" functional capability to yield the most benefit from innovation collaborations. For instance, we suggest, as summarized in Table (4.14), that a firm needs to invest in building marketing capability if it is driven by differentiation and considering agreements or licenses with suppliers. In contrast, we suggest that the firm should develop its operations and technological capabilities if it is driven by cost-leadership and is considering a joint venture. *Third*, our results warn against blindly copying the practices of other firms, 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 design effective contracts. Thus, blanket prescriptions for one or the other types of contracts (e.g., joint ventures during downturns) may be misdirected.

Table (4.14): Conditions Under Which Each Functional Capability is Needed to Enhance Innovation Performance

Strategy Adopted	Governance Mode Utilized	Capabilities to Build	Underlying Resources to Invest in
Differentiation	Agreements or Licenses	Marketing	▪ Invest in marketing activities and market research. ▪ Develop a large customer base. ▪ Build strong relationships with profitable customers and channel members.
	JVs	Operations	▪ Invest in training employees to integrate components and technologies flexibly and efficiently from diverse sources. ▪ Incorporate agile manufacturing techniques to respond quickly to changing customer needs. ▪ Build strong relationships with suppliers.
Cost Leadership	JVs	Technological	▪ Invest in R&D activities. ▪ Develop new products and processes and create large patent stock. ▪ Develop new technologies that facilitate coordination among diverse activities.
		Operations	▪ Make the best use of resources (e.g., employees' skills, machine time) to manufacture products efficiently. ▪ Reduce labor costs and costs of capital to the lowest possible level.

4.8. 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). Similarly, we focus only on the generic strategies of cost-leadership and product differentiation. We call for studying other conceptualizations of strategies to 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.

On the estimation side, the varied measures in our data, including continuous, categorical, and count variables, raised some econometric challenges and prohibited us from utilizing simultaneous equations estimations to test the three-way interaction in our model. Although we control for potential endogeneity using the Gaussian copula and two-stage residual inclusion methods, we hope future studies will consider ways to address these limitations.

5. Conclusion

As we live in a knowledge-based economy that is driven by advanced technologies and innovation, firms – especially those in high-tech sectors – aim at enhancing their innovation performance to survive and prosper. One common practice to achieve this goal, especially during times of economic downturns, is to participate in product development collaborations. Thus, I dedicated my doctoral studies to investigating PDC and uncovering whether and when they would boost the innovation performance of high-tech firms. PDCs are fundamental instruments for firms to overcome their limitations and face economic challenges and environmental uncertainties. Notwithstanding, they are surrounded by several contractual hazards and risks that raise the concerns of many executives. Previous studies attempted to address several of these concerns. In fact, our marketing literature is quite rich with studies on this topic. My dissertation contributes to this literature in several ways.

First, it offers the first systematic review – to the best of my knowledge – of the marketing studies on the PDC topic. I reviewed nearly all marketing studies published on the topic in five top marketing journals over more than two decades. I conducted a bibliometric analysis for the papers and demonstrated that (a) studies on the PDC topic grow by about 5% every year, (b) the IMM journal contributes largely (by 74% of the articles) to our knowledge on the topic, (c) the top three influential articles on the topic are Rindfleisch & Moorman, 2001, Sivadas & Dwyer, 2000, and Fang, 2008; all are published in JM, and (d) the studies employed diverse research techniques; the most frequently used are survey and case studies. My review reveals that theories that are more common in the articles are TCE, RBV, dynamic capabilities, organizational learning, and social network. In the study, I highlight the key drivers for firms to establish PDCs, the drawbacks and potential risks of PDCs, and the different PDC types.

Further, I gave more attention to one of the intensively examined research questions: PDC effectiveness. I illustrated the disagreement in the literature regarding the impact of PDCs on firm performance and discussed the different factors that would impact PDC success. I argued that some of these factors are firm-specific such as capabilities, absorptive capacity, and strategy. While others are collaboration-related such as partner selection, relational governance, and collaboration form. Moreover, I discussed conflict and alliance termination, highlighting the different causes and types of PDC termination. I ended up my review study with an agenda for future studies. For instance, I recommend the need for investigating (a) mutual outcomes of PDCs to all partners, (b) the "green" PDC topic, (c) how firm capabilities might impact partner selection, and (d) how firm strategy might drive the choice of an appropriate PDC form to enhance firm performance.

Not only that I integrated marketing knowledge on the PDC topic and identified numerous research gaps, but I have also delved into examining several research questions to create new knowledge, provide novel insights, and help research in our discipline to advance. I started by empirically investigating the competency trap effect of strong functional capabilities on the Innov-Perf of high-tech firms in PDCs. I drew on the RBV and dynamic capabilities perspectives to explain the benefits and drawbacks/costs of strong functional capabilities and to argue that at high levels of functional capabilities, the costs would outweigh the benefits, and thus functional capabilities would negatively impact Innov-Perf. My empirical results provide evidence for the competency trap effect of strong functional capabilities on Innov-Perf. This investigation adds to our marketing literature one of the few studies on the relationship between the three functional capabilities and Innov-Perf. In addition, it provides new insight into the nature of the capabilities-performance relationship. Unlike the dominant theme in the extant marketing studies of a linear positive relationship between capabilities and firm performance, I demonstrate that the relationship between each of marketing, technological, and operations capabilities and Innov-perf is inverted U-shaped.

After illustrating the downside effects of strong functional capabilities, I studied the interaction effect of the three capabilities. My dissertation is the first – as far as I know – marketing study to consider the "non-linear" interaction between the three capabilities. My empirical analysis provides interesting results which support my postulates that the interactions between different capabilities would impact Innov-Perf differently. In particular, I find that MCAPs would positively moderate the relationship between strong TCAPs and Innov-Perf. Similarly, TCAPs interact positively with strong OCAPs to enhance Innov-Perf. In contrast, MCAPs would negatively moderate the relationship between strong OCAPs and Innov-Perf.

In addition to examining the impact of capabilities interactions on Innov-Perf, I built on the dynamic capabilities perspective and the institutional theory to investigate the moderating effect of international versus domestic PDCs in the relationship between functional capabilities and Innov-Perf. My study is the first – to the best of my knowledge – to investigate the interaction between the three functional capabilities and international PDCs. Unlike most of the previous marketing studies that understudied the role of external resources in the capabilities-performance relationship, my study considers the role of external (foreign versus domestic) partners' knowledge and technologies in the relationship between functional capabilities and Innov-Perf. My findings add to existing marketing knowledge by demonstrating when international PDCs are better than domestic PDCs in protecting firms from competency traps of strong functional capabilities. These results also contribute to the extant literature on alliance partner selection by revealing that the type and level of firm functional capabilities must be considered when deciding whether to collaborate with foreign or domestic partners. Particularly, the results indicate that for firms with high MCAPs or OCAPs, collaborating with foreign partners is associated with superior Innov-Perf than forming PDCs with domestic firms. In contrast, collaborating with international, as compared to domestic, partners is associated with less Innov-Perf when a firm possesses high TCAPs.

I proceeded my empirical investigations of PDC effectiveness by examining the structure of PDCs and its relationship with functional capabilities and product positioning strategy and how these factors and their interactions would impact Innov-Perf. I grounded my hypotheses on the RBV, TCE, and GVA approaches. The series of research questions investigated in this study (i.e., chapter four) address multiple research gaps and offer further insights on the PDC topic. I started by examining the relationship between three different formal governance mechanisms (JVs, agreements, and licenses) and Innov-Perf. By studying a continuum of governance modes, I hope to fill a wide research gap in our marketing PDC literature where all previous marketing studies – as far as I know – treated governance as a binary variable (e.g., equity versus non-equity). My scrutinization of the granular differences among the common formal governance modes would help in advancing our understanding of how to structure effective PDCs.

After contrasting the relationships between the three governance mechanisms and Innov-Perf, I investigated the simultaneous impact of governance mechanisms and functional capabilities on Innov-Perf. This is the first study – as far as I know – to investigate the interaction between the three governance mechanisms and the three functional capabilities, providing new insights into how PDC governance and capabilities interact to affect Innov-Perf.

Explaining the moderating role of functional capabilities in the relationship between governance and Innov-Perf is an important contribution to the marketing literature. Yet, a stronger contribution is the demonstration of the fundamental role of considering positioning strategy along with functional capabilities in selecting a governance mechanism that would yield superior Innov-Perf. This presents one of the very few direct and full tests of the GVA framework, providing an empirical testimony to its validity in a PDC context. It also gets the attention of future researchers to the importance of considering firm strategy when examining PDC-related issues.

Not only that my dissertation contributes theoretically to extant marketing literature, but it also presents and validates a new statistical technique to measure positioning strategy using archival data of firms' financial statements.   Previous studies (e.g., Mintzberg, 1987) differentiated 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, realized strategy can be inferred from financial data reported by the firm (Banker et al., 2014). That is a firm would dedicate more resources to the activities that are essential to the deployment of its strategy, and these investments would be reflected in the firm's financial statements.

At its core, a differentiation strategy is mainly centered on deploying idiosyncratic innovations and unique marketing efforts to create "unique" value for customers that is difficult to be imitated. A such, a firm adopting a differentiation strategy would invest more in R&D and marketing activities. On the other hand, a cost-leadership strategy emphasizes efficiency and low-cost relative to competitors, and thus the firm would make the most efficient use of its resources to generate revenue and would use as few assets as possible per unit of output.

Utilizing this operationalization of firm strategy, several studies (e.g., Hambric, 1983; David et al., 2002; Balsam et al., 2011; Banker et al., 2014) used financial ratios to infer firm strategy form archival data. I borrowed this method from the accounting literature and validated it in my dissertation, hoping that future marketing scholars would adopt it in their studies, especially if they are concerned with the "realized" strategy and are using archival methods rather than a survey to collect data.

Perhaps, one last addition of my dissertation to the literature is its consideration of three indicators of Innov-Perf. Arguably, not all inventions are patentable, or not patented for strategic reasons (Ahuja, 2000), and not all patented inventions are turned into products, or directly map onto particular products (e.g., a patent involving a manufacturing process). Thus, I adopted a broad definition of Innov-Perf to capture a firm's innovation accomplishments over the course of developing a new product, from "technical" innovation to success in bringing the new product to the market (Hagedoorn & Cloodt, 2003). Building on this definition, I used (a) patent counts as an indicator of the *quantity* of the technological inventions of a firm, (b) patent citations as an indicator of the *quality* of a firm's patents/inventions, and (c) new product announcements to indicate a firm's success in converting its inventions into commercializable products (Hagedoorn & Cloodt, 2003; Artz et al., 2010). Using three indicators served at least two purposes. It first allowed me to measure different dimensions of Innov-Perf. It also provided a robustness check for my results.

In addition to its numerous contributions to the literature, my dissertation offers several interesting ***managerial implications*** regarding some important firm strategic factors including capabilities, positioning strategy, PDC governance, and partner selection. *First*, my studies demonstrate the downside effect of strong functional capabilities on Innov-Perf, indicating that intensifying investments in MCAPs, TCAPs, or OCAPs might drive a firm into a competency trap and hurt its innovativeness. In contrast, I illustrate that possessing moderate levels, as compared to low and high levels, of functional capabilities is associated with superior Innov-Perf.

Second, I provide managers with clear guidance on which capabilities to build under several conditions to yield the most benefit from PDC and enhance their Innov-Perf. For instance, I find that a firm with strong TCAPs would avoid the competency trap effect and enhance its Innov-Perf if it invested in MCAPs as well. A similar result would happen to a firm with strong OCAPs that also possesses high TCAPs. On the contrary, possessing MCAPs along with strong OCAPs would amplify the competency trap effect of the latter and hurt Innov-Perf. Further, my results suggest that a firm needs to build MCAPs if it is adopting a differentiation strategy and considering either agreement or license as a collaboration form. In contrast, a firm should develop its OCAPs or TCAPs if it is cost-efficient and considering a JV form.

Third, I present a guideline for executives tasked with selecting PDC partners. My studies reveal the importance of considering the type and level of existing functional capabilities when choosing between international and domestic partners. For instance, my findings demonstrate that choosing a foreign partner is associated with higher Innov-Perf for firms with strong MCAPs or OCAPs. While domestic partners would enhance the Innov-Perf of firms with strong TCAPs more than international firms.

Fourth, my findings identify the appropriate governance mechanism that a firm needs to select given its existing level and type of functional capabilities and the chosen positioning strategy to enhance its Innov-Perf. As I demonstrate in my study, fit among these three factors has significant implications as it would protect a firm from the opportunistic behavior of its partner and motivate the sharing of valuable knowledge necessary for effective collaboration.

Further, these findings send a warning message to managers of blindly copying practices of other firms in establishing PDCs without considering their own positioning strategy and functional capabilities.

Despite all my efforts to cover my research comprehensively and to be as accurate as possible, my dissertation – like any other human work – is not immune to limitations and even mistakes. One of the main limitations that I am aware of is that I studied the PDC's effectiveness from the OEM's perspective and overlooked the supplier's point of view due to data restrictions. I encourage forthcoming studies to address this. Also, in my test of the GVA framework, I did not consider transaction characteristics in my models due also to data limitations. I call for further tests of the GVA while accounting for exchange characteristics. Moreover, in my second empirical paper, I tried not to add more complexity to the inherently complex GVA model by examining functional capabilities linearly. I hope that future studies can investigate the curvilinear nature of capabilities in their tests of the GVA framework.

Overall, my dissertation study product development collaboration, a special type of strategic alliances that is particularly important to firm innovation, survival, and success in current times of uncertain economic conditions and dynamic business environment. It synthesize our knowledge on the PDC topic and adds several new insights and empirical implications that hopefully will contribute to the advancement of our marketing discipline and assist executives in making well-informed strategic decisions.

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Appendices

Appendix (A): Marketing Studies on Product Development Collaborations:

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
1	**Aarikka-stenroos et al. (2017)- IMM**	Innovation networks	Investigate the management of the innovation process in the extensive innovation networks that incorporates diverse actors and stakeholders (e.g., firms, public organizations, policy makers, research centers, customers), highlighting the role of the innovation goal (radical vs. incremental) in the management process.	Industrial marketing and purchasing approach along with strategic and innovation network literature.	Two longitudinal case studies.	Six management activities of the innovation process in the extensive networks were identified. These incorporated goal setting and refining; resources identification, sharing, and updating; motivating participants in the innovation process; consolidating and building trust and commitment; coordinating and dividing tasks; controlling; and leveraging and preparing participants to the upcoming innovation. The extent of diversity among actors in the network would enhance or hinder each of these activities. Likewise, each of these activities would be more critical based on the innovation goal (radical vs. incremental).
2	**Amaldoss & Rapoport (2005) -MS**	Product development networks	Study the effect of the structure of the competition on investments made by network partners.	Strategic alliances research	Two-stage competition game/ Experiments on business students.	In equilibrium, as the number of competing networks (or technologies) increases, partners tend to invest more in market, rather than product, development.
3	**Amaldoss et al. (2000) -MS**	NPD alliances	Examine the impact of an alliance's structure (i.e., the type of alliance, the profit-sharing arrangement, and market size) on its partners resource-commitment decisions.	Literature on strategic alliances	Game theory and Lab experiments	In the same-function alliances and when the rewards to win the competition is high, the profit-sharing arrangements tend to have very little impact on the resources committed by partners.
4	**Borah & Tellis (2014) -MS**	Innovation alliances	Compare the payoffs, in terms of abnormal stock return, from announcing decisions of make, buy, or ally for innovation, and investigate the factors that affect these payoffs.	Literature on make, buy, or ally strategies	Several industries/ Event study	Announcements of make and ally result in positive abnormal returns. In contrast, buy announcements generate negative returns.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
5	**Bouncken et al. (2016) - IMM**	Downstream partnerships	Examine the effect of singular (transactional or relational) vs. plural (transactional and relational) governance on product innovation in coopetition alliances.	Research on transactional and relational 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.
6	**Bouncken et al. (2020) -IMM**	NPD alliances	Study the factors that affect the value–creation–capture–equilibrium in NPD alliances.	Research on innovation alliances and relational view	Several highly innovative industries/ Survey	Coopetition intensity can result in more equilibrium in value creation and capture in NPD alliances.
7	**Boyd & Spekman (2008) -JAMS**	Vertical and horizontal alliances	Explore the effect of indirect ties between firms resulting from forming technology alliances on firm value.	Inter-organizational relationships literature	Diverse high-tech industries/ Event Study	Indirect ties are associated with a technology alliance enhance a firm's market value when the alliance is older, the alliance partners are operating in the same country, the alliance is horizontal, the alliance partner's portfolio size is large, and the alliance portfolio of the partner is not highly overlapping with the current alliance with the focal firm.
8	**Breslin et al. (2021) - IMM**	Innovation ecosystems	Conceptualize the innovation ecosystem phenomena and explain the coevolutionary rules that define the interactions among the actors in a network.	The ecological metaphor	Ecological metaphor to develop a theory of innovation ecosystem	Redefined the concept of innovation ecosystem to mean a complex adaptive system and explained the rules that define the interactions among its actors and how innovation alter these rules.
9	**Brink (2017) - IMM**	Innovation collaboration between SMEs and large firms	Investigate three different routs (i.e., demand-driven cooperation, supplier-driven cooperation and partner-driven collaboration) for SMEs to collaborate with larger enterprises to contribute to the industry competitiveness.	Literature on innovation collaboration.	Offshore wind farm industry/ Longitudinal case study with follow-up interviews	SMEs contribution to innovation and competitiveness is different within the three routes. In the demand-driven cooperation, it contributes by providing specific knowledge. Its contribution in the supplier-driven cooperation is to collaborate with other SMEs to provide a 'one-stop' SME-supplier-unit. In the partner-driven collaboration, SMEs can collaborate to innovate with large enterprises on equal terms.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
10	**Campbell & Cooper (1999) - IMM**	Downstream alliances	Examine whether collaborating with customers would result in a product that is superior to products developed in-house.	Research on B2B cooperation	Chemical, electronic, and industrial products sectors/ Survey	Products developed through customer alliances did not outperform those developed in-house in terms of the studied performance metrics.
11	**Canhoto et al. (2016) - IMM**	R&D collaborations between industry and universities	Investigate the collaborative R&D projects between universities and firms and factors driving its success.	The service dominant logic approach	Group interviews with UK university researchers and managers.	It demonstrated the types of interaction, resources, and outcomes sought that characterize successful collaborations. Also, several individual, organizational, and external factors are identified that would drive the development of successful collaborative R&D projects between firms and universities.
12	**Chakravarty et al. (2020) - JM**	R&D and product development alliances	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.
13	**Chang (2017) - IMM**	Upstream collaboration	Examine the effects of two integration mechanisms (supplier task involvement and joint planning) on new product and end customer knowledge acquisition, and in turn, the impact of the latter two kinds of knowledge on product innovation performance.	The buyer-supplier gray-box integration approach, knowledge-based view, and agency theory.	Manufacturing firms in China/ Survey	Both supplier task involvement and joint planning have positive impact on product knowledge acquisition. Also, supplier task involvement has positive impact on customer knowledge acquisition, but joint planning has no impact. Both product and customer knowledge acquisition enhance product development performance.
14	**Chiambaretto & Fernandez (2016) - IMM**	Alliance portfolio	Investigate how market uncertainty affects the composition of alliance portfolio, focusing on two dimensions of an alliance composition: the partner type (pure partner vs. competitor) and partner interactions (horizontal vs. vertical vs. mixed).	The resource dependence theory	A longitudinal case study of Air France's alliance portfolio	Under high market uncertainty, firms rely more on competitor alliances and use more horizontal interactions as compared to collaborative alliances and using vertical interactions.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
15	**Clausen (2014) - IMM**	National innovation systems	Study the impact of acquiring knowledge from network partners in foreign countries on the product innovation performance of a firm.	Institutional arbitrage perspective	Secondary survey data	Innovation collaboration with partners in foreign countries is positively and significantly associated with innovation performance.
16	**Clauss & Kesting (2017) - IMM**	University-industry collaborations	Examine the impact of governance mechanisms (relational vs. transactional) on knowledge sharing in university-business collaborations, and in turn, the effect of knowledge sharing mechanisms on the accomplishment of joint goals of partners.	TCE, knowledge-based, & social exchange theory	An online survey among professors in Germany	Relational governance has a positive impact on knowledge sharing and transactional governance has negative impact. Both knowledge combination and co-poiesis have positive impact on joint goals achievement and learning has negative impact.
17	**Corsaro et al. (2012) - IMM**	Innovation network	Explore the relationship between three different network configurations (believers, seekers, and doubters) and value outcomes for the network's actors.	The resource-dependency theory and literature on business networks.	High-technology entrepreneurial firms in an innovation network/ Case study.	The same innovation network can contain different network configurations that interact with each other to create value. Value outcomes are different for different network configurations and value recipient.
18	**Corsaro et al. (2012) - IMM**	Innovation network	Develop a conceptual framework to identify the sources of heterogeneity among network actors that might impact the co-development of innovation.	Extant studies on innovation networks	Conceptual paper	Six relevant attributes of actors' heterogeneity are identified to be goals, knowledge bases, capabilities, perceptions, power, and culture. These features are prone to modify overtime as a result of interactions among the network actors.
19	**Cremer & Loebbecke (2020) - IMM**	Innovation network	Investigate the relationships between cultural looseness (i.e., the social norms strength and sanction degree within societies) and innovation performance of innovation networks.	Literature on innovation networks	Firms from 61 countries/ secondary survey data	Cultural looseness positively affects innovation both directly and indirectly through its impact on knowledge depth and knowledge breadth.
20	**Cui & O'Connor (2012) - JM**	Alliance portfolio/ multiple marketing, manufacturing, and/or R&D alliances	Investigate the impact of alliance portfolio resource diversity on firm innovation by examining the moderating role of several factors along three dimensions, namely: the composition of an alliance	Literature on alliance portfolio	A sample of the Fortune 1000 companies in several industries/ Secondary survey and archival data	Resource diversity of alliance portfolio enhances a firm's innovation performance only under some conditions including having majority control of alliances and possessing alliance management capability.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
			portfolio, alliance management, and the market environment.			
21	**Dan & Zondag (2016) - IMM**	Upstream alliances	Predict alliance termination propensity based on characteristics of partnering firms.	The exploration-exploitation framework	The biopharmaceutical industry/ Archival method	A high perceived future value of an alliance reduces the hazard of its termination. In contrast, high market density and strong technological intensity of partners increase the termination propensity. While product market diversity has a bell-shaped relationship with the propensity to terminate an alliance.
22	**Daniel et al. (2002) - IMM**	Industry-University research consortia	Examine how the technology transfer behavior might mediate the relationship between the research capacity of research collaborations and their outcomes in terms of satisfaction and commitment	Services marketing theory	The national science foundation's industry university cooperative research centers program/ Secondary survey and archival method	As the research capacity of a research center increases, a participant's propensity to share and transfer knowledge and technology increases. In turn, this technology transfer behavior has a positive relationship with the participant's satisfaction and commitment to continue the relationship.
23	**Du (2021) - IMM**	R&D collaboration	Study the interaction between the different technological fields of a firm (core, related non-core, and distant non-core technologies) and collaboration governance mechanisms (selective, contingent, and orchestrated openness) and its impact on innovation performance of the firm.	Literature on R&D collaborations.	A large multi-national, multi-divisional global manufacturing firm/ Archival data	As compared to alliances in core and distant non-core technologies, related non-core technological collaborations are associated with the highest innovation performance. While there are no significant differences in innovation performance between collaborating with market-based versus science-based partners.
24	**Einola et al. (2017) - IMM**	International R&D collaborations	Conceptualize the retrospective relational sensemaking construct and study its mechanisms in the context of international R&D collaborations.	Sensemaking theory	Two Swedish multinational companies/ Comparative case study	The study provided a framework for the relational sensemaking process between international R&D collaboration partners. It found that low performance in the early stages of the partnership triggers retrospective relational sensemaking.
25	**Eng & Ozdemir (2014) - IMM**	International R&D alliances	Study the impact of the integration of intra- and inter-firm activities on new product development performance.	Resource dependency & contingency theories	Electronics manufacturing firms in China/ Survey	Product newness has no significant impact on the level of integration of a firm's R&D with its partner's R&D, but R&D distance between partners has a

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
						positive impact and R&D experience has a negative effect. Moreover, the cross-functional integration between R&D, marketing, and production enhances NPD performance of products with high (low) levels of newness in the initial stage of development (engineering validation test stage). While interfirm R&D integration is important for the engineering validation test stage (initial stage) for products with high (low) levels of newness.
26	**Eslami et al. (2018)- IMM**	Downstream co-product development projects	Examine the change in knowledge integration mechanisms implemented by a collaboration's partners over the different phases of a product development process.	Literature on collaborative product development	The capital goods industry/ Case study	Knowledge integration mechanisms employed by partners change based on the interaction between the phase of the product development, the content (tacit vs. explicit) of knowledge, and the source of knowledge.
27	**Estrada et al. (2016) - IMM**	Horizontal alliances	Investigate the impact of collaborating with competitors on product innovation performance.	Capability-based view & TCE	Flemish firms/ Survey	Collaborating with competitors enhances innovation performance only when a firm deploys internal knowledge sharing and formal knowledge protection mechanisms.
28	**Fang (2008) - JM**	Downstream alliances	Study the effect of two dimensions of customer participation (i.e., customer participation as an information resource and customer participation as a codeveloper) 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.
29	**Fang et al. (2008) - JAMS**	Downstream alliances	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	General machinery, electrical & electronic machinery, and transportation	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

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
					equipment industries / Survey	invested by both the customer and supplier.
30	**Fang et al. (2016) - JMR**	Ego (direct network of partners) and global network (indirect connections in an industry)	Investigate the effect of a firm's position in a global network on its incremental and breakthrough new product launches with moderating the firm's ego network and R&D capability.	Prior studies on alliance networks and innovation	The consumer-packaged goods (CPG) industry/ Archival method	A central position of a firm in a global network improves incremental new product launches but hurts breakthrough launches. The firm's collaboration with diverse partners in the ego network can mitigate the negative impact of its central position on its breakthrough innovation. While its R&D capabilities would enhance the gains for its incremental innovation.
31	**Fang et al. (2015) - JM**	Downstream partnerships	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 economics	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. While there was no significant moderating effect of market competitiveness.
32	**Goduscheit (2014) - IMM**	Inter-organizational innovation projects	Explore the role of innovation (power, expert, process, and relationship) promotors in loosely coupled inter-organizational innovation projects.	Prior studies on innovation promotors.	Danish companies/ Case studies	The division of labour between various innovation promotors is more challenging in inter-organizational, as compared to intra-organizational, innovation projects.
33	**Greco (2020) - IMM**	Alliance portfolio	Investigate the impact of alliance portfolio diversity on innovation abandonment, compare the effect of different types of alliance partners on innovation abandonment, and examine the relationship between foreign versus domestic alliances and innovation abandonment.	Research on collaborations and innovation abandonment	Italian manufacturing firms/ Secondary survey	Collaborating with diverse firms reduces innovation abandonment. While there is no significant difference between the effect of vertical versus horizontal alliances on innovation abandonment. In contrast, cross-border collaborations are associated with greater innovation abandonment than domestic alliances.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
34	**Greco et al. (2019)- IMM**	Downstream innovation collaboration	Explore how virtual technology (videoconferencing) enhance customer engagement in supplier-customer collaborations.	Social networking theory	Biotech SMEs/ In-depth interviews	Videoconferencing is a useful tool for customer engagement as it helps building and maintaining trusting relationships. It is effective in technical exchanges, but not effective in close exchanges that aim at building personal relationships or in complex technical exchanges.
35	**Harmancioglu et al. (2019) - JAMS**	International co-development alliances	Investigate 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.
36	**Ho & Ganesan (2013) - JM**	Horizontal collaborations between suppliers of an OEM	Examine the impact of knowledge base compatibility between collaborating suppliers on knowledge sharing intentions, and the moderating roles of customer participation and customer value in this relationship.	TCE	MBA students & Technology-based companies/Lab experiments & survey	The compatibility of knowledge base between suppliers positively impacts supplier knowledge sharing intentions when both customer participation and customer value are high.
37	**Huikkola et al. (2013) - IMM**	Downstream R&D collaborations	Explore the relational practices that facilitate joint learning between partners in R&D collaborations.	Evolutionary economics and dynamic capabilities perspective.	Finnish companies/ Case studies	Joint learning is facilitated by investments in relational information systems, relational capital, and physical proximity of partners.
38	**Hurmelinna-laukkanen & Nätti (2018) - IMM**	Innovation networks	Investigate the roles of orchestrator type and capabilities in innovation networks	Research in network management and orchestration	Conceptual study	Different types of orchestrators master different capabilities that enable them to carry out certain activities in different ways.
39	**Inigo et al. (2020) - IMM**	Innovation networks	Study the impact of two alliance capabilities (alliance proactiveness and alliance portfolio coordination) on radical and incremental sustainability-oriented innovation (SOI) of a firm.	Prior studies on innovation systems and collaborations.	Spanish companies/ Survey	Alliance proactiveness is positively related to radical SOI and alliance portfolio coordination is positively associated with incremental SOI. The interaction between both alliance capabilities positively affects radical SOI.
40	**Jakobsen (2020) - IMM**	Horizontal R&D alliances	Explore how firms manage tensions related to power and dependence in a R&D horizontal alliance over time.	Literature on R&D collaborations.	Longitudinal case study	At the early stages of a partnership, firms depend on structural dependence to manage tension. Over time, they build psychological dependence through trust and generosity.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
41	**Kandemir et al. (2006) - JAMS**	Product development alliances	Examine the relationship among alliance orientation, alliance network performance, and market performance.	Dynamic capabilities view	American High-tech companies/ Survey	Alliance orientation enhances alliance network performance, which in turn improves market performance.
42	**Khamseh et al. et al. (2017)- IMM**	Development alliances	Study the impact of the learning approach that a firm adopts to learn from a partner and the level of the partner similarity on the firm's utilization of knowledge acquired from that partner.	Organizational search and learning perspectives	French companies operating in several industries/ Mixed methods (survey & archival method)	Exploring external knowledge enhances the benefits that a firm gets from it. While the dissimilarity between partners' knowledge bases has an inverted U-shaped relationship with the utilization of a partner's knowledge.
43	**Kreye & Perunovic (2020) - IMM**	Innovation networks	Explore the relationship of inter-organizational relationships and performance of publicly funded innovation networks.	Prior studies on innovation networks.	The Nordic maritime industry / Longitudinal case study	There are three patterns of inter-organisational relationships (functional, dysfunctional, and anarchic) and each of them has different impact on the performance of the innovation network.
44	**Laage-hellman, Landqvist, & Lind (2018) - IMM**	Downstream product development collaborations	Analyze how technology-based, start-up companies develop and manage product development collaborations with customers.	Industrial network approach	A technology-based, start-up company/ Case study	Five aspects impact the effectiveness of the collaborations that include early customer involvement, partner selection, application area selection, the external network, and the internal organization of the partnership.
45	**Lam & Chin (2005) - IMM**	Vertical NPD collaborations	Identify the key success factors of conflict management in NPD collaborations.	Literature on conflict management and NPD alliances.	The analytic process hierarchy method	Out of the 13 factors identified, communication management, trust, and commitment to the partnership are the most critical factors for conflict management success in NPD collaborations.
46	**Lee & Chang (2014)- IMM**	R&D and Marketing alliances	Examine how the alignment between R&D and marketing across firms might affect firm performance	Inter-organizational relationships literature	Diverse High- and low-tech industries/ Archival method	A high-tech firm may gain greater profitability when it focuses on R&D both internally and externally. In contrast, A low-tech firm would achieve greater performance if it invested in R&D (marketing) internally and established marketing (R&D) alliances.
47	**Lee (2011) - JM**	Technological partnership portfolio	Investigate how the alignment of contract terms of technological partnerships might impact the outcomes of collaborations to a firm.	Inter-organizational 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.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
48	**Leminen et al. (2020) - IMM**	Open innovation networks	Explore change processes in living labs, a form of open innovation networks, and the facilitating factors of changes in these networks.	Network perspective	Urban development living labs in a Northern European city/ Case study	There are six processes of change in open innovation networks, namely: expansion, reinforcement, focusing, unification, termination, and recurrence. These processes can be enhanced by three network boosters (i.e., needs, data, and operations) that support the development of a network.
49	**Li et al. (2022) - IMM**	Upstream innovation collaborations	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 and the motivation-opportunity-ability framework.	Chinese companies/ Survey	The back-box supplier involvement impacts the supplier's contribution to innovation only when the suppler perceive relationship benefits from the collaboration.
50	**Liu et al. (2020) - IMM**	NPD networks	Explore how firms in NPD networks learn through direct and indirect relationships.	The knowledge-based, practice-based and relational-governance approaches.	Multiple case studies	Along the different phases of the NPD process, network firms are involved in four learning modes.
51	**Luo et al. (2007) - JMR**	Horizontal alliances with rivals	Examine the impact of competitor alliances on the financial performance of focal firms	Research on horizontal alliances	Diverse high- and low-tech industries / Mixed methods (survey & archival method)	Moderate intensity of competitor alliances would enhance firm profitability, while a high (or low) intensity might have a negative impact.
52	**Luzzini et al. (2015) - IMM**	Upstream product development collaborations	Investigate the impact of supplier collaboration, strategic sourcing, and purchasing knowledge on innovation performance.	RBV and dynamic capabilities.	Companies in Europe and North America/ Survey.	Innovation strategy motivates supplier collaboration which in turn enhances innovation performance.
53	**Markovic et al. (2020) - IMM**	Horizontal and upstream innovation collaborations	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.
54	**Melander & Lakemond (2015) - IMM**	Upstream NPD collaborations	Investigate governance mechanisms (relational and transactional) in NPD collaborations with suppliers.	TCE	Multiple case studies	In technologically uncertain collaborations, relational and transactional governance issues are separated between different entities (R&D and purchasing) in a firm.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
55	**Munksgaard et al. (2012) - IMM**	Innovation networks	Examine sources of conflict in NPD networks and their impact on a firm's innovation strategies.	Literature of conflict and NPD networks.	The food industry/ Multiple case studies	The conflict in innovation networks is likely to result from the partners' differences in defining and negotiation the product development tasks. For a network to achieve innovation, the strategic intentions of the multiple partners need to be integrated.
56	**Najafi-Tavani et al. (2018) - IMM**	Innovation networks	Study the mediating role of product and process innovation capabilities in the relationships between each of innovation networks and absorptive capacity and new product performance.	RBV and organizational learning theory	Iranian high and medium technology manufacturing industries/ Survey	Innovation networks have a significant relationship with product and process innovation capabilities only in the presence of absorptive capacity. While product and process innovation capabilities have a positive impact on new product performance.
57	**Navío-marco et al., (2019) - IMM**	Horizontal innovation collaborations	Examine the relationship between horizontal alliances and innovation and the effect of the geographical distance between partners on this relationship.	Literature on coopetition	Firms in Germany/ Secondary survey	German firms are less likely to collaborate with domestic, as compared to international, competitors to innovate new products.
58	**Nissen et al. (2014) - IMM**	Public–Private innovation partnerships	Study the interaction modes (collaboration and cooperation), and how heterogenous teams use them to share knowledge and progress in innovation processes.	Literature on group learning.	Multiple case studies.	Teams that can balance the collaboration and cooperation forms of interactions to share knowledge continuously would achieve progress in innovation processes.
59	**Noordhoff et al. (2011) - JM**	Downstream vertical partnerships	Investigate 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.
60	**O'Malley et al. (2014) - IMM**	Innovation networks	Explore the relationships between organizational identity and radical innovation in innovation networks.	Prior studies on organizational identity and innovation.	The Irish pharmaceutical industry/Case study.	Organizational identity impedes collaborating for radical innovation.
61	**Ozdemir et al. (2017) - IMM**	Vertical alliances with suppliers and research institutions, and	Examine how different types of alliances might help firms in developing responsive vs. proactive market orientation that, in turn, may enhance firm performance	Organizational learning perspective	Turkish firms operating in high-and medium technology industries/ Survey.	Horizontal alliances enhance the responsive market orientation of firms, while vertical alliances with research institutions improve their proactive market orientation. Also, both responsive and proactive market

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
		horizontal alliances				orientations have a positive impact on new product performance and firm financial performance.
62	**Park, Srivastava, & Gnyawali (2014) - IMM**	Horizontal innovation collaborations	Investigate the effect of the intensities of competition and cooperation between alliance partners on innovation performance.	Literature on Coopetition.	The semiconductor industry/ Archival data	The intensity of each of competition and cooperation has an inverted U-shaped relationship with innovation of the focal firm. While balanced coopetition (high cooperation and moderate high competition) enhances innovation performance.
63	**Perks & Moxey (2011) - IMM**	Innovation networks	Explore how collaborating firms might divide and share tasks and resources to enhance product innovation in a network.	The RBV	The mobile telecommunications industry/ Case studies	When lead firms control the tasks and resources within the network to achieve efficiency, they will enhance their innovation performance, but this approach would render the network unutilized for innovation. While when a lead firm devises mechanisms to share tasks and resources within a network, all partnering firms will participate in enhancing a network-level innovation.
64	**Perks (2000) - IMM**	Horizontal Partnerships	Investigate the role of marketing information in collaborative new product development processes.	Research on marketing integration within co-product development	Computer, Automobile, Photocopiers, and Inkjet printer Companies /Case Studies	The nature of resources contributed by partners determines the effective mechanisms for integrating marketing information into the NPD process
65	**Plata et al. (2021) - IMM**	Innovation networks	Examine the relationship between institutional structures and the development of innovation networks.	Prior studies on innovation networks.	Ninety-four countries/ Secondary data	Formal institutions (i. e., public policies and regulatory variables) have positive impact on the development of innovation ecosystems.
66	**Poblete et al. (2022) - IMM**	Innovation ecosystems	Explore the temporary structures in innovation ecosystems and the role of the key actor's orchestration capabilities.	Literature on innovation networks and temporality.	A construction project/ Longitudinal case study	Temporary structures enhance innovation in innovation networks. Deploying orchestration capabilities early in the project increases the potential for joint value creation.
67	**Purchase et al. (2014) - IMM**	Innovation networks	Study the relationship between resource bundles configurations in innovation networks and network success.	Business network literature	A case study & A fuzzy set theory simulation	The interaction between knowledge and financial resources is the greatest determinant of network success.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
68	**Raesfeld et al. (2012) - IMM**	University-industry R&D collaborations	Investigate the impact of resource heterogeneity, user interaction, value chain complementarity, and network stability on application and value creation performance of R&D projects.	The business interaction Model.	Public nanotechnology R&D projects/ Secondary data.	There is an inverted U-shaped relationship between the interaction between network stability, network heterogeneity, value chain complementarity, and user interaction in the R&D partnership portfolios, and both application and value creation performance.
69	**Rampersad et al. (2010) - IMM**	Innovation networks	Examine the factors that influence the effective management of innovation networks from the perspective of diverse participants in these networks.	Network perspective	Australian high technology (information and communications, and biotechnology/ nanotechnology) industries/ Survey	R&D efficiency has a positive relationship with network effectiveness, in all cases studied. While communication efficiency enhances network effectiveness only in the case of biotechnology/ nanotechnology networks.
70	**Reypens et al. (2016)- IMM**	Innovation networks	Study how value is created and captured by stakeholders participating in innovation networks.	Service-dominant logic and stakeholder theory	The health care industry/ Case study	Value creation process consists of three stages: coordination, consultation, and compromise of stakeholders in a network. This process would result in three outcomes: innovation, knowledge, and relations.
71	**Rindfleisch & Moorman (2001) - JM**	Vertical & horizontal alliances	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.
72	**Rindfleisch & Moorman (2003) - JMR**	Vertical and horizontal alliances to develop and/or commercialize new products	Study the impact of new product alliances on a firm's level of customer orientation	Research on interfirm cooperation	U.S. Companies/ Longitudinal survey.	Collaborating with competitors tends to negatively affect a firm's level of customer orientation over time. This negative impact may be attenuated if the alliance was monitored by a third-party, or there were strong relational ties among partners.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
73	**Servajean-hilst, Donada, & Benmahmoud-jouini (2021) - IMM**	Downstream innovation alliances	Examine the effect of vertical innovation partnership types (free, project-based, elaborated, and exclusive) on relational performance directly and through relationship atmosphere (trust, interdependence, and familiarity).	Industrial Marketing and Purchasing studies	French companies/ Survey	There is no direct relationship between vertical partnership types and performance. Trust positively mediates the relationships between each of project-based and exclusive partnerships and performance.
74	**Sivadas & Dwyer (2000) - JM**	NPD alliances	Develop a new construct, cooperative competency, and examine its impact on NPD success.	Institutional economics	Semiconductor industry & Health care sector/ Survey	Cooperative competency (trust, communication, and coordination) is important for the success of the NPD process, regardless of whether it was an internal or collaborative process.
75	**Sivakumar et al. (2011) - JAMS**	International innovation alliances	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 & RBV	U.S. pharmaceutical Companies/ Archival data.	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.
76	**Skippari, Laukkanen, & Salo (2017) - IMM**	Innovation collaboration	Understand how cognitive basis of supply chain members affect the generation of collaborative innovation between them.	Prior studies on innovation collaborations.	The packaged consumer goods supply chain/ Case study.	The generation of collaborative innovation depends on the nature of the relationships among the supply chain members and the managers' perceptions about the value of these relationships.
77	**Smals & Smits (2012) - IMM**	Upstream alliances	Explore why suppliers would be willing to invest in their customers' innovation endeavours.	Relationship-value perspective	High-tech industries/ Case studies	Suppliers can experience direct (financial returns) and indirect (knowledge, competencies, and good reputation) value from collaborating in their customers' innovation activities.
78	**Smirnova et al. (2018) - IMM**	Innovation collaborations	Study the impact of relational learning on firm performance through the timing of innovation collaboration.	RBV and dynamic capabilities.	Russian firms/ Survey.	Relational learning enhances innovation collaboration in both early and late stages. Yet, innovation in late stage only has a positive impact on firm performance.
79	**Statsenko & Zubielqui (2020) - IMM**	Downstream collaborations	Investigate the impact of customer collaboration on service and market diversification and innovation performance.	The resource-based view and dynamic capability literature	Mining equipment, technology and services firms in South Australia/	Customer collaboration has no direct impact on innovation performance. However, it has an indirect impact

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
					Survey and Case studies.	through service and market diversifications of service firms.
80	**Tracey et al. (2014) - JM**	Clustered networks	Examine the relationship between cluster configurations and governance mechanisms and their impact on new product outcomes	Social network theory	Conceptual framework	The interaction between dense clusters and relational governance would enhance product novelty, while the interaction between centralized clusters and hierarchical governance would increase speed to market.
81	**Winkelbach & Walter (2015) - IMM**	Science-industry R&D projects	Investigate the moderating effect of absorptive capacity in the relationship between knowledge complexity and value creation in R&D projects.	Literature on knowledge transfer and value creation.	R&D projects between firms and public research centres/ Survey.	High levels of absorptive capacity and prior knowledge enhance the impact of complex knowledge on value creation.
82	**Wu (2014) - IMM**	Horizontal alliances	Examine the impact of cooperation with competitors in R&D activities on a firm's product innovation and the moderating roles of technological capabilities and research collaborations.	Research of dynamic coopetition	Chinese firms operating in several industries/ Survey	Collaborating with competitors has an inverted U-shaped relationship with product innovation and this relationship is negatively moderated by technological capabilities and collaborations with research institutions.
83	**Wu et al. (2015) - JAMS**	Horizontal collaborations	Study stock market reaction to horizontal NPD collaborations in different development stages: initiation, development, and commercialization.	Research on interfirm collaboration	Public companies in China/ Event study	Horizontal collaborations in the initiation phase generate positive abnormal returns, while collaborations in the development and commercialization phases hurts it.
84	**Wuyts et al. (2004) - JM**	Portfolio of upstream R&D agreements	Investigate 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.
85	**Xu et al. (2021) - IMM**	Horizontal innovation collaborations	Examine the effect of interfirm coopetition and collaborative innovation performance directly and through interfirm knowledge creation.	The knowledge creation theory.	Chinese high-tech firms/ Survey.	Interfirm coopetition positively impacts collaborative innovation performance directly and through interfirm knowledge creation.

No.	Study-Journal	PDC Type	Research objective(s)	Theoretical perspective	Empirical context/ Methods	Key findings
86	**Yami & Nemeh (2014) - IMM**	Horizontal innovation collaborations	Explore which form of coopetition (dyadic vs. multiple) is more effective for which innovation type (incremental vs. radical).	Previous studies on coopetition and innovation.	The wireless telecommunication sector in Europe/ Case study.	Dyadic coopetition is more appropriate for incremental innovation and multiple coopetition suits radical innovation more.
87	**Yeniyurt et al. (2014) - JAMS**	Upstream collaborations	Study factors that drive suppliers' attitudes toward co-innovation with customers and the impact of the co-innovation behavior on the innovation and sales performance of customers as well as the sales performance of suppliers	The social exchange theory	The North American automotive industry/ Survey and secondary data	Drivers of suppliers' attitude towards co-innovation activities are supplier–buyer communication and inter-dependence, suppliers' anticipated long-term returns, and suppliers' trust of a buyer. The co-innovation behavior enhances performance of both partners (customers and suppliers).
88	**Ylimäki (2014) - IMM**	Vertical product development collaborations	Analyze transitions in collaboration types according to emerging needs of partners.	Literature on product development collaborations.	A longitudinal case study.	Developed a dynamic framework that explain the changes in collaboration types and their causes. These transitions can take place in the same collaboration without terminating the partnership.
89	**Yu et al. (2021) - IMM**	Innovation networks of green products	Explore the mechanisms of trust-building among multiple actors in innovation networks for developing green products.	Previous studies on trust and collaborations.	The digital infrastructure in China / A longitudinal case study.	Identified innovation in peripheral components incremental and radical innovation in core components as the three stages of a collaborative NPD process. And presented the trust measures relevant to each of these stages for each stakeholder.
90	**Zhang et al. (2022)- IMM**	University-industry alliance portfolio	Study the impact of an alliance portfolio's depth and breadth on firm growth with moderating government subsidies.	Previous studies on alliance portfolio.	New technology-based firms/Archival data.	A portfolio depth (breadth) has a negative (positive) impact on firm growth.
91	**Zhao et al. (2020) - IMM**	Horizontal innovation alliances	Examine the effect of firms' operational routines, technological, and organizational responsiveness heterogeneities on relationship embeddedness and innovation development.	The dynamic capability perspective.	The Chinese cell phone companies/ survey	Operational routines and organizational responsiveness heterogeneity have positive impact on innovation development, but negative effect on relationship embeddedness. While technological heterogeneity has positive effect on both innovation development and relationship embeddedness.

Appendix (B): Selected Marketing Studies on Functional Capabilities and Firm Performance:

Study	Capabilities studied as IV	Other main variables	Theoretical lens	Performance aspect	Capabilities measurement	Context/ Method	Relevant Findings
Dutta et al. (1999)	Marketing, R&D, and operations capabilities and their interactions	N/A	The Resource-Based View (RBV)	Firm profitability	Stochastic Frontier Estimation (SFE)	Semiconductor firms/ Archival data	The interaction between marketing and R&D capabilities has the most significant impact on firm performance.
Feng et al. (2017)	Marketing, R&D, and operations capabilities & their interaction	Munificence & Competitive dynamism	The contingency theory	Firm performance (Revenue growth & Profit growth)	SFE	Several US industries/ Panel data	The relationship between marketing capabilities and firm performance is moderated positively by R&D capabilities and negatively by operations capabilities.
Krasnikov & Jayachandran (2008)	Marketing, R&D, and operations capabilities	Study characteristics (e.g., B2B vs. B2C and US vs. non-US firms)	RBV	Efficiency performance and Market performance	N/A	Meta-analysis	All three firm capabilities have positive impact on firm performance, even though marketing capabilities have the strongest effect among them.
Moorman & Slotegraaf (1999)	Marketing X technological capabilities (their complementarity)	External information	RBV/ economics of information literature	New product outcomes: brand quality improvements & their speeds	Observable outcomes associated with the firm capability	Food products/ Longitudinal quasi-experiment	In the presence of external information, firms with strong marketing and technological capabilities can create (a) more and (b) faster brand quality improvements than their rivals.
Morgan et al. (2012)	Architectural & specialized marketing capabilities	Export marketing strategy implementation effectiveness	The implementation literature	Export market performance & financial performance	Questionnaire	Manufacturing firms in multiple industries / Survey	Marketing capabilities have positive impact on the effective implementation of marketing strategy in export ventures.
Morgan et al. (2009)	Marketing (market sensing, brand management, and CRM) capabilities and their complementarities.	N/A	RBV & dynamic capabilities theory	Profit growth: revenue growth & margin growth	Questionnaire	Multiple US industries/ Mixed methods (survey & secondary data)	There is no significant impact of the marketing capabilities on the overall profit growth rate. Yet, market sensing and brand management capabilities enhance revenue growth rates and CRM capabilities improve margin growth rates.
Mu et al. (2018)	Outside-in Marketing capability	Inside-out marketing capability, strategic	Marketing capabilities literature	Market performance & financial performance	Questionnaire	U.S. technology companies/ Survey	Outside-in marketing capabilities have a positive indirect relationship with firm performance through the inside-

Study	Capabilities studied as IV	Other main variables	Theoretical lens	Performance aspect	Capabilities measurement	Context/ Method	Relevant Findings
		flexibility, transformational leadership, and employee proactivity					out marketing capabilities and strategic flexibility. Also, the relationship between the outside-in marketing capabilities and firm performance is only significant when transformational leadership and employee proactivity are high.
Narasimhan et al. (2006)	Marketing, R&D, and operations capabilities	Absorptive capacity & technological change	RBV	Firm profitability	SFE	Semiconductors and computers firms/ Archival data	The three functional capabilities have a positive impact on the absorptive capacity of the firm, which in turn, is positively associated with higher profitability.
Narasimhan et al. (2006)	Marketing & operations capabilities	Diversification strategy & Efficiency	RBV	Firm profitability	Data Envelopment Analysis	Logistics companies in UK/ Archival data	Both marketing and operations capabilities have a positive impact on firm performance.
Ramaswami, Srivastava, & Bhargava (2009)	Market-based (new product development, customer management, and supply chain management) capabilities	R&D intensity	RBV	Financial performance (ROA, net profit, sales, market share)	Questionnaire	Public and private firms/ Survey	Market-based capabilities have an indirect positive impact on the financial performance of firms through their effect on the processes of new product development, customer management, and supply chain management.
Sok & O'Cass (2011)	Innovation capability	Innovation resources & learning capabilities	RBV	Innovation-based performance	Questionnaire	Manufacturing SMEs in Cambodia/ Survey	The complementarity between innovation resources and innovation capabilities enhances performance.
Song et al. (2007)	Technology, information technology, market-linking, and marketing capabilities	Miles–Snow strategic type	RBV	Financial performance (firm profitability)	Questionnaire	Several industries/ Survey data	Capabilities do not have a main effect on performance. They only impact it when they interact with strategic types.
Yu et al. (2014)	Marketing capabilities	Operations capabilities	RBV	Retail efficiency	Data Envelopment Analysis	Retail firms in UK/ Archival data	Marketing capabilities have no direct significant effect on firm performance, but they have a positive indirect effect through operations capability.

Study	Capabilities studied as IV	Other main variables	Theoretical lens	Performance aspect	Capabilities measurement	Context/ Method	Relevant Findings
Zhou et al. (2014)	Marketing & technological capabilities	Managerial (Political & Business) Ties and Market development	The institutional theory	Return on Assets (ROA)	Questionnaire	Manufacturing firms in China/ Archival data and longitudinal survey	Technological capabilities have a stronger impact on ROA as the market develops from lower to higher levels, whereas marketing capabilities have a persistent impact. Also, as the market develops, marketing (technological) capabilities interact with business (political) ties to enhance ROA.
This study	**Marketing, technological, and operations capabilities and their interactions**	**International PDCs**	**RBV, dynamic capabilities, organizational inertia, and institutional theory**	**Innovation performance (Innov-Perf)**	**SFE**	**High-tech firms participating in innovation collaborations/ Archival data**	**There are curvilinear relationships between capabilities and Innov-Perf. Capabilities interact differently to impact Innov-Perf. International, versus domestic, PDCs have different impact on Innov-Perf depending on the type and level of firm capabilities.**

Appendix (C): Selected Marketing Studies on Product Development Collaborations and Performance:

Paper-Journal	Collaboration	Governance	Performance examined	Capabilities studied	Firm strategy covered	Theoretical lens	Level of analysis	Empirical context/ Method
Bouncken et al. (2016) - IMM*	Downstream Vertical partnerships	Relational and/or formal governance	Innovation performance	None	None	Research on transactional and relational governance	Development alliance	The European Medical device industry / Survey
Boyd & Spekman (2008) - JAMS	Vertical and horizontal alliances	None	Market value of the focal firm	None	None	Inter-organizational relationships (IOR) literature	Indirect ties created by focal firms	Diverse high-tech industries/ Event Study
Eng & Ozdemir (2014) - IMM	International R&D alliances	None	NPD performance (i.e., product effectiveness & process efficiency)	None	None	Resource dependency & contingency theories	Multiple levels	Electronics manufacturing firms in China/ Survey
Fang (2008) - JM	Downstream vertical alliances	None	new product innovativeness & speed to market	None	None	Social network theory	New component development project	General machinery, electrical and electronic machinery & transportation equipment industries / Survey
Fang et al. (2015) - JM	Downstream Vertical partnerships	Equity governance	Market value of both partnering firms	Technologi-cal capabilities	None	Transaction cost economics	Multiple levels	The biotech and pharmaceutical industries/ Event study
Kandemir et al. (2006) - JAMS	Strategic alliances	None	Alliance network performance & market performance of the focal firm	None	None	Dynamic capabilities view	Firm level	American High-tech companies/ Survey
Knudsen (2007) - JPIM	Alliance portfolio	None	Innovative performance	None	None	IOR literature	Main product line of the firm	Five industrial sectors/ Survey
Lambe et al. (2002) - JAMS	Domestic and international horizontal and vertical alliances	None	Joint profits	Alliance manager development capability	None	Resource-advantage theory	Dyadic alliances	US companies forming strategic alliances/ Survey

Paper-Journal	**Collaboration**	**Governance**	**Performance examined**	**Capabilities studied**	**Firm strategy covered**	**Theoretical lens**	**Level of analysis**	**Empirical context/ Method**
Lee & Chang (2014) - IMM	R&D and Marketing alliances	None	Return on Assets (ROA) of focal firm	R&D and Marketing capabilities	None	IOR literature	Firm level	Diverse High- and low-tech industries/ Archival data
Lee (2011) - JM	Knowledge-creating and appropriating interfirm partnerships	Equity sharing vs. non-equity sharing	The number of radical and incremental new drugs approved	None	None	IOR literature	Relationship portfolio	Pharmaceutical industry/ Archival data
Luo et al. (2007) - JMR	Horizontal alliances with rivals	None	Firm profitability (ROE)	None	Competitor-oriented strategy	Resource-Based View	Firm level	Diverse high- and low-tech industries / Mixed methods (survey & archival data)
Noordhoff et al. (2011) - JM	Downstream vertical partnerships	Relational & formal modes (specific investments & formalization)	Focal firm (i.e., Supplier) financial performance	None	None	Research on joint innovation activities	Individual innovation project	Dutch industries / Survey
Rindfleisch & Moorman, (2001) - JM	Vertical & horizontal alliances	None	New product creativity & new product speed	None	None	Social Network Theory	New product alliance	U.S companies /Survey
Sivadas & Dwyer (2000) - JM	Internal NPD teams vs. external alliances	Cooperative competency (trust, coordination, & communication)	NPD success (i.e., quality, speed to market, market share & meeting of target costs)	None	None	Institutional economics	New product projects	Semiconductor industry & Health care sector/ Survey
Tracey et al. (2014) - JM	Clustered networks (i.e., vertical & horizontal)	Relational & formal modes	New product performance (i.e., novelty & speed to market)	None	None	Social network theory	Individual NPD projects	Conceptual framework
Wu et al. (2015) - JAMS	Horizontal collaborations	None	Market value of the focal firm	None	None	Research on interfirm collaboration	NPD project	Public companies in China/ Event study
Zhang et al. (2010) - JIM	Domestic and international alliances	None	Innovative performance of focal firm	None	None	Resource-Based View	Individual Dyad	Diverse industries in Germany/ Survey

Paper-Journal	Collaboration	Governance	Performance examined	Capabilities studied	Firm strategy covered	Theoretical lens	Level of analysis	Empirical context/ Method
Wuyts et al. (2004) - JM	Portfolio of upstream R&D agreements	None	Innovative success & Firm profitability	None	None	Research on interfirm cooperation	Multiple levels	The pharmaceutical industry/ Archival data
This study	**Upstream partnerships (OEM-supplier)**	**Formal governance (JVs, agreements, or licenses)**	**Innovation performance of OEMs (patents, citations, new product announcements)**	**Marketing, Technological, Operations capabilities**	**Product differentiation vs. cost leadership**	**Governance Value Analysis (GVA)**	**Multiple levels (dyad, and firm levels)**	**Diverse high-tech industries/ Archival data**

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

JPIM: The Journal of Product Innovation Management JMR: Journal of Marketing Research JIM: Journal of International Marketing