A study in Cooperative Innovation:

Mediating Role of Innovation Novelty in Innovation Success

and Effect of Cooperating with Foreign vs. Domestic Partners on Innovation Success and Novelty

Hesam Salehihikooei

Supervisor: Elham Ghazimatin

UNIVERSITY OF STAVANGER BUSINESS SCHOOL

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TITLE:

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AUTHOR(S)		SUPERVISOR:
Candidate number:	Name:	
2000	**Hesam Salehihikooei**	**Elham Ghazimatin**
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Abstract

Cooperative innovation is active participation in a joint innovation project with other partners. Cooperative innovation has recently attracted significant attention in the literature; however, it still requires a deeper scrutiny more contemplation to find out its copious aspects and its relationship with other innovation-relevant concepts. In this thesis, I examine how (1) inter-firm cooperation and (2) heterogeneity of the involved firms would lead to innovation success. In examining the hypotheses, I carried out an analysis on 2619 Indian manufacturing firms.

In the first study, I conducted a set of descriptive analyses to depict the details of the variables. I then took the degree of novelty as a mediator and tested whether/how it mediates the relationship between interfirm cooperation and firm's heterogeneity with the innovation success. For the purpose of this study, I performed linear regression model and employed Baron and Kenny test of mediation and confirmed the results with Sobel test. The results revealed that while the degree of novelty does not mediate the effect of inter-firm cooperation on innovation success, it is a partial mediator for the effect of the portfolio heterogeneity on the innovation success that mediates just 7% of this effect. Firm size and the level of export -as control variables- were statistically significant predictors of innovation success. I showed that the other three organizational variables including internal R&D intensity, being a partial firm, and the level of expenditure on technology acquisition are insignificant in my model.

In the second study, I delved into the composition of network portfolio of the firms and examined how the cooperation with foreign vs. domestic firms influence the degree of novelty and the innovation success. Using a seemingly unrelated regression model (SUR), I found that cooperation with foreign and domestic firms increases the probability of achieving higher innovation success. The results show that, cooperation with a foreign firm can increase the sales of firms 5 times more than cooperation with a domestic firm. I did not find any evidence for the effect of domestic cooperation on the degree of novelty. However, the results showed that cooperation with a foreign partner significantly increases the level of novelty of innovation, meaning that it would have a profound impact to help the firm diffuse to the international market.

Foreword

This master thesis finalizes my study in MSc in Business Administration, specialized in Strategic Marketing and Analytics. The thesis concentrates on cooperation in innovation activities and tries to contribute to the literature in two ways. First I have examined the mediating role of innovation novelty in the effect of both cooperation and partners' portfolio on innovation success. The models in this part also include five control variables that represent firms' background specifications. Second, I contemplated the contribution of cooperation with foreign and domestic partners on innovation success and novelty. In brief, the result related to the mediating effect of innovation novelty is the main contribution of the thesis to the literature as the issue was not scrutinized in the literature. Regarding the other parts, some results are aligned with previous studies while some are in contradiction with other bodies of research.

I would like to express my sincere gratitude to my advisor Elham Ghazimatin for her continuous support, patience, motivation, enthusiasm, and immense knowledge. Definitely, the thesis suffers from several drawbacks that are due to my own lack of proficiencies. I gratefully thank my dear compassionate wife, Hediyeh, and my warmhearted son, Mohammad who have supported me spiritually and kindly tolerated the hard times of my study. My special thanks also go to my dear cousin, Chavoosh for all his support and motivation.

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1. Introduction

Economists started their systematic empirical approach towards innovation since the 1960s (Freeman, 1991). Innovation has become the main driver of firms' growth for which firms should have a holistic understanding of its antecedents in order to achieve higher performance and better results out of it (Kamasak, 2015). The success of innovation activities is highly dependent on accessing the necessary resources including R&D activities, bodies of knowledge, technologies, etc. (Miotti & Sachwald, 2003). Recent swift technological developments and knowledge creation practices have resulted in the necessity of access to a wide range of substantial resources that can be barely found entirely in a firm (Fischer & Varga, 2002). The variety and complexity of required knowledge for innovation make the firms unprecedentedly dependent on external resources for their innovation activities (Fagerberg, 2004).

Inter-firm cooperation is a significant source of knowledge and resources for organizations which can appear in the form of strategic alliances among multiple firms (Hitt et al., 2011). It facilitates organizational learning and provides access to knowledge and resources that are otherwise unavailable to either of the involved firms (Fischer & Varga, 2002). This cooperative approach has leveraged the R&D and innovation in the firms as well. Firms' cooperative arrangements for their innovative activities have led to the concept of *cooperative innovation* to be emerged (Tether, 2002). Besides the knowledge acquisition benefits, firms can obtain synergies by replacing competition with cooperation (Chandy and Tellis, 1998).

Previous bodies of research contemplated the existence of cooperative arrangements as well as the diversity and composition of the partners in innovation activities of firms (Teece, 1992). The literature reveals the disparate effects of cooperation with domestic and foreign partners and it has largely examined alliances among external firms, customers, suppliers, research institutes and universities, consultants, and government (e.g., Freel & Harrison, 2006; Tether, 2002; Whitley, 2002). Several studies have also considered vertical (i.e. cooperation within the supply chain) vs. horizontal (i.e. cooperation with competitors) form of cooperation (e.g., Fischer & Varga, 2002).

Despite the existing literature, the implications of cooperation for innovation initiatives and comparison between countries is a subject of further research (Carvalho et al., 2015). Tether (2002) also recommends speculating *who cooperates for innovation and why* across different countries. It is also important to study how cooperation for innovation works and try to identify possible patterns among its determinants (Carvalho et al., 2018). Following the recommendations of this literature, in the current thesis, I delve into the nature of cooperative innovation and shed some light on the process through which cooperative

innovations and heterogeneity of firm's portfolio lead to a great number of innovations. For the purpose of this study, I use *Enterprise Survey* and *Innovation Follow-up* data provided by the World Bank to test hypotheses. The data is output of a survey that was carried out among the Indian manufacturing firms in 2013-2014. India with its large and growing economy has a vast variety of innovation and R&D initiatives. Nowadays, many multinational corporations are motivated to outsource a substantial part of their R&D activities to India (Tellis et al., 2008).

Shedding light on mediation effect is important as it is often a key part of a causal model and helps understand the mechanisms of interdependence among parameters. I test the mediation role of novelty through two causal effects including: (1) the effect of inter-firm cooperation on the innovation success, and (2) the effect of firm's portfolio heterogeneity on innovation success. Five organizational measures are also used as controlling variables of firms' background specifications. Jointly with the main idea of the thesis and to have some detailed depiction of the influence of cooperation portfolio composition, I have also investigated the effect of cooperation with foreign and domestic firms on innovation success and degree of novelty.

The thesis is structured as follows. Section 2 provides an introduction to the background literature and focuses on reviewing some relevant studies about innovation, cooperative innovation, absorptive capacity, innovation success, cooperation network, and degree of novelty. Then I review the resource-based theory as the focal theory that the thesis is constructed on. Section 3 discusses the method of analysis, the data I have used, variables, hypotheses, and descriptive analysis of relevant variables. In section 4, I report the results of the analysis and discuss the analysis outputs. Finally, section 5 concludes the main contributions of the thesis and indicates suggestions for further studies.

2. Literature Review

2.1. Innovation

Innovation has a critical role in contemporary economy as it is an essential initiative in individuals' living improvement, firms' success, and nations' wealth creation. Considering the firm level, investment in R&D and innovative activities is a prerequisite for firms' survival in the competitive market (Tellis et al., 2008).

In the 1960s innovation was referred to mostly as a process and introduction to change (Cumming, 1998). Until the early 1970s, almost all the studies were focused on innovations and their technical success in

idea implementation (Freeman, 1991). In early 1970s a new approach toward innovation started to emerge in which innovation takes place when the process of idea generation is brought into commercial use successfully (Cumming, 1998). Nowadays, innovation has become a cross-disciplinary subject that a single discipline cannot delve into all its aspects. That is why a combination of insights from various disciplines is necessary for having a realistic view of the innovation, (Fagerberg, 2004).

Baregheh, Rowley, and Sambrook (2009, p. 1334) propose a definition of innovation through a content analysis of 60 definitions of innovation in the literature: "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services, or processes, in order to advance, compete and differentiate themselves successfully in their marketplace". This definition frames innovation based on the level of novelty through which a firm improves its value proposition.

Based on the current literature, four types of innovation can take place at the organizational level, including product, process, marketing, and organizational innovation (Cristo-Andrade & Franco, 2019). Although Kahn (2018) adds two more types of business model and supply chain innovation as well. *Product innovation* refers to introduction of a totally new or modified product or service to the market (Un et al., 2010). As the technologies are changing dramatically, existing products in the market become obsolete. This reality justifies the need for product innovation to replace or improve current products (Cooper & Kleinschmidt, 1987). Process innovation entails changes in production methods and operations to increase the production performance and enhance productivity (Reichstein & Salter, 2006), particularly by reducing the production costs (Boone, 2000) and economy of scale (Frishammar et al., 2012). The concept of process innovation is mainly discussed in manufacturing and production sector (Frishammar et al., 2012). *Marketing innovation* deals with employing new channels to connect with customers that can also include more sophisticated promotional efforts (Kahn, 2018) and leads to higher levels of firm's competitiveness (Gupta & Malhotra, 2013). This definition reveals that like process innovation, the output of marketing innovation is not something that could be sold directly to the customers. Unlike the other types of innovations, Levitt (1960) believes that marketing innovation is not an organization's systematic effort towards a set goal. Rather, marketing innovation emerges thoughtlessly during the firm's activities. Organizational innovation refers to improvements in organizational structure and management (Kahn, 2018). It is adoption of a new organizational behavior (Damanpour, 1996). Lam (2004) argues that organizational innovation is a prerequisite for other types of innovations, especially technological innovations.

Studies have already incorporated various typologies for innovation from different perspectives. On one hand, innovations can be categorized as radical and incremental (Chandy & Tellis, 2000). It is one of the most common theoretical typologies in the literature in which the distinction between radical and incremental innovation is mainly based on the newness of the technology, either exploited in the production process or offered to the users (Ettlie et al., 1984). While incremental innovations are fulfilled based on the current technology, radical innovations deal with sophisticated technologies that require more marketing skills and offer more benefits for users (Chandy & Tellis, 1998). Innovation is perceived as radical if it demonstrates distinction to existing products in two dimensions: incorporation of substantially different technology and better fulfillment of essential customer needs (Chandy & Tellis, 1998). These two types of innovations are not a substitute for each other. The firms that have a high amount of radical innovations show also a high tendency to have incremental innovations (Sorescu et al., 2003).

Jorde and Teece (1990) have also proposed two distinct models for innovation processes. The *Serial Model* is the traditional description of innovation that considers innovation as a stage-gate process (Jorde & Teece, 1990). This linear predictable model cannot address incremental innovations. On the contrary, the *Simultaneous Model* depicts innovation as an incremental process in which novelty is built upon previous achievements. In this model innovation is not a stage-gate process, but rather a continuous process of correction based on feedbacks (Jorde & Teece, 1990). Simultaneous model recognizes all the organizational linkages in both intra-organizational (internal) and inter-organizational (external) through which the organization should react quickly to the market for its innovation purposes. It proposes that an effective innovation process necessitates external cooperation to provide the organization with its required complementary resources (Jorde & Teece, 1990).

2.2. Inter-firm Cooperation

Cooperation is an agreement between two or more participants through which they "take responsibility for a task or series of tasks and information is shared between the parties to facilitate the agreement" (OECD/Eurostat, 2018). Hence, partners cooperate to fulfill a task and obtain mutual benefits (Li et al., 2017). Cooperation has increasingly become a strategic resource for firms as it encompasses establishing partnerships and alliances (Hitt et al., 2011). In order to have efficiency in the value creation system, cooperation with partners beyond the boundaries of the firms has become essential (Walters & Rainbird, 2007). Considering the rapidly evolving technologies, it is so expensive to have all this complex

knowledge internally (Tether, 2002). That is why cooperation among firms is getting more common. The same implication applies to the context of innovation. To have effective innovating activities firms should take advantage of cooperative alliances (Teece, 1992).

2.3. Cooperative Innovation

The concept of cooperative innovation was first introduced through "a joint R&D effort by five large oil companies and two plant contractors to develop a fluid bed catalytic cracking process for the oil industry in the 1930s" (Freeman, 1991, p. 501). Innovation from the very first days of being studied was perceived as an interactive process (e.g., Von Hippel, 1988). However, it was from the mid-1980s that "distributed forms of innovation" -which refers to strategic technological alliances, cooperative R&D initiatives, and innovation networks- attracted considerable attention (Tether, 2002). Today, cooperation in innovation is a strategic alliance in governance strategy to facilitate innovation (Teece, 1992).

Innovation is a "collective achievement" and has a "systematic nature" (Van de Ven et al., 1999, p. 149). The "collectiveness" and "system" aspect of innovation implies that innovation occurs in a network that encompasses a set of inter-linked actors and not in an isolation. A system in comparison with a network has a more elaborate, coherent and stable structure that facilitates improved interactions (Van de Ven et al., 1999). Also, components of a system have complementarity roles towards each other (Fagerberg, 2004). In this regard, innovation steps beyond current organizational boundaries to seek new innovation-oriented alliances outside the firm and come up with new cooperative structures (Sutton, 1998, p. 118). That is why a cooperative approach towards innovation initiatives is making the firms' boundaries "fuzzy" (Teece, 1992).

External cooperation is important not only for the firms that do not conduct R&D, but also for the firms that have their own R&D activities (Freeman, 1991). External cooperation has a positive effect on organizational innovations because it helps the firm with environmental scanning and knowledge adoption (Damanpour, 1991). A continuous cooperation in knowledge sharing among all the heterogeneous partners can increase the probability of progressing a cooperative innovation (Nissen et al., 2014).

Although cooperation and interactive learning are fundamental in the innovation activities, the existence of a high volume of successful innovations that are not conducted cooperatively implies that cooperation is not a necessary prerequisite for success in innovation (Freel & Harrison, 2006).

2.3.1. Motivations for cooperative innovation

Several studies speculated some of the key reasons of using cooperative innovation. Lack of essential resources (e.g., knowledge) (Cristo-Andrade & Franco, 2019; Tether, 2002), reducing the innovation risks (e.g., spillovers) (Teece, 1992; Tether, 2002), reducing transaction costs (Günther, 2004), and benefiting from economies of scale in joint R&D and/or production (Fischer & Varga, 2002) are among the most common motivations for cooperative innovation.

To derive competitive advantage from the innovation, organizations should be capable of producing a series of innovations. To implement such a strategy, organizations need to establish an organizational architecture to cooperate with external parties especially for knowledge appropriation (Kay, 1993). On the other hand, firms often cooperate with each other in their complex innovative projects to increase their chance to success in those projects (Dachs et al., 2008; Miotti & Sachwald, 2003).

2.3.2. Cooperation and Firm Specifications

Several previous studies contributed to depict the interrelationship between cooperative behaviors of the firms and their background specifications. Miotti and Sachwald (2003) found that firms working on innovations in technologically complex projects tend more to establish cooperative arrangements. As Dachs et al. (2008) claim, the cooperative behavior of firms in high-technology sectors is due to the complexity of the field, its fast generation of knowledge, and rapid changes. The studies have found a direct relationship between the inter-firm cooperation for innovation with size of the firm (Negassi, 2004; Tether, 2002), internal R&D intensity (Miotti & Sachwald, 2003; Negassi, 2004; Tether, 2002), spending more on acquired technologies (Tether, 2002), level of exporting activities (De Faria et al., 2010), and being part of a larger firm (Tether, 2002). These bodies of research consider all types of innovations including product and process.

Firm's size is a classical variable in innovation studies (Tether, 2002). Theoretically, both small and large firms have tendency to cooperate for their innovative activities. While small firms are in lack of internal resources for innovation and need to cooperate to achieve the required innovation prerequisites, larger firms are more likely to be engaged in broader range of innovations that call for external resources and cooperation, particularly with research organizations (Tether, 2002). Majority of previous studies suggest that the intensity of cooperation for innovation has a direct relationship with the size of the firm (Hagedoorn et al., 2000; Negassi, 2004). But Rogers (2004) shows that networking for product

innovation is mainly observed among smaller firms. The size of the firm is supposed also to be a predictor for the innovation success in the firm level, meaning that larger firms are expected to attain higher levels of innovation output (Negassi, 2004). Compared to the cooperation propensity, the effect of firm's size on innovation performance -measured based on the firms' turnover- is significantly more dominant (Negassi, 2004).

The intensity of firm's internal R&D is shown to affect the cooperation propensity of the firms for their innovation activities (Negassi, 2004). The more the firm's internal R&D intensity, the more its tendency to cooperate for innovation (Colombo & Garrone, 1996; Fritsch & Lukas, 2001). Gu et al. (2016) contemplated that not only does internal R&D intensity enhances innovation performance in high-tech SMEs, but also it plays a moderating role between the cooperation network heterogeneity and innovation success. They took the revenue generated from new innovations in the recent three years as the indicator for innovation performance. Internal R&D intensity is also the key indicator of absorptive capacity within a firm (Cohen & Levinthal, 1989). Since absorptive capacity increases innovation performance in the firm, it is concluded that internal R&D intensity has the same considerable effect on the number of joint cooperated patents of the firm as its innovation performance (Lin et al., 2012).

Expenditure on technology acquisition is related to the firm's investment to adopt externally developed technologies in any of the forms of equipment, machinery, and software (Tether, 2002). It is an organizational phenomenon that stretches beyond the firm's borders. Hence, it encompasses external ties and is associated with cooperation, especially in innovative activities. Such alliance shows acquiring some technologies that are more sophisticated than standard technologies. Simultaneously, this type of cooperation reduces the risks associated with new technology adoption (Tether, 2002). External technology acquisition plays also a complementary role for internal R&D activities and fosters it substantially (Cassiman & Veugelers, 2002). Several bodies of research (e.g., Charmjuree et al., 2021; Jeon et al., 2015; Stuart, 2000) have also proved the positive and significant effect of external technology adoption on innovation performance.

Firm's level of export (share of sales that is due to export) is shown to have a direct relationship with the firms' intention to cooperate for innovation (De Faria et al., 2010). It represents the competition intensity that firms deal with in their ecosystem (Abramovsky et al. 2009; Cassiman & Veugelers, 2002). On the other hand, participating in the international market helps firms access more knowledge and enhance their learning process that leads to innovation performance of the firms (Golovko & Valentini, 2011).

Tether (2002) depicts two perspectives of the effect of being part of a larger firm on cooperative innovation. Being part of a group company facilitates accessing the required resources for innovation that obviates the need for external cooperation. But on the other hand, the firm can leverage some part of the power and prestige of its principle group to take advantage of cooperation for innovation purposes (Tether, 2002). The same study illustrates the higher probability of cooperative innovation among group firms rather than independent firms (Tether, 2002). The two above-mentioned perspectives help the group firms to take more out of their innovation activities. Accessing a rich pool of internal resources and strong external cooperation ties are competitive advantage of group firms for which they are supposed to achieve high levels of innovation performance (Frenz & Ietto-Gillies, 2009).

2.4. Innovation Performance and Absorptive Capacity

Absorptive capacity is a key concept in the context of innovation studies. The notion of absorptive capacity was first introduced by Cohen & Levinthal (1989) and further developed by Kamien & Zang (2000). It underlines the importance of some internal knowledge existence for the firms to be capable of adopting external knowledge (Cassiman & Veugelers, 2002). The notion has strong ties with other concepts such as innovation performance, R&D activities, and networking (Cohen & Levinthal, 1990; Fischer & Varga, 2002). Zahra and George (2002, p. 186) define absorptive capacity as "a set of organizational routines and strategic processes by which firms acquire, assimilate, transform, and exploit knowledge for purpose of value creation". The concept is not restricted to knowledge acquisition, but it also encompasses the process of knowledge exploitation (Cohen, & Levinthal, 1990) and determines the level of innovation performance (Jeon et al., 2015). It is a dynamic capability enabling firms to obtain a sustained competitive advantage by acquisition and utilization of required bodies of knowledge (Zahra & George, 2002). The study of Cohen and Levinthal (1990) on organizational R&D activities and absorptive capacities of the firms contributed to the literature in two ways. First, the R&D activities not only generate new knowledge but also can contribute to enhancing the firm's absorptive capacity through which the firms become better learners. Secondly, they showed that firms are sensitive to the environment they operate in. In other words, by investing in R&D, firms can also take advantage of accessible R&D outputs and spillovers of their competitors in the market.

The notion of absorptive capacity lies in the center of the networking approach to innovation (Fischer & Varga, 2002). A firm's network that includes heterogeneous external connections is a diverse portfolio in which it can cooperate effectively to facilitate its innovation activities. The success of cooperation

highly depends on the type of partners and their strategic fit with mutual objectives (Sivadas & Dwyer, 2000). The conflict is more likely to arise when the partners are more similar rather than being complementary in their motives, knowledge, and skills (Sivadas & Dwyer, 2000). Based on the results from the SAPPHO project, successful innovation projects significantly benefited from external sources of knowledge and technology (Freeman, 1991).

Miotti and Sachwald (2003) and Faems et al. (2005) found a direct relationship between inter-firm cooperation and innovation success. They focused on the composition of cooperating partners and try to explain the effect of cooperation on innovation performance through the effects of cooperating with different types of partners. Based on their research, cooperating with customers and suppliers contributes to turnover increase by introducing improved products (named as "exploitative collaboration" by Faems et al. (2005)), while the turnover increase due to cooperating with universities and research institutes is through launching new products to the market (named as "explorative collaboration" by Faems et al. (2005)). All these positive effects of cooperation on innovation success is due to the complementary role of partners for innovative firms. Comparing cooperative and non-cooperative firms in the field of innovation reveals that cooperative firms obtain higher levels of success (Abramovsky et al., 2009) and profit more from R&D (Belderbos et al., 2004). This is because they attract external knowledge and capabilities and share the costs and risks (De Faria et al., 2010).

2.5. Cooperation Networks

Networks can differ based on their content as they are shaped based on the objective they seek for (Fischer & Varga, 2002). The correct choice of partners is a crucial decision to have an effective cooperation for innovation. A suitable partnership is a result of a delicate assessing of a variety of criteria which brings about socio-psychological drivers of constructive cooperation, namely trust, honesty, and responsibility (Cristo-Andrade & Franco, 2019).

Cooperation for innovation can be both vertical and horizontal (Tether, 2002). Teece (1992) defines vertical cooperation within the supply chain, from suppliers to customers, while horizontal cooperation incorporates cooperation among the partners that are competing for the same customers in the same market. Cooperation occurs mostly vertically than horizontally (Fischer & Varga, 2002). Vertical and horizontal cooperation play complementary roles for a successful innovation and its commercialization. Commercialization of innovation incurs a significant cost that a single firm can hardly afford. That is

why a combination of vertical and horizontal cooperation would make the innovation viable (Teece, 1992). Horizontal linkages are beneficial in setting technical standards, overcoming spillover problems, and reducing effort duplication (Teece, 1992). While vertical cooperation with customers depicts an accurate understanding of the customers' needs as the first step of the innovation process, close cooperation with suppliers ensures the adoption and diffusion of new technologies (Teece, 1992).

An empirical research conducted by Belderbos, Carree, and Lokshin (2004) on Dutch manufacturing firms in the Netherlands between 1996-1998 shows that while competitors and suppliers are partners of the firms for incremental innovations, most of the radical innovations are conducted in cooperation with customers and universities. Freel and Harrison (2006) found that new product innovations are promoted through cooperation with customers and public-sector institutions, while process innovations are positively influenced by suppliers and universities. Vertical cooperation with suppliers and clients brings relevant knowledge and skills about markets and sophisticated technologies (Whitley, 2002), especially when developing more novel and complex innovations (Tether, 2002).

As we see in horizontal cooperation, firms also cooperate also with their competitors to establish industry standards and to carry out fundamental research projects (Tether, 2002). Firms are more sensitive to cost-benefit analysis when cooperating with competitors as the risk of imitating or information leakage is higher in these cases (Nieto & Santamaría, 2007). That is why such cooperation is rarely exploited in product innovation projects. Research organizations can also contribute to cooperative innovations by providing the firms with new technologies and scientific knowledge (Nieto & Santamaría, 2007).

From another point of view, cooperation can be divided into partnerships with domestic and foreign partners. Both local and cross-border cooperation enhance company's innovation and performance (Raposo et al., 2014). Cooperation occurs more internationally rather than locally (Fischer & Varga, 2002). Firms choose foreign partners to benefit from resources in foreign countries, particularly for technology seeking. Hence, whether to cooperate with a foreign partner depends on the relative strength of the firm and hosting country (Miotti & Sachwald, 2003). For instance, European countries cooperate mainly with American partners as the U.S. pioneers in technological fields such as biotechnology or electronics (Miotti & Sachwald, 2003). In the case of necessity of a firm for foreign partnerships, its foreign cooperation would be to acquire *complementary* knowledge, while domestic cooperation helps the firm with *similar* information resources (Miotti & Sachwald, 2003).

To summarize, firms have access to various potential partners to cooperate for innovation. Each type of partner offers a unique competitive advantage to the innovating firm. Not only each partner has its own

specific capabilities, but also the degree of diversity of external partners are important. A heterogeneous portfolio of the cooperative network increases the contingency of innovation success and higher performance (Faems et al., 2005).

2.6. Innovation Novelty

Novelty is a concept that is deeply ingrained in innovation. Some bodies of research define novelty as "technological distance from older and current competing innovations" (Koc & Bozdag, 2017, p. 560). Innovated products with higher degrees of novelty contribute to opening up new markets for the firms and enhancing the firms' competitive advantage (Hernandez-Espallardo et al., 2012; Schmidt et al., 2009).

Several studies (e.g., Germain, 1996; Koberg et al., 2003) consider the term *radical innovation* to describe the higher degrees of novelty. But regarding the two above-mentioned essential dimensions of radical innovation (Chandy & Tellis, 1998) it is not precise to consider a more-novel innovation as a radical innovation. Hence, this study differentiates between radical innovation and the degree of novelty.

Firms conducting radical innovations showed more cooperative arrangements in their innovation strategies (De Faria et al., 2010). This aligns with the other findings indicating that the lack of market knowledge, customers' responsiveness, and economic/financing issues motivate firms to cooperate (Tether, 2002). In the opposite direction, prior empirical studies in the manufacturing sector (e.g., Kaufmann and Tödling, 2001; Tether, 2002) show also the positive effect of inter-firm cooperation on the degree of innovation novelty. There is a positive relationship between knowledge-based cooperation in innovation and a higher degree of novelty (Barbosa et al., 2014) if the cooperation initiatives are not performed with competitors (Mention, 2011). It can be due to the essence of innovations with higher degrees of novelty that require a broader range of knowledge (Schoenmakers & Duysters, 2010). Also, such a consequence is explained by the indirect effect of absorptive capacity that facilitates external knowledge adoption (Cohen & Levinthal, 1989). The greatest effect on the novelty of innovations appears when the cooperation encompasses various types of partners (Nieto & Santamaría, 2007).

On the other hand, literature has probed the effect of innovation novelty on innovation performance. The degree of novelty is a determinant factor that has been shown to influence the commercial performance or failure of innovation activities (Danneels & Kleinschmidt, 2001; Duhamel & Santi, 2012; Kleinschmidt & Cooper, 1991). One perspective is that there is not any significant relationship between

innovation novelty and its performance (Kleinschmidt & Cooper, 1991). While Duhamel and Santi (2012) have represented the negative effect of innovation newness on innovation's performance, Zuo et al. (2019) have shown the positive effect of innovation novelty on firm performance in high-technology industries. Not only on the firm performance, in some cases, the degree of novelty has direct relationship with innovation performance (Laursen & Salter, 2006; Li et al., 2019).

Firms have several R&D capabilities that affect the novelty of innovation output and explains the heterogeneity of this degree of novelty in a specific industry (Therrien et al., 2011). Novelty has been investigated from the perspective of the product, customer, firm, or a combination of them (Koc & Bozdag, 2017). In this thesis, novelty is observed from the product perspective in which the products that leverage larger markets are perceived as more novel

On the other hand, the higher the degree of innovation novelty, the higher the probability of innovation failure (D'Este et al., 2016), and more substantial the degree of risk it entails (Koc & Bozdag, 2017). Therefore, the firms should be cautious about the degree of novelty of their innovation and set a balance between the intensity of novelty and its entailed risk.

2.7. Resource-Based Theory

Theoretically, cooperative innovation is studied from two perspectives. First, the *transaction cost theory* focuses on the effectiveness of cooperative agreements in organizational governance (Stuckey, 1983). Meanwhile, the *resource-based theory* concentrates on the need for strategic resources. Since this approach can consider both the motivations for partnerships and characteristics of the partners simultaneously, it appears to fit the essence of this study better.

Analyzing the firms from their resources perspective rather than product perspective is illustrative and useful (Wernerfelt, 1984). Profitability of a firm is determined by its resources and capabilities (Wernerfelt, 1984). The resource-based theory (RBT) helps understand the technology and knowledge transfer to the firms for entrepreneurial purposes (Barney et al., 2001). While traditional studies of strategy emphasize the firm's external environment and competitive position, RBT places the focus on the firm's resources. The firm's possessions determine its accomplishments (Amit & Schoemaker, 1993; Das & Teng, 2000). The contribution of RBT is that it couples the firm's competitive position with its pool of resources and alliances (Rumelt, 1984). It accounts for intangible complementary resources as the main driver of competitive advantage and firm's performance (Kozlenkova et al., 2014).

RBT's main idea is the heterogeneity of firm's resources and capabilities (Wernerfelt, 1984). Wernerfelt (1984, p. 172) defines a firm's resources as "those (tangible and intangible) assets which are tied semi-permanently to the firm". *Capabilities* are categorized as subsets of resources as "an organizationally embedded non-transferable firm-specific resource that its purpose is to improve the productivity of the other resources possessed by the firm" (Makadok 2001, p. 389). Capabilities refer to the processes through which the firm can take advantage of deploying its other resources more efficiently in order to obtain more productivity out of its resources. Teece (1997) introduces the concept of *dynamic capabilities* which are the capabilities that are recreated and improved continuously to meet the needs of an ever-changing environment and to maintain the unique asset portfolio of the firm. Creating partnerships and making alliances are examples of the dynamic capability of the firm (Kozlenkova et al., 2014).

Considering the firms as a compilation of resources was a breakthrough approach towards studying the firms (Wernerfelt, 1984). The RBT is constructed on two assumptions that explain a firm's resource specifications. First, the notion of *resource heterogeneity* implying that firms have a bunch of resources that are distinct from the other firms, even if those firms are within the same industry (Barney, 1991; Peteraf & Barney, 2003). The second assumption is *resource immobility*, meaning that resource transmission across the firms is a very difficult process (Barney & Hesterly, 2010). RBT proposes a framework in which the resources can bring about sustained competitive advantage if they have four criteria. This consists of whether resources provide competitive advantage (*Value*), are possessed by competitors as well (*Rareness*), are costly to imitate (*Imitability*), and are exploitable by the organization (*Organization*) (Barney, 1991). This framework is known as VRIO criteria for resources (Kozlenkova et al., 2014).

In the management literature, RBT considers that the need for complementary resources is a key driver of inter-firm cooperation, especially when partners require inter-dependent innovation processes or high technology knowledge (Miotti & Sachwald, 2003). Van de Ven (1976) proposes that an inter-firm cooperation is a context to facilitate the flow of resources (Das & Teng, 2000). RBT concentrates on the need for strategic resources. Focusing on the growth strategy and based on this resource-based approach towards the firms, growth requires setting a balance between using existing resources and acquiring new ones (Wernerfelt, 1984). This approach can consider both the motivations for partnerships and characteristics of the partners simultaneously (Miotti & Sachwald, 2003).

In addition to the cooperative activities, RBT has a significant contribution to the innovation literature. Innovation is considered as an internal firm-specific resource in the strategy literature (Kamasak, 2015). RBT has extensively influenced innovation studies and provided the literature with new insights into innovation management. The theory suggests that in the case of conducting complex, effortful, risky, and expensive research projects, firms are more intended to make cooperative agreements. Based on this theory, the main intention for which firms cooperate, particularly in innovation and R&D activities is to complement their internal resources (Miotti & Sachwald, 2003). Such cooperation corroborates resource supplementation and knowledge augmentation. The literature confirms that the more organizational resources and capabilities a firm acquires, the more satisfactory and successful the innovation outcomes are (Kostopoulos et al., 2002).

Kostopoulos, Spanos, and Prastacos (2002) depict the fundamental aspects of the contribution of RBT to organizational innovation. They claim that innovation is not simply driven by market study or marketing feedbacks, but it also necessitates the firm to access intimate bodies of knowledge to achieve success in innovation. For instance, Hoopes and Postrel (1999) found that shared knowledge is a key resource for success in new product launching. Further, resources are taken as the *fuel* of innovative activities. The firms are not capable of accomplishing the set goals without such resources (Kostopoulos et al., 2002). On the other hand, heterogeneity of inter-firm connections and resources creates value and a sustainable competitive advantage for the firm. Because it brings the firm one step before the competition and saves the firm from passive reactions to potential rivals (Kostopoulos et al., 2002). They also believe that RBT and innovation mutually benefit each other. While RBT helps the firm being equipped with the necessary fuel for innovation, innovation is reciprocally "one mechanism through which a firm can renew the value of its assets" (Kostopoulos et al., 2002, p. 13).

2.8. Hypotheses and Conceptual Frameworks

The degree of novelty is a factor that is supposed to be affected by cooperation in innovation but affect innovation performance. Although the degree of innovation novelty can affect the firm's performance differently, the case is not studied deeply (Therrien et al., 2011). Different studies reveal contradictory results about the effect of innovation novelty on innovation success. While some studies deny existence of any relationship (e.g., Kleinschmidt & Cooper, 1991), the others have found both positive (e.g., Laursen & Salter, 2006) and negative (e.g., Duhamel and Santi, 2012) effect of novelty on innovation performance. It seems logical that higher levels of novelty result in incremental innovations that are

distinct from the other incumbent products. Launching novel products in this regard would help the firms be first-movers in the market which in turn increases the innovation success probability. But simultaneously, innovations with higher levels of novelty are always accompanied by higher level of risks that increases the innovation failure probability (D'Este et al., 2016; Koc & Bozdag, 2017). On the other hand, there is also no clue that the literature has investigated the mediating role of degree of novelty in the effect of cooperative innovation on innovation success. Therefore, in its first part, the thesis proposes two hypotheses regarding the degree of novelty in product innovation:

- *H1: The degree of novelty in product innovation mediates the effect of inter-firm cooperation on product innovation success.*
- *H2: The degree of novelty in product innovation mediates the effect of heterogeneity of the firm's portfolio on product innovation success.*

By carrying out this analysis I would also empirically test the direct effects of cooperation, portfolio heterogeneity, and novelty on innovation performance. Figure 1 shows the conceptual framework related to this part of the study.

Figure 1
Conceptual framework of testing the mediating role of the degree of novelty
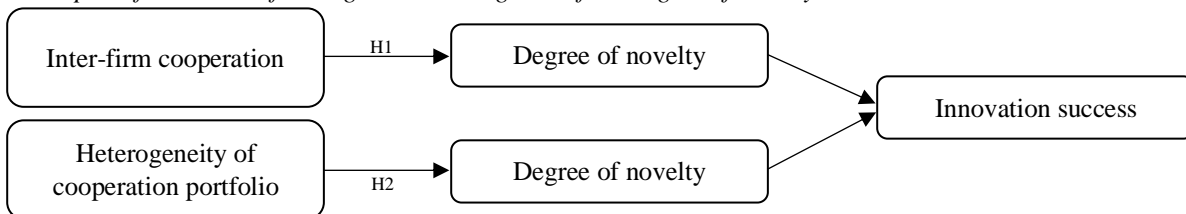
To test the mediation role, I use the 4-steps method of Baron and Kenny (1986). This process of mediation testing includes:

1. Testing the significance of the relationship between IV and DV (X → Y)
2. Testing the significance of the relationship between IV and the mediator (X → M)
3. Testing the significance of relationship between the mediator and DV (M → Y)
4. Testing the insignificance (or the meaningful reduction in effect) of the relationship between the IV and DV in the presence of the mediator (X|M → Y)

Implementation of each step requires running a separate regression model. Since the DV in steps 1, 3, and 4 is innovation success that is a continuous numerical variable, linear regression would be a good fit.

But step 2 includes the degree of novelty as DV that is an ordinal variable and requires an ordinal logistic regression to be carried out.

In addition to cooperation existence and its portfolio heterogeneity, the literature delves into the portfolio combination and contemplates the effect of different types of partners on innovation success and degree of novelty. Therefore, I also test the effect of cooperation with domestic and foreign firms on the degree of novelty and innovation success in the context of Indian manufacturing firms. These relationships can be hypothesized as below:

- *H3: Cooperation with domestic firms has a positive impact on product innovation success.*
- *H4: Cooperation with domestic firms has a positive impact on the degree of novelty of product innovations.*
- *H5: Cooperation with foreign firms has a positive impact on product innovation success.*
- *H6: Cooperation with foreign firms has a positive impact on the degree of novelty of product innovations.*

These hypotheses are modelled as in figure 2.

Figure 2
Conceptual framework of testing the effect of cooperation with domestic and foreign firms on success and novelty
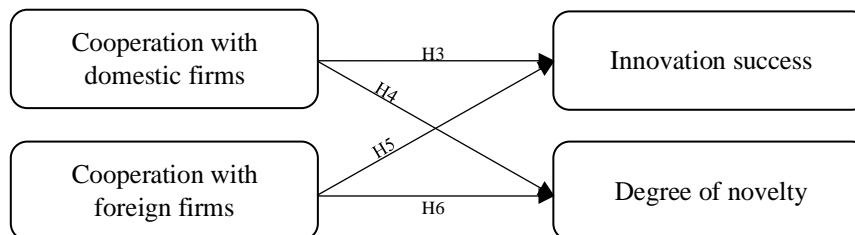
This model includes two equations that should be analyzed:

- Innovation success $= f$ (cooperation with domestic firms , cooperation with foreign firms)
- Degree of novelty $= f$ (cooperation with domestic firms , cooperation with foreign firms)

To conduct this analysis, I employ the seemingly unrelated regressions (SUR) approach that includes any correlation between the error terms of two equations. Since the explanatory variables in both equations are the same, there would be possibly no deviation between the results of one SUR model and two separate OLS models in this case. But the interrelationship between the two dependent variables increases the probability of correlation of error terms across two equations.

3. Methodology

3.1. Data

The analysis in this thesis is based on the surveys that were carried out in India in 2013-2014. The survey questionnaires belong to *Enterprise Survey* and *Innovation Follow-up*, both of which are organized by the World Bank (The World Bank, 2021). The enterprise survey is a firm-level survey that has been conducted since 1998 across the economy's private sector. It covers all small, medium, and large firms to gather information about the business environment in a specific country (Enterprise Surveys, 2021). The innovation follow-up survey was first launched in 2011 to study innovation-related initiatives at the firm level. The main purpose of the survey is to improve innovation investigation and measurement in emerging economies and developing countries (The World Bank, 2021).

In this thesis, the two datasets are combined and narrowed to manufacturing firms. The final dataset includes 471 variables and 2691 observations that are private manufacturing firms distributed across the country. It investigates the activities of the firms in the period of three fiscal years, from 2010/2011 thru 2012/2013. I used Stata 16 to refine the dataset and run the analyses.

3.2. Variables

To conduct the analysis, nine variables were extracted from the dataset. Among these, four variables are the main focus of this thesis and represent inter-firm cooperation, firm's portfolio heterogeneity, innovation novelty, and innovation success. The other five variables are controlling variables that represent the background characteristics of the firms. Table 1 illustrates all these variables.

Inter-firm Cooperation (INTF_COP) is a dummy variable and refers to the existence of any cooperation alliance. It indicates whether the firm has undertaken cooperative initiatives for its innovation activities. The survey does not include any direct yes/no questions about inter-firm cooperation. Instead, it asks respondents to determine the type of partners they have had cooperation with through a set of yes/no question for each type of partners. Hence, INTF_COP is valued 1 if cooperation exists with any of six options including domestic firm, foreign firm, domestic research institute, foreign research institute, private consultant, and government.

Heterogeneity of firm's portfolio (PTF_HTG) depicts the level of diversity of the firm's partners for its cooperation in innovation activities. By allocating value 1 to the "yes" responses for all the six questions

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Table 1
Description of the variables

Parameter	Variable	Description
Dependent variable		
Innovation success	INV_SUC	Ratio - Percent of sales that is due to sales of innovation outcomes
Explanatory Variables		
Inter-firm cooperation	INTF_COP	Dummy – Existence of cooperation in firm's innovation activities
Firm's portfolio heterogeneity	PTF_HTG	Ordinal (0-6) – Number of types of partners that firm has cooperated with
Degree of novelty	DGR_NOV	Ordinal (1-3) – Degree of novelty of innovation output
Cooperation with foreign partners	FRN_COP	Dummy – Existence of cooperation with foreign firms / research institutes
Cooperation with domestic partners	DOM_COP	Dummy – Existence of cooperation with domestic firms / research institutes
Control variables		
Firm size	FRM_SIZ	Ordinal (1-4) – Size of the firm
Internal R&D intensity	RD_INTS	Ratio – Internal R&D cost divided by number of permanent employees
Firm's level of export	LVL_EXP	Ratio – Percent of sales that was earned through export
Being part of a group firm	PRT_FRM	Dummy – Firm is part of a larger or a group company
Expenditure on technology acquisition	TCH_ACQ	Ratio – Expenditure on technological software, machinery, etc. acquisition

about the type of partners, the existence of each type of cooperation is recoded to a dummy variable. I measured the level of heterogeneity as the sum of these six values -between 0 to 6- in an ordinal variable. The higher the value of PTF_HTG, the higher the level of firm's heterogeneity in its cooperation portfolio. I claim that the survey could even provide a detailed image of such a portfolio. If the survey would go beyond just the existence of cooperation and could specify the number of partners in each category, the variable could depict the level of heterogeneity more holistically.

Degree of novelty (DGR_NOV) is measured through a model with nominal typology by describing whether the innovation output is new to the local, national, or international market. This categorical type for measuring the degree of novelty was first applied by Amara and Landry (2005). Except this and despite the importance of the emerging concept of novelty, the literature lacks a structured holistic theory for novelty by which it could be measured either (Witt, 2016). Products leveraging the larger markets are more novel and therefore, I converted this categorical variable into an ordinal variable that ranks the degree of novelty. To show the intensity of novelty, DGR_NOV is valued 1 for "new to the local market", 2 for "new to the national market", and 3 for "new to the international market".

Innovation success (INV_SUC) is related to the sales of innovation outputs. The dataset includes various types of information that help find out the firm's success. To measure this variable, I focused on the percentage of the firm's total sales that was due to sales from its innovative products. This percentage explains the share of innovation contribution in the total sales of the firm. It can be a fit for my model due to two reasons. First, it is a proportional variable that is congruent with the proportional essence of

the concept of performance. Second, it is limited to the product innovations of the firms and does not include the effects of the other types of innovation in the model. Contrariwise, considering the total sales as to represent the innovation success is illusive. Because in this regard, I would ignore the firm size and all other basic capabilities of the firm that affect the total sales. Firm size is also one of the controlling variables in the model. In the case of focusing on the firm's total sales to represent innovation performance I would influence the size of the firm on both dependent and explanatory sides of the model. Further, the total sales of the firm encompass all the firm's activities and innovations and are not restricted to just product innovation. R&D performance -as a ratio of R&D expenditure to total sales or number of permanent employees- is not a subtle substitute either. Because the survey includes the total R&D expenditure of the firms for all their innovative activities.

Firm size (FRM_SIZ) is measured directly by an ordinal scale to identify whether the firm is a micro (with fewer than 5 employees), small (with 5-19 employees), medium (with 20-99 employees), or large (more than 100 employees) enterprise. To be measurable, the responses were recoded to a numerical variable which entails the numbers 1 to 4 for the micro to large firms respectively.

Internal R&D intensity (RD_INTS) appears in the literature in various forms. The survey defines internal R&D as "creative work undertaken to increase knowledge for developing innovative products and processes". While some studies consider R&D intensity simply as the internal R&D expenditure of the firm (e.g., Deeds, 2001; Katila & Ahuja, 2002), others calculate it as a ratio. In the second form, it can be a proportion of internal R&D expenditure to either of the firm's total sales (e.g., Garriga et al., 2013; Laursen & Salter, 2006) or the number of employees (e.g., Vivarelli et al., 1996). I calculate internal R&D intensity as the proportion of firm's R&D expenditure to the number of permanent employees.

Firms' level of export (LVL_EXP) is measured in the dataset by asking respondents to indicate the percent of total sales that was through each of the national market, indirect export (through a domestic third party), and direct export. Being an exporting firm contributes to performance and innovation from different perspectives. On the one hand, it equals more international inter-firm connections, especially in direct export activities which facilitates resource adoption and knowledge acquisition for the firm. On the other hand, exporting firms are logically expected to offer more novel products and have a higher level of reputation in contrast to non-exporting firms. Hence, any kind of exporting activities are considerable measures that affect a firm's innovation and its success. I calculated the level of export for the firms as a total share of their sales represented in export, by adding up percentages of both direct and indirect export.

Being part of a larger firm (PRT_FRM) has been explicitly measured in the questionnaire. It is a yes/no question that is recoded to a dummy variable to be included in the model. This thesis does not separate foreign-owned and domestic-owned firms, as Tether (2002) has done. Instead, all the firms that are owned by a larger firm are grouped in the same set and allocated 1, while independent firms take the value of 0 in the new dummy variable.

Expenditure on technology acquisition (TCH_ACQ) is measured directly in the survey. The survey asks respondents about the purchase of "new equipment, machinery, or software to develop or produce any innovative products" in the last three years. It includes a dummy variable about the existence of such a purchase and a numerical variable about the amount of this expenditure in the Indian Rupee. I employ the latter as it is more holistic by incorporating both purchase existence and its intensity.

For the analysis in the second part of this thesis, I introduce two explanatory variables. The *existence of cooperation with foreign partners* (FRN_COP) is a dummy variable indicating whether the firm has had cooperative innovation with any foreign firm or research institute. On the other hand, the *existence of cooperation with domestic partners* (DOM_COP) is also a dummy variable to show if the firm cooperated with domestic firms or research institutes.

3.3. Descriptive Analysis

Of the 2691 respondents, 2732 firms (88.15%) explicitly claimed to have introduced at least one innovation in any of the fields of product, process, organization, and marketing. A further 476 (17.70%) firms indicated that they had been engaged in innovation activities that were abandoned or suspended before completion. Table 2 shows the distribution of different types of innovation among the firms.

Table 2
Innovating firms based on the type of their innovation

Type of innovation	N	Amongst all the firms (%)	Amongst innovating firms (%)
Product innovation	1845	68.56	67.53
Process innovation	1915	71.27	70.09
Organizational innovation	1490	55.37	54.54
Marketing innovation	1528	56.78	55.93
Total (with at least one innovation)	2732	88.15	100

Cooperation in product innovation activities is the main focus of this thesis. The dataset investigates cooperation in two types of product and process innovation. A total of 376 firms (13.97%) did cooperate

in their innovating initiatives. It shows that cooperation is not a trend in innovation activities among Indian firms. The distribution of cooperation for product and process innovations is shown in Table 3. While 141 out of 376 cooperating firms have had alliances for their product innovation, almost twice, 285 firms cooperated for their process innovation.

Table 3
Cooperating firms in their innovation initiatives

Type of innovation	N	Amongst all the firms (%)	Amongst innovating firms (%)	Amongst cooperating firms (%)
Cooperated firms in product innovation	141	4.76	5.16	37.5
Cooperated firms in process innovation	285	9.62	10.43	75.8
Total (at least one type of cooperation)	376	12.7	13.76	100

On the other hand, firms cooperate with different types of external partners in their innovation activities. The dataset underlines six different types of partners of firms in their cooperation for innovation. These six partners appear in cooperation for both product and process innovations. Table 4 summarizes the cooperation of firms with various external partners.

Table 4
Different types of partners in firms' cooperation arrangements for innovation

Type of partner	N	Amongst innovating firms (%)	Amongst cooperating firms (%)
Domestic firms	114	4.17	30.32
Foreign firms or foreign-owned parent firm	13	0.47	3.46
Domestic academic/research institutions	15	0.54	4
Foreign academic/research institutions	3	0.1	0.8
Private consulting company/individuals	21	0.76	5.58
Government	7	0.25	1.86

While the major cooperative innovations are carried out by partnerships with domestic firms, the partners with which the least cooperative innovations took place are foreign academic/research institutes. From another point of view, cooperation activities with all types of domestic partners dominate cooperation with all the foreign partners. But this result represents just the number of partnerships and cannot depict the depth of cooperation effect, meaning that a more detailed study is needed to clarify the intensity of the effects of cooperation with each of domestic and foreign firms. Comparing also the cooperation with external firms and academic/research institutes implies that firms cooperate with external firms, both domestic and foreign, seven times more than academic/research institutes.

Fischer and Varga (2002) claim that most of the cooperation arrangements occur in the first stages of an innovation process, particularly in R&D activities. While 1392 firms (51.94%) conducted internal R&D, 276 firms (9.96%) out of all 2691 firms carried out external R&D.

Figure 3
Frequency of cooperative innovations in different industries
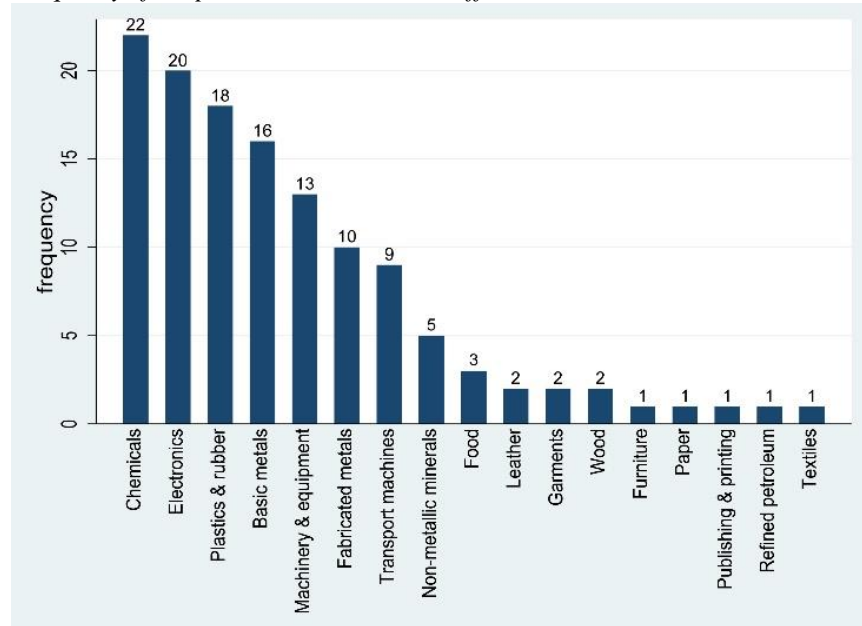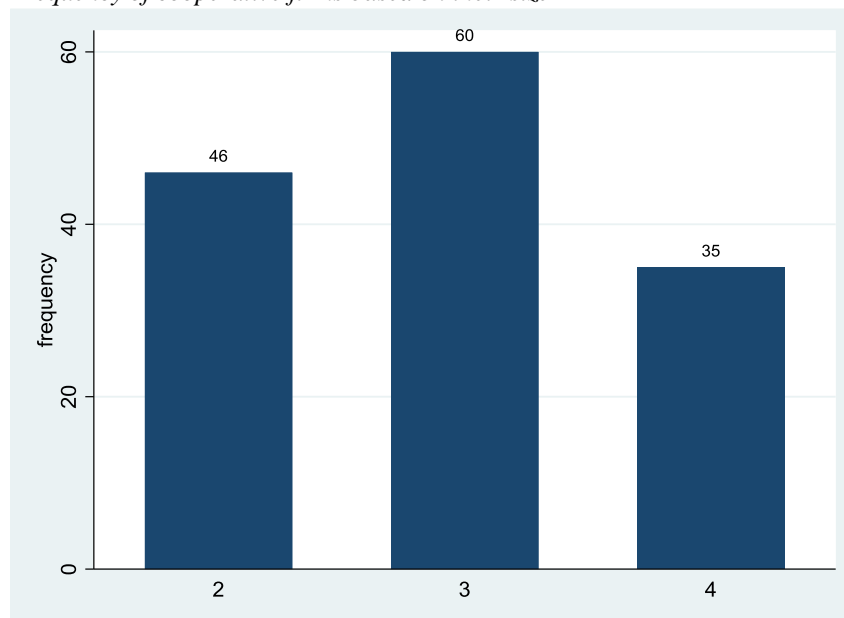

Figure 4
Frequency of cooperative firms based on their size

Considering different industries, most of the cooperative innovations took place in chemicals (22 firms), electronics (20 firms), plastics & rubber (18 firms), and basic metals (16 firms) respectively (Figure 3). On the other hand, micro-sized firms did not have any product innovation in the last three fiscal years. Regarding firm size (measured in terms of number of employees), among all the innovating cooperating firms, 46 firms (32.62%) are small, 60 firms (42.55%) are medium, and 35 (24.82%) are large firms (Figure 4).

4. Results and Discussion

I tested the mediation role of the degree of novelty through two distinct models. One model tests its mediation in the effect of cooperation on innovation success and the other investigates the mediation in the effect of portfolio heterogeneity on innovation success. Each model consists of four independent regression analyses. Figure 5 shows the output results for the mediation test of the first model.

Figure 5
Mediation of the degree of novelty in the effect of cooperation on innovation success
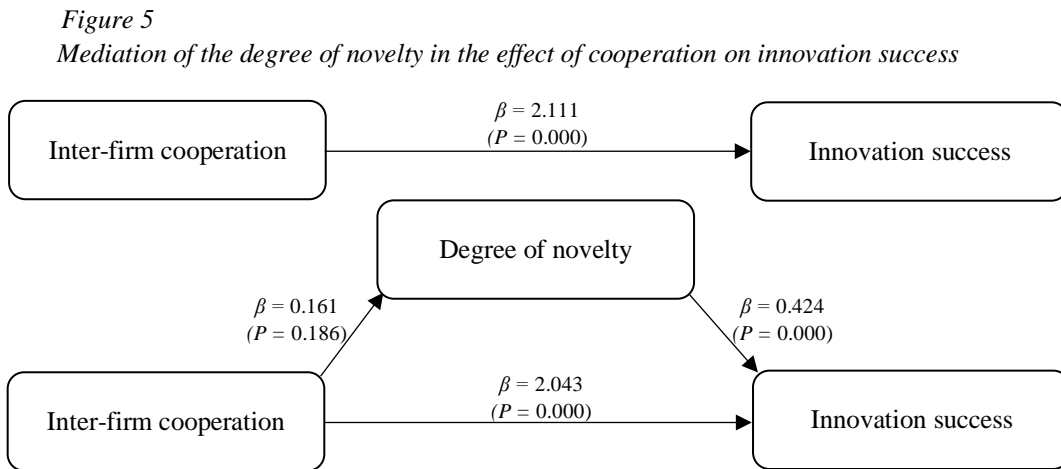
In the first step of this mediation model, a multiple linear regression was calculated to predict innovation success based on cooperation. This relationship, ignoring the mediator, found to be significant ($\beta = 2.111$, $P < 0.01$) as the model showed ($F_{(6, 2673)} = 8.39$, $P = 0.018$)). Second step revealed the non-significant relationship between cooperation and degree of novelty ($\beta = 0.161$, $P = 0.186$). Although steps 3 and 4 in this model are significant, I reject the *H1* about the mediating role of the degree of novelty in the effect of cooperation on innovation success.

The results show that inter-firm cooperation is a significant predictor of innovation success. It aligns with the major part of literature in this field (e.g., Abramovsky et al., 2009; Belderbos et al., 2004; Faems et

al., 2005; Miotti and Sachwald, 2003) and is due to transaction cost reduction, innovation risk mitigation, and external resources adoption. The same model reveals that the degree of novelty has also a direct positive effect on innovation success. This result proposes that if all the other determinants remain untouched, more radical innovations lead to higher levels of performance and success in innovation. However, radical innovations involve high risks of innovation failure that could be mitigated through cooperative innovation.

On the other hand, the causal effect of cooperation on novelty in my model (step 2) is non-significant. This result shows that just the existence of inter-firm cooperation does not guarantee the innovation to end up in a more novel output. In other words, firms can cooperate for various reasons that are not exclusively related to the novelty of innovation. In the context of my research, just 9 out of 1639 innovative firms (0.5%) aimed to have new technology or industrial design in their product innovation. This fact is considerable because technology plays a key role in the radicalness of an innovation. The respondents reflected that their intention for innovation is mostly extending the range of products (1668 firms), opening up new markets (1572 firms), or offering products that are already offered by competitors (1371 firms).

Since the second step in the mediation model test is not significant, novelty does not mediate the relationship between cooperation and innovation success. It shows that the degree of novelty cannot explain how or why the relationship between cooperation and innovation success occurs.

The second model of mediation testing is carried out in the same way as the first model. The results are shown in Figure 6.

Figure 6
Mediation of the degree of novelty in the effect of cooperation profile heterogeneity on innovation success
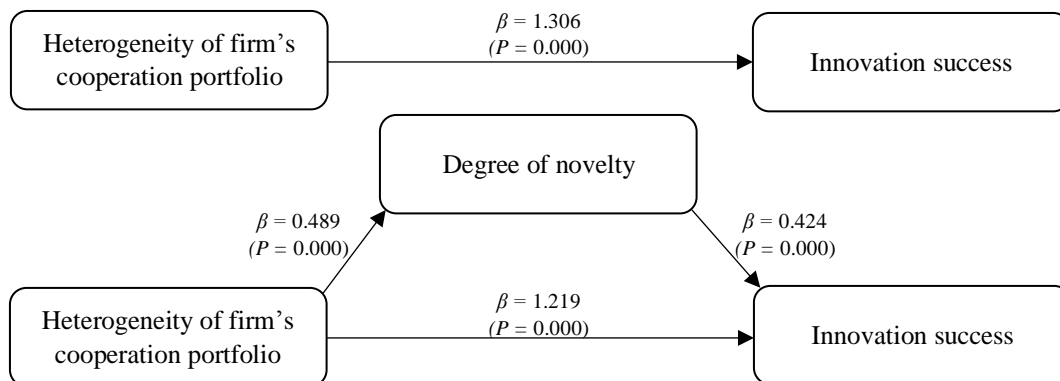
The linear regression in the first step, ignoring the mediator, reveals a significant relationship between the portfolio heterogeneity and innovation success ($\beta = 1.306$, $P < 0.01$) in a significant model (F (6, 2673) = 7.47, $P = 0.000$)). The second step shows the meaningful causal effect of portfolio heterogeneity on the degree of novelty ($\beta = 0.489$, $P < 0.01$). In the third step, the model indicates that mediator can appear as an IV for success as both the relationship ($\beta = 0.424$, $P < 0.01$) and the model are significant (F (6, 2673) = 10.78, $P = 0.000$)). The final step depicts the whole model and consists of simultaneous effect of portfolio ($\beta = 1.219$, $P < 0.01$) and novelty ($\beta = 0.412$, $P < 0.01$) on innovation success. The result in this step is meaningful and statistically significant for the whole model (F (6, 2672) = 11.47, $P < 0.01$)). In this regard, the null hypothesis is rejected, and I confirm the *H2* about the mediating role of novelty in the effect of cooperation portfolio heterogeneity on innovation success.

In this model, I have found a direct positive relationship between portfolio heterogeneity and innovation success, meaning that not only is inter-firm cooperation determinant in innovation success, but also the diversity of the partners affects the innovation success positively. Comparing the effects of cooperation ($\beta = 2.111$) and heterogeneity ($\beta = 1.306$) on innovation success reveals that one-unit change in cooperation (starting to cooperate) increases the probability of innovation success more substantially. But heterogeneity has the capability of being increased up to 6 times (adding new types of partners to cooperation portfolio) and therefore, it can show greater influence on innovation success gradually. By adding two or more new type of partners to a firm's cooperation portfolio, the effect of heterogeneity on innovation success would go beyond the effect of inter-firm cooperation on success.

Portfolio heterogeneity is shown to have a causal effect on the degree of novelty. It is in accordance with previous studies that in the case of accessing more heterogeneous partners for cooperation, firms can adopt more diverse resources and bodies of knowledge. This resource diversity is in turn a prerequisite for radical innovations (Zhou & Li, 2012). The model also confirms the direct effect of novelty on innovation success with the same coefficient as the previous model.

I carried out the Sobel test for this mediation model to be assured of the accuracy of the output and found the same results. Since the indirect effect of X|M → Y (in the presence of mediator) does not show a meaningful reduction when compared to the direct X → Y, the relationship of X → Y is not fully mediated by the degree of novelty. This mediating effect is partial and based on the results of the Sobel test (Indirect effect = 0.091, p-value = 0.026), about 7% of the effect of portfolio heterogeneity on innovation success is mediated by the degree of novelty. Also, the mediated effect is about 0.1 times as large as the direct effect of portfolio heterogeneity on innovation success.

These two models also include control variables that are the background characteristics of the firms. Although these control variables are present in all the regression equations, I use the direct relationship of cooperation with success as well as heterogeneity with success to calculate the effect of these control variables. Tables 5 and 6 show the output results of these regression equations.

Table 5
Linear regression for innovation success over cooperation and control variables

Source	SS	df	MS			
Model	1309.27727	6	218.212878			
Residual	69511.4989	2,673	26.0050501			
Total	70820.7761	2,679	26.4355267			

Number of obs = 2,680
F(6, 2673) = 8.39
Prob > F = 0.0000
R-squared = 0.0185
Adj R-squared = 0.0163
Root MSE = 5.0995

INV_SUC	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
INTF_COP	2.110719	.4420199	4.78	0.000	1.243983	2.977454
FRM_SIZ	.3569289	.1458788	2.45	0.014	.0708822	.6429755
RD_INTS	-.0076363	.0382866	-0.20	0.842	-.0827107	.067483
LVL_EXP	.0150535	.0041887	3.59	0.000	.006842	.023265
PRT_FRM	.1267572	.2425091	0.52	0.601	-.3487672	.6022816
TCH_ACQ	-.0004962	.0012231	-0.41	0.685	-.0028946	.0019021
_cons	1.082582	.4410777	2.45	0.014	.2176943	1.94747

Table 6
Linear regression for innovation success over cooperation portfolio heterogeneity and control variables

Source	SS	df	MS			
Model	1168.13369	6	194.6888948			
Residual	69652.6424	2,673	26.0578535			
Total	70820.7761	2,679	26.4355267			

Number of obs = 2,680
F(6, 2673) = 7.47
Prob > F = 0.0000
R-squared = 0.0165
Adj R-squared = 0.0143
Root MSE = 5.1047

INV_SUC	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
PTF_HTG	1.305766	.3235793	4.16	0.000	.690883	1.920648
FRM_SIZ	.352939	.146018	2.42	0.016	.0666194	.6392586
RD_INTS	-.0056666	.0383246	-0.15	0.882	-.0808154	.0694821
LVL_EXP	.015221	.0041915	3.63	0.000	0070021	.0234398
PRT_FRM	.1306655	.2427642	0.54	0.590	-.3453593	.6066902
TCH_ACQ	-.0004644	.0012243	-0.38	0.704	-.002865	.0019362
_cons	1.115533	.4413061	2.53	0.012	.2501973	1.980869

While the literature contemplated that the firm size (Negassi, 2004), internal R&D intensity (Miotti & Sachwald, 2003), expenditure on acquired technologies (Tether, 2002), level of exporting (De Faria et al., 2010), and being part of a larger firm (Tether, 2002) contribute substantially in innovation success, I found that just the firm size and level of export are statistically significant predictors of innovation success. These two predictors show almost the same coefficient in both equations. Firm size accounts for innovation success with $\beta = 0.357$ and $P < 0.01$ in the first model (F (6, 2673) = 8.39, $P < 0.01$)) and

with $\beta = 0.353$ and $P < 0.01$ in the second model (F (6, 2673) = 7.47, $P < 0.01$)). The result for the level of export is also statistically significant with $\beta = 0.015$ and $P < 0.01$ in both models. It indicates that both the firm size and level of export have a positive direct relationship with innovation success. The result signifies that given a one-unit increase in the firm size while holding the other variables in the model constant, would increase the mean of innovation success (percent of sales that is represented by innovation) by 0.35%. In the same way, each one-unit increase in the level of export would positively change the innovation success by 0.015%, meaning that the effect of these factors on innovation success is partial. The other controlling variables in my model including internal R&D intensity, being a partial firm, and expenditure on technology acquisition are not statistically significant that is in contradiction with previous studies.

I carried out a measurement error test for both of the above-mentioned models by considering the IV as $X = X^* + \eta x$ in which the ηx is the error term. IVs in the original equations (cooperation in the first model and portfolio heterogeneity in the second) were derived from this formula by taking the error term as zero. By assuming that $\eta x \neq 0$, I would have new IVs that are error-contaminated. The regression models are then run again with these new variables. The results do not show any considerable change when compared to the previous results. Since none of the significant parameters in the first calculations has become non-significant in the second one and vice versa, I can conclude that there is no measurement error in the models.

In the second part of the analysis, I investigate the effect of cooperation with foreign and domestic firms on (1) innovation success and (2) degree of novelty. To run the model for both DVs simultaneously, I carried out a seemingly unrelated regression (SUR) the result of which is shown in Table 7.

The result reveals that both foreign and domestic partners in the cooperation portfolio are statistically significant in the first model and contribute to innovation success positively. For this, I approve the *H3* (*P<0.01*) and *H5 (P<0.01)* hypotheses. It aligns with the results of the first part of this thesis that have shown the positive effect of cooperation on innovation success. The coefficients of foreign cooperation ($\beta = 6.123$) and domestic cooperation ($\beta = 1.285$) in this model indicate that the effect of cooperation with foreign partners on innovation success is much larger than the effect of cooperation with domestic partners. If a firm without any cooperation for innovation begins to cooperate with a foreign firm (a one-unit shift in the IV), its mean of innovation success would probably increase by almost 6.1%. However, this increase in the case of beginning to cooperate with a domestic firm would be almost 1.3%. The larger

Table 7
Seemingly unrelated regression (SUR) for innovation success and degree of novelty

Equation	Obs	Parms	RMSE	"R-sq"	chi2	p
INV_SUC	2,691	2	5.111693	0.0105	28.44	0.0000
DGR_NOV	2,691	2	1.412323	0.0022	5.97	0.0500

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
INV_SUC						
FRN_COP	6.123411	1.372277	4.46	0.000	3.433798	8.813023
DOM_COP	1.284667	.486085	2.64	0.008	.3319582	2.237376
_cons	2.315589	.1009044	22.95	0.000	2.11782	2.513358
DGR_NOV						
FRN_COP	.8538709	.3791498	2.25	0.024	.1107509	1.596991
DOM_COP	.1087961	.1343017	0.81	0.418	-.1544304	.3720225
_cons	.7656728	.0278791	27.46	0.000	.7110307	.8203149

effect of cooperating with foreign firms is acceptable as foreign cooperation provides the firm with more unique resources and sophisticated technologies that is barely accessible via domestic cooperation.

The second part of the SUR model indicates the relationship between the same IVs (domestic and foreign partners) on the degree of innovation novelty. The result shows that in this equation, cooperation with domestic firms is not a significant predictor of novelty ($P > 0.1$) and I reject the *H4* hypothesis. But cooperation with a foreign firm can contribute to increasing the level of novelty by 0.85 units, approving the *H6 (P < 0.1)*. The results show that cooperation with foreign partners has an extremely significant effect on the degree of novelty of product innovation. The influence of this part of cooperation on novelty is in contradiction with the previous results of this thesis that showed the insignificant effect of cooperation on novelty. This difference could be due to the composition of partners in cooperative innovations in India. Based on Table 4, just 4.26% of cooperating firms have cooperated with foreign partners (including foreign firms and foreign research institutes). Since cooperation with domestic partners plays the dominant role in the composition of the cooperation portfolio, the variable of cooperation represents mostly this part of the portfolio. For this reason, the effect of cooperation -as a whole- on innovation novelty is almost the same as the effect of domestic cooperation.

5. Conclusion

Despite the growing studies on cooperation performance, little evidence has emerged on the degree of novelty in this context. The analysis in this thesis consists of two studies. In the first study, I examine the level of novelty mediates the effect of inter-firm cooperation and firm's portfolio heterogeneity on

innovation success. The second study sheds light on the effect of cooperation with foreign vs. domestic partners on innovation success and novelty. I have used a dataset with 2691 respondents including information about Indian manufacturing firms and their activities between the fiscal years of 2010/2011 thru 2012/2013. The dataset is the combination of gathered data in 2013-2014 through two surveys of Enterprise Survey and Innovation Follow-up organized by the World Bank. Stata 16 was used to conduct the analyses.

The main contribution of this thesis is the examination of the nature of relationship between inter-firm cooperation and firm's portfolio heterogeneity with the innovation success. Using the linear regression model, I have found that the level of novelty is not a mediator in the effect of inter-firm cooperation on innovation success. However, novelty plays a mediating role in the effect of cooperation portfolio heterogeneity on innovation success. The results show that this mediating effect is partial (not full mediation) with a small coefficient ($\beta = 1.219$), showing that adding a new type of partner to the firm's portfolio would probably lead to a 1.22% increase in the percent of sales due to innovation. Based on this model, just 7% of the effect of portfolio heterogeneity on innovation success is mediated by novelty. Simultaneously, I indicate that both inter-firm cooperation and portfolio heterogeneity have a positive direct impact on innovation success. However, the effect of cooperation is higher than the effect of portfolio heterogeneity.

The model also accounted for the analysis of some background organizational measures as control variables. Firm size and the level of export of the firm are shown to have a positive effect on innovation success. This part aligns with the previous literature. But three variables of internal R&D intensity, being a partial firm, and the level of expenditure on technology acquisition showed not to have a statistically significant relationship with innovation success. This part is in contradiction with the major of the previous studies in this context.

My second contribution in this thesis is to shed light on the effect of cooperation with foreign and domestic partners on innovation success and novelty. To control for the correlation of error terms in the two equations, I used a seemingly unrelated regression (SUR) model. Cooperation with both domestic and foreign firms has a positive and significant effect the success of innovation, although cooperation with a foreign firm has a stronger effect (almost 5 times more) than cooperation with a domestic firm.

When it comes to the degree of novelty, cooperation with foreign partners has a positive determinant effect, while cooperation with domestic partners is shown to have no significant effect on the degree of novelty. The effect of foreign cooperation on the level of novelty is high enough and can lead to

introducing more novel innovations and opening up larger markets. It means that to achieve a more radical innovation output that can leverage an extremely larger market, firms are recommended to cooperate with a foreign partner.

The dataset included the types of partners that firms cooperated with for their innovation purposes. There is a category of six potential types of partners and for any of them, there is just a yes/no response. I used this information as the measure of a firm's cooperation portfolio heterogeneity. But the data lacks the number of partners in each category. It seems to be complementary to access this additional data as it depicts the depth of firm's cooperation in each category. Hence, I suggest further research to take it into account and investigate the effect of the composition of cooperation portfolio on innovation success and degree of novelty. Also, the data did not include competitors as potential partners in the cooperation portfolio. Recent literature has studied the effect of cooperation with competitors as a separate subject (e.g., Belderbos et al., 2004; Nieto & Santamaría, 2007; Tether, 2002) due to its emerging results and considerable potentials to contribute to innovation literature and transaction governance. I propose the future studies include cooperation with competitors as a single distinct option in the cooperation portfolio. On the other hand, Cristo-Andrade and Franco (2019) claim that setting a cooperative relationship requires socio-psychological backgrounds such as honesty and trust. These specifications are highly cultural and society-dependent. Therefore, it is supposed to achieve various results when conducting the cooperation study in developing vs developed or even North American vs European countries. That is why I suggest carrying out the same study in different socio-cultural contexts. Finally, the mediation effects of the degree of novelty in the models were partial and quite more moderate than expected. As the previous studies in the literature are also silent about this moderating effect, it is highly recommended for further studies to deeply probe the mediating role of the degree of novelty in the context of cooperative innovation.

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