The interaction between supply networks and internal networks: Performance implications.

Abstract

Purpose – The importance of the supply network to firm performance is well documented. Until now, the firm and its suppliers have been conceptualized as single entities. Yet, multinational corporations (MNC) are composed of a complex, geographically dispersed internal network of subsidiaries. The supply and internal networks are inherently linked. We study the impact of the interaction of these networks on firm-level financial performance.

Design/methodology/approach – Building on supply network, internal network, and dual embeddedness research, we investigate the interaction of these networks using supply network data from FactSet and internal network data from Orbis. We assess the impact at the MNC level, using measures of firm-level financial performance, physical proximity between the two networks and geographic dispersion of the internal network.

Findings – The results show that the performance effect of physical proximity of the firm with its supply network is negatively moderated by the geographic dispersion of the firm's internal network. This effect can be traced back to the diminishing marginal profitability of a firm's assets. Moreover, the benefits of dual embeddedness to the individual subsidiary come at a cost at the firm-level due to the operational challenges of managing a complex subsidiary network.

Research limitations/implications – This study is the first to investigate the supply and internal networks of MNCs simultaneously.

Originality/value – The paper extends supply network literature by considering the internal network of the focal firm and its suppliers. This paper is one of the first studies that offer an understanding of the interaction between supply and internal networks of a focal firm and the effect on financial performance.

Keywords Supply network, internal network, dual embeddedness

Paper type Research paper

1- Introduction

In today's extended supply chains, firms depend heavily on their supply networks since these networks are a vital source of resources, materials, and knowledge for the focal firm (Choi and Hong, 2002; Bellamy *et al.,* 2014). Effective management of their supply networks allows firms to improve their operational (Kim, 2014) and financial performance (Lu and Shang, 2017). There is a significant amount of works on supply networks (cf. Kim *et al.,* 2011; Bellamy *et al.,* 2014). Yet, past research has considered both, the focal firm, and its suppliers, comprised as single entities. In reality, for multinational corporations (MNC) each of these firms is itself composed of a complex, geographically dispersed internal network of subsidiaries. The consideration of these internal networks is important for two reasons: First, with dispersed internal networks, the overall coordination of material and information flows with suppliers becomes more complicated. Second, the subsidiaries can play a key role in managing the supply network as the relation between the focal firm and its suppliers is not necessarily only through one link - say the parent company of the focal firm and the supplier - but through the multiple links between these networks (Demeter *et al.,* 2016).

The interplay between supply and internal networks has been recognized at the subsidiary-level. Dual embeddedness research, as shown in Figure 1, considers the subsidiary as embedded in two distinct networks: the supply network and the internal network of the focal firm, and has shown the performance benefits to the subsidiary of being simultaneously embedded in both networks (cf. Figueiredo, 2011; Achcaoucaou *et al*., 2014; Ciabuschi *et al*., 2014; Cenamor *et al*., 2019).

These studies have focused on the relational embeddedness of each subsidiary in both the external and internal network. Demeter *et al.,* (2016) and Golini *et al.,* (2016) are the few studies that have applied an operations and supply chain management lens to dual embeddedness.

Yet, the internal network of subsidiaries significantly complicates the operations of the MNC. Subsidiaries are located in countries with economic and social differences (Prahalad and Doz, 1987). They are also interdependent (Prahalad and Doz, 1987), which creates the need of integrating and coordinating the subsidiary network (Ghoshal and Bartlett, 1990). The question of how the supply and internal network cumulatively and in relation to each other affect firm performance has been overlooked so far.

-- INSERT FIGURE 1 HERE --

This study aims to address this gap by bridging supply network (cf. Choi and Hong, 2002; Bellamy *et al.,* 2014), internal network (cf. Nell and Andersson, 2012; Demeter *et al.,* 2016) and dual embeddedness (cf. Figueiredo, 2011; Meyer *et al.,* 2011) research. Given that we study the link between the focal firm and its suppliers at the network-level, we follow a social network approach of the firm to explain the interaction of both networks by considering them simultaneously. From the dual embeddedness perspective, it has been shown that the parent company can shape the knowledge flows by carefully considering the subsidiaries in relation to both the external and internal networks (Achcaoucaou *et al.,* 2014). Thus, the role of the parent company in creating relational embeddedness of the subsidiary has been investigated in the past. Yet, the impact of structural embeddedness of this overall subsidiary network has not been explored so far. We address this gap by considering: (1) the whole structure of the internal and supply networks and how they link, (2) the firm-level effects of the interaction between these networks. Accordingly, we investigate how the interaction between these two networks affects the financial performance of global corporations using a large-scale study. We capture the internal network through its geographical dispersion (Stock *et al.,* 2000; Lorentz *et al.*, 2012) and the focal firm-supplier links through the physical proximity (Narasimhan and Nair, 2005; Bray *et al.*, 2019) of the suppliers with the focal firm, including their subsidiaries.

In doing so, the main contributions of our proposed model are twofold: (1) it expands the work on supply networks by including the internal network structure of multinational entities and shows that this structure negatively impacts firm-level performance due to the operational challenges of managing a complex internal subsidiary structure, and (2) it advances the dual embeddedness literature by revealing that the improved subsidiary performance, that has been shown in previous studies, may be offset by increased structural complexity at the firm-level which offers a new understanding to the impact of dual embeddedness at the firm, rather than the subsidiary-level. Our results received from hierarchical regression analyses offer partial support for our model and reveal that the geographic dispersion of the focal buying firm's internal operations can alleviate the benefits attainable from physical proximity to suppliers. An increasingly global internal network of the focal firm requires managing a large amount of infrastructure in terms of assets which will eventually exhaust managerial capacity and reduce the firm's efficiency.

The paper is organised as follows. In section 2, the literature is reviewed, and the concepts are defined. The research hypotheses are introduced in section 3. The methodology of the empirical study is presented in section 4. Sections 5 and 6 present the results of the analysis and the discussion, respectively. Finally, in section 7, the contributions of the paper are summarised, and the limitations and future research opportunities are highlighted.

2- Literature Review

Our goal is to understand the interaction between a focal firm's suppliers and the parent company as well as its subsidiaries at the network-level. For this reason, we review past work on supply networks, internal networks, and dual embeddedness in the following sections.

2.1 Supply networks

A supply network is defined as all the interlinked companies that exist upstream to any focal firm in the value system (Porter, 1985). These companies are generally referred to as supply network partners of a given focal firm. Thus, the focal firm is considered as embedded in the large network of interconnected supply partners (Choi *et al*., 2001).

Supply chain management research is increasingly examining supply chain relationships beyond the traditional buyer-supplier dyad, looking instead at the supply network (Wagner and Neshat, 2010; Giannoccaro *et al*., 2017). Previously, the focus has been on the relationship between just two nodes: supplier to focal firm, and focal firm to customer. Given that in reality supply chains are networks of companies and thus comprise several interrelated parties, the social network approach highlights the advantages of viewing a company as embedded within a larger network of relationships. A firm's economic activities are embedded in structures of social interactions (Granovetter, 1985), which comprise "a set of actors and the set of ties representing some relationship or lack of relationship between the actors" (Brass et al., 2004, pp. 795). The assumption that organizational entities are embedded within a network of relationships is fundamental to the social network approach (Lin and Kede, 2011). Social network models consider actors such as firms or individuals as being interdependent instead of independent, conceive relational links between actors as means for transfer of resources and perceive the network structures as offering opportunities or constraints for the actors, their decisions, and their actions (Granovetter, 1985). This view allows assessing the benefits gained from reach of resources, knowledge and information sharing within a network of interdependent entities (Granovetter, 1985).

The supply network is integral for the focal firm to achieve operational effectiveness, better performance, and sustainable competitive advantage (Choi and Hong, 2002). Firms improve their competitive advantage by being part of supply networks when they can benefit

from lower production costs, higher product quality (Bray *et al.*, 2019), and be more responsive with respect to the rapidly changing customers' needs and expectations (Sodhi and Lee, 2007). The supply network of a firm has also been viewed as a source of innovation (Bellamy *et al.*, 2014).

On the other hand, these supply networks also create significant challenges for the focal firm, as what occurs in one part of the supply network affects what occurs in other parts of the network (see, for example, Hendricks and Singhal, 2005). These challenges are exasperated further when the network is geographically dispersed: The more global the supply network is, the higher its exposure to risks (Bode and Wagner, 2015). Being located in different countries of the world, different parts of the network also have to obey various rules and regulations imposed by governments.

To sum up, different structures have different levels of efficiency, but they also exhibit different levels of complexity at the network-level. Scholars have underlined the need to investigate the complexity of supply chains in more detail. Fawcett *et al*. (2011), for example, believe that it is crucial to understand the trade-off between efficiency and complexity of supply networks. In addition, scholars have encouraged future research to study the structural dimension of supply networks, specifically, accounting for the embedded nature of buyer-supplier dyads (Autry and Griffis, 2008; Bode and Wagner, 2015).

In a supply network, the structural complexity dimensions include vertical complexity which refers to the number of firms and the number of tiers in the supply network (Choi and Hong, 2002), horizontal complexity which refers to the number of suppliers in each tier (Choi and Hong, 2002; Bode and Wagner, 2015), and spatial complexity which refers to the geographical dispersion of the supply network (Choi and Hong, 2002; Bode and Wagner, 2015). Also, these supply network dimensions of complexity increase the level of supplier interactions or interrelationships (Bozarth *et al*., 2009; Choi and Krause, 2006; Vachon and

Klassen 2002). Although exact definitions and measurements of supply chain complexity may differ due to contextual differences, there is a general agreement that supply chain complexity refers to the number and variety of elements and the degree to which they interrelate (Vachon and Klassen, 2002; Choi and Krause, 2006; Brandon-Jones *et al*., 2014; Bode and Wagner, 2015; Giannoccaro *et al*., 2017; Lu and Shang, 2017).

Previous studies on supply networks have considered each supplier and the focal firm as single entities neglecting the internal network of the focal firm and its suppliers that interact on the business activities as suggested by previous literature (Nell and Andersson, 2012; Demeter *et al*., 2016). The subsidiaries of the focal firm and the subsidiaries of their suppliers form what we are calling their respective internal networks. The number of subsidiaries, their geographical dispersion, the number of countries they are located in and other factors related to the internal networks of each entity in the supply chain increase the internal network complexity which, in turn, increase the overall network complexity. To fill this gap, we use the geographic dispersion of the firm, that is how widely a firm's subsidiaries are dispersed throughout various geographically defined countries (Stock *et al.*, 2000), to interpret it as a measure of internal spatial complexity.

2.2 Internal networks

As previously mentioned, the firm's internal network includes its subsidiaries and quite often these subsidiaries are dispersed around the world forming a multinational company network. These "MNCs are companies who engage in foreign direct investments (FDI) and who own or, to a certain extent, control value-added activities in several countries" (Dunning and Lundan, 2008, pp. 3).

The value-added activities generally take place within the subsidiaries that are embedded in local networks and interact with a variety of actors such as suppliers, customers,

and their subsidiaries (Ciabuschi *et al*., 2014). Extending a company's internal network to dispersed geographic locations is commonly viewed as a way to strengthen the competences of the company by transferring, recombining, and exploiting resources through several contexts and between countries (Meyer *et a*l., 2011) and to achieve high performance (Tsai, 2001). As a consequence, MNCs operate international networks of subsidiaries that are dispersed around the world (Ghoshal and Bartlett, 1990). This geographic dispersion also creates possibilities to experience multicultural regions which expose the employees to heterogeneous and valuable resources, problem-solving techniques and information sources that allow them to build competitive advantages for the MNC (Andersson *et al*., 2002; Nell and Andersson., 2012).

Previous literature has shown how such local embeddedness of subsidiaries positively influences the stock of knowledge (Meyer *et al*., 2011) and the performance (Andersson *et al*., 2002) helping to build and maintain the competitive advantage of the MNC (Schmid and Shurig, 2003). Gaining external skills and expertise is an important strategic factor for the company's growth (Tsai, 2001). Being embedded with local business units and learning from them is strategically important for subsidiaries because they can access valuable resources and knowledge to build a competitive advantage for themselves and their parent company (Rosenkopf and Almeida, 2003). For example, technological knowledge mainly resides in various geographic regions (Dunning and Lundan, 2008) and this pushes the firms to scout, access, and source external technologies. Yet, only when subsidiaries develop close links with other network units such as consistent and frequent interactions with suppliers and their subsidiaries, intra-network knowledge transfer and intra-organizational learning are facilitated and enabled more quickly (Schmid and Schurig, 2003). Thus, subsidiaries need to be deeply integrated into their local network, i.e., more participation in knowledge and information sharing activities between network members is required.

This is why encouraging local activities and promoting geographical proximity to supplier or development of clusters, appear essential. It is necessary for companies to locate their internal networks of subsidiaries in geographical proximity to their suppliers and their subsidiaries in order to benefit from the effects of the flow and transfer of tacit knowledge. Internal networks are extremely important conduits that enable knowledge transfer, facilitate performance improvement, and improve the competitive advantage of the MNC (Figueiredo, 2011; Demeter et *al.,* 2016).

Besides the advantage of operating global networks in close geographical proximity to suppliers, previous studies have also identified several challenges related to the consequences of operating a high number of sites or locations in terms of corresponding management difficulties such as increased coordination requirements and reduced spontaneous communications (O'Leary and Cummings, 2007). Clearly, internal networks result in numerous rewards, but greater challenges emerge from a growing internal complexity with each additional subsidiary.

2.3 Dual embeddedness

Embeddedness refers to the extent to which a firm depends on its network partners in any specific network structure (Granovetter, 1985; Uzzi, 1997). Embeddedness forms the social network, in which specific resources and regulations that bring benefits constitute the social capital (Lin and Kede, 2011). Granovetter (1985) divides embeddedness into structural and relational aspects. Structural embeddedness stresses on the configuration of an entity's network of relationships, while relational embeddedness emphasises the role of quality of those relationships (Rowley *et al*., 2000).

The supply network structure and embeddedness and their impact on performance are important subject areas of interest. The concept of structural embeddedness asserts that

companies are affected not only by the nodes they are directly connected to but also by distant nodes they are indirectly connected to (Uzzi, 1997). In other words, being embedded implies being embedded in both direct relationships such as suppliers and indirect relationships such as suppliers 'subsidiaries.

Most studies focus on the likely positive effects of embedded relationships in the supply network (Bellamy *et al.*, 2014). However, some researchers have also highlighted negative effects on firm performance such as complexity, opportunism, redundant information, and relationship inertia that all lead to higher relationship and maintenance cost and, therefore reduce the positive impact of relational and structural embeddedness (Uzzi, 1997; Rowley *et al*., 2000). By looking at both, supply networks and internal networks, a broader view could explain these divergent results of previous studies.

In this study, the focus is on the structural embeddedness and mainly on the ties of the external and internal networks of the focal company. In the international business literature, the term dual embeddedness refers to the simultaneous integration of a subsidiary into its external and internal network (Figueiredo, 2011; Meyer *et al*., 2011). Dual embeddedness is defined as the dual linkages used by the firm to create capabilities to achieve better performance (Ciabuschi *et al*., 2014). It indicates that the firm simultaneously sustains a relationship within its external and internal networks. Focal firms have to be sufficiently close to the supply network within the local environment to generate access and inflows, and simultaneously close to its internal network for the knowledge to be successfully transferred and exploited through the MNC (Figueiredo, 2011; Meyer *et al*., 2011). This may require physical proximity between the supply and internal networks. In line with this, focal firms have to manage two networks (see Figure 1): the internal network of subsidiaries and the external supply network delimited through the flows of information and material between the different companies that cooperate in the supply chain. These two networks are inherently linked.

3- Hypotheses Development

Previous studies have noted that there has been rarely any empirical research considering the impact of external and internal networks simultaneously (Meyer *et al*., 2011; Demeter *et al*., 2016). This study answers this call by investigating the relationship between proximity of the focal firm to its supply network and financial firm performance and the moderating effect of geographic dispersion of the focal firm's internal network. These relationships are shown in Figure 2 and discussed in more detail in the following sections.

-- INSERT FIGURE 2 HERE --

3.1 Physical proximity

Physical proximity to suppliers has been widely regarded as an effective way to improve buyer performance (Narasimhan and Nair, 2005; Dou *et al*., 2018). Buyers prefer nearby suppliers and consider proximity to be the third most important rationale behind facility location after market entry and personnel cost (Berking *et al*., 2016). Narasimhan and Nair (2005) defined supply chain proximity as "the physical closeness of the buying and supplying firm" and proved that it is positively associated with the formation of a strategic alliance program and firm performance. The distance between the buyer's and supplier's facilities is particularly detrimental when they are located in different countries (Bray *et al.*, 2019).

Physical proximity to suppliers enhances the ability of the focal firm to provide superior customer service, allows for better control the flow of materials and improves the coordination of production schedules to be more responsive to changes in demands (Narasimhan and Nair, 2005; Dou *et al*., 2018). The physical closeness of buyers and suppliers allows to monitor suppliers more easily and to lower monitoring costs (Cousins *et al.*, 2008; Bray *et al.*, 2019), it also facilitates the development of local norms and makes it easier for companies to acquire

information about the supplier's plants (Dou *et al*., 2018). It provides a chance to develop or improve the relationship with the supplier leading to an adaptation of the product design to co-create solutions to problems, or even co-design when developing new components for the local environments as well as reduce product defect rates (Bray *et al*., 2019). Geographic proximity to suppliers reduces the need to use internal firm assets when production materials and/or facilities are at the same location as is the case for automobile and phone makers, for instance. These advantages operate as incentives as well as financial rewards to the firms.

Physical proximity of buyers and their subsidiaries to their suppliers and the suppliers' subsidiaries, in a given country, facilitates a deeper understanding of that country. For example, this mechanism allows these companies and their subsidiaries to search deeply and understand the relevance of new technologies for problem-solving (Alcácer and Zhao, 2012). This proximity increases the opportunities for identifying technologies that are not always apparent to the firms and helps them improving their knowledge. Since firms with strong ties can better assimilate external knowledge with internal technologies (Alcácer and Zhao, 2012), proximity enables a subsidiary to achieve the focus required to integrate external knowledge into the parent company's routines and technologies, to accelerate organizational learning and to leverage the benefits of proximity to improve the firm's financial performance. In addition, a local partner is likely to have more in-depth information about several features of the host country environment, in comparison with other partner options. Local partners are familiar with the requirements and concerns of the local customers, have the appropriate information about local competitors and have the local links to contacts that can offer timely information.

Altogether, being close to a supplier, whether at the parent company or the subsidiary-level, can reduce local knowledge deficiencies, help to identify suitable solutions, and increase the essential astuteness to propose solutions and strategies that can be effectively and rapidly developed and implemented. This, in turn, can improve the financial performance of the firm.

All of the aforementioned studies seem to agree on the positive effects on firm performance. Therefore, we hypothesize the following:

Hypothesis 1: There is a positive relationship between physical proximity of internal and supply networks and financial firm performance.

3.2 Geographic dispersion

While the previous hypothesis focuses on the relationship between the supplier and buyer, including their networks, this section focuses on another issue. It is not only the structure of supplier network that matters, a point that has received significant attention in supply chain literature (Choi and Hong, 2002; Bode and Wagner, 2015; Lu and Shang, 2017) but also the internal network of the focal firm itself. Firms that manage a large number of suppliers, with whom they have physical proximity are likely to experience lower financial benefits when their internal network of subsidiaries is geographically dispersed. In other words, leveraging the benefits of close physical proximity to the supply network may be less effective in terms of financial performance when it requires a widely dispersed geographical network of subsidiaries.

Geographic dispersion is strongly associated with the spatial complexity of the network which has been defined by Bode and Wagner (2015) as the extent of the dispersion among members within the network. O'Leary and Cummings (2007) suggest that geographic dispersion has generally been defined in spatial terms, drawing on measures that take into consideration physical distances, number of countries, sites, or locations. Network complexity may cause lower network performance because it increases the interdependence among firms, which, in turn, leads to a higher need for coordination, conflicting goals, and trade-offs that are not easily resolved (Giannocaro *et al.*, 2017). A high degree of complexity in the internal network may cause high levels of risks and/or costs for firms when they consider maintaining

or further increasing the relation to specific investments, i.e., embeddedness (Manuj and Mentzer, 2008). Given that these studies consider the focal firm as a single entity, the complexity of the internal network is not considered yet.

In this study, the geographically dispersed internal network of the focal firm captures this internal complexity that is unrecognised when studying network complexity. The dispersed internal network of subsidiaries significantly complicates the operations of the MNC as well as the overall coordination of material and information flows with suppliers. Bausch and Krist (2007) indicated that the ability to manage complexity is a key success feature. Higher levels of physical proximity therefore contribute positively to firm performance only if there is no high internal complexity. This implies that companies should appropriately manage internal systems while being able to deal with external networks to enable performance benefits. In line with this, we hypothesise the following:

Hypothesis 2: The geographic dispersion of the internal network negatively moderates the relationship between physical proximity and financial firm performance.

4- Methodology

4.1 Data Collection

The main purpose of this study is to understand how the supply and internal networks collectively affect firm performance. For this reason, the sample for this study was drawn from the electronics industry, which is composed of large MNCs that make use of global internal networks of subsidiaries as well as global supply networks (Bellamy *et al*., 2014). In addition, the electronics industry faces short product lifespans and high market unpredictability (Sodhi and Lee, 2007) which increases the pressure to work closely with suppliers and to deploy their technology to continually offer new product and process innovations that add value (Bellamy

et al., 2014). Thus, we find the internal and supply networks in the form of subsidiary structures and supply chain structures in the electronics industry to be a suitable research setting to investigate the network-level implications for firm performance. We capture the network-level factors through the analysis of physical proximity and geographic dispersion of those two networks in the context of dual embeddedness.

This study builds on a supply chain dataset of 100 public buying firms (focal firms) from the electronics industry, 5,028 suppliers, 23,228 buyers' subsidiaries and 243,216 suppliers' subsidiaries spanning across 139 countries. We started by identifying large, public manufacturing firms in Orbis that had a market capitalization above $6bn and had a primary business Standard Industry Classification (SIC) code of either SIC 35 (Industrial Machinery & Equipment), or SIC 36 (Electronic & Other Electric Equipment). In total, we obtained 104 companies that matched the outlined criteria. We then identified the supply networks of these 104 focal firms using FactSet, which is a global database that collects interfirm relationship data from primary public sources such as investor reports, SEC 10-K annual filings and press releases. Both the relationships disclosed by the company as well as reverse relationships which are reported by their suppliers are included in the database. For all companies, focal firms and suppliers, we retrieved the subsidiary information from Orbis. We collected data on the geographic location of the focal buying firms, its subsidiaries, its identified suppliers, and their subsidiaries. Finally, we also retrieved the data for the dependent and control variables for each focal firm from Orbis. In the data collection process, we had to drop 4 focal firms from the sample due to missing data which resulted in a final sample of 100 firms with their internal and external networks.

4.2 Measures and Analysis

The dependent variables for this study are chosen from among firm-level financial performance measures. Financial performance is frequently used as a proxy in supply chain research (cf. Stock *et al*., 2000; Hendricks and Singhal, 2005; Lanier *et al*., 2010; Kim and Henderson, 2015; Lu and Shang., 2017) as it allows to assess a firm based on factors outside of the firm's boundaries (Stock *et al*., 2000) that are externally observable and have been validated in the course of the annual audit processes. Moreover, it represents the ultimate bottom line of firm performance in terms of value captured from creating and delivering products and services less cost incurred to do so. While previous papers have addressed the implications of embedded relationships with supply chain partners based on innovation and product development measures (cf. Bellamy et al., 2014; Kim, 2014), operations-related measures (cf. Stock et al., 2000; Bray et al., 2019), market-based measures (cf. Narasimhan and Kim 2002, Kim, 2014), or financial measures (cf. Kim and Henderson, 2015; Lu and Shang, 2017), no study has investigated the firm's financial implications of dual embeddedness into supply and internal networks so far.

More specifically, in this study, we use three ratios to assess the financial performance implications for the focal buying firm: Return on Assets (ROA), Profit Margin Percentage (PMP) and Cash Flow to Sales Ratio (CFSR). ROA, measured by net income as a percentage of total assets, is one of the most frequently used performance measures in studies on firm internationalization (Bausch and Krist, 2007). It takes into account fixed as well as current assets to support business activities and highlights the profit generated from these assets. Therefore, ROA is an indicator of how profitable an operation is relative to its total assets. PMP, measured by net income as percentage of operating revenue, is a frequently studied efficiency measure in the supply chain context (see, for example, Choi and Hong, 2002). It allows to assess a firm's ability to control its costs at a given level of sales (Lanier *et al.,* 2010).

Lower costs due to more efficient internal operations or improved supply chain efficiency allows for higher profit margins and thus increased PMP. Lastly, CFSR, measured by cash flow as a percentage of operating revenue, has been adopted in studies assessing the financial state of a firm and its valuation (Rujoub *et al.,* 1995; Dickinson, 2011). It refers to a firm's ability to turn sales into cash, after paying for operating expenses and capital expenditures, which can be used to expand operations, reduce debt and/or to pay dividends. Lower CFSR can indicate high capital expenditures, increasing receivable volumes, or increasing overhead cost.

One of the central independent variables for this study is the physical proximity between a focal firm and its suppliers. We measured the physical proximity in two ways. In the first case, similar to past network-level supply chain research (Bray *et al.,* 2019), we ignored the internal networks of subsidiaries for the focal firm and its suppliers. Thus, we considered the fraction of suppliers being located in the same country as the focal firm at the parent company level only. In the second case, we considered the fraction of suppliers being located in the same country as the focal firm including the internal networks of subsidiaries for the focal firm and its suppliers in addition to their parent companies. This resulted in the two following proximity measures P_j (note that superscript 1 denotes the parent company level while superscript N denotes the network-level):

$$P_j^1 = \frac{\sum_i s_{ij} x_{ij}}{\sum_i s_{ij}}$$

where s_{ij} denotes supplier i of the focal buying firm j and x_{ij} is a binary variable that is 1 if parent company of supplier i is located in the same country as the parent company of the focal buying firm j, and 0 otherwise.

$$P_j^N = \frac{\sum_i \sum_k s_{ijk} x_{ijk}}{\sum_i \sum_k s_{ijk}}$$

where s_{ijk} denotes entity k (including parent company and subsidiaries) of supplier i of the focal buying firm j and x_{ijk} is a binary variable that is 1 if entity k of supplier i is located in the same country as an entity (parent company or subsidiaries) of the focal buying firm j, and 0 otherwise.

Next, we derived the geographic dispersion of the focal firm's internal network incorporating both, the breadth and depth, following Stock *et al*. (2000) and Lorentz *et al*. (2012). The breadth of the buyer's internal network is measured by the number of foreign countries in which the buyer has at least one subsidiary, whereas the depth of the buyer is captured by the total number of subsidiaries per foreign country. Those two measures allowed us to calculate the percentage of subsidiaries in each country. The geographic dispersion was afterwards obtained as:

$$D_j = 1 - \frac{\sum_n \left| c_{jn} - \frac{1}{N} \right|}{2\left(1 - \frac{1}{N}\right)}$$

where c_{jn} denotes the fraction of subsidiaries of focal firm j located in country n and $N = 139$ is the number of countries considered in this study. The geographic dispersion measure ranges from 0 to 1. A value of 0 or close to 0 implies that the internal network is entirely concentrated in a single country, whereas a value of 1 or close to 1 implies an evenly spread internal network across all 139 countries.

Finally, we included firm size, firm age, and number of suppliers as our control variables for the focal buying firm. Firm size is measured as the natural logarithm of the number of employees and was included for three reasons: First, past literature provides evidence of a positive association between firm size and financial performance (Lanier *et al*., 2010). Second, it is more likely that larger firms tend to have a higher physical proximity intensity with their suppliers and a wider geographic dispersion of their internal networks than smaller firms. Third, firm size is likely to influence the buyer's tendency to engage in visits and socialisation

with suppliers that suggest capitalizing on supply chain proximity (Cousins *et al.*, 2008). Firm age was measured as the difference between the year of foundation and the year of the data collection, it was included to account for knowledge and experience gained over time. Long-established firms may have a better understanding of how to utilize their supply network as well as their internal network of subsidiaries and how to derive valuable information from them over the years. Therefore, their experience is an important way for them to learn how to operate in foreign markets (Rosenkopf and Almeida, 2003). Lastly, we considered the firm's number of suppliers. A firm with more suppliers is more likely to be flexible with regard to supplier switching and to make use of redundancy in case of disruptions which may result in better financial performance (Lu and Shang, 2017). Also, a firm with more suppliers is likely to have a higher degree of proximity of its internal and supply networks allowing for improved access to information and resources which is more likely increase the financial performance in the long run (Demeter, 2013).

We employed multilevel hierarchical regression to test our hypotheses using version 25.0 of SPSS (IBM Corporation, 2015). To reduce the concern of multicollinearity, in line with established procedures, especially in the presence of interaction terms, related variables were mean centred before calculating the interaction term.

5- Results

Table 1 presents the descriptive statistics for the variables: description, mean and standard deviation; Table 2 includes the models' specifications that explain the different models of Figure 2 and Table 3 shows the zero-order correlations for all the study variables. A multicollinearity analysis for the sample was conducted. The variance inflation factor coefficient (VIF) values were all lower than the agreed threshold (VIF < 10).

Our results are presented in Table 4. As explained earlier, we measured physical proximity using two different variables and ran a multiple linear regression for each of them separately for the three considered financial performance measures (as illustrated in Table 2).

-- INSERT TABLE 1 HERE --

-- INSERT TABLE 2 HERE --

-- INSERT TABLE 3 HERE –

-- INSERT TABLE 4 HERE --

We did not find a significant positive relationship between the physical proximity of supplier and internal networks and firm performance for either one of the two physical proximity measures. Therefore, hypothesis 1 is not supported.

As for the moderating effect of geographic dispersion on the relationship between physical proximity and financial performance, the results varied across the proximity measures and performance variables. Geographic dispersion of the buyer's internal network negatively moderates the relationship between physical proximity at the parent company level and the firm's profitability relative to its assets, i.e., the relationship between variables P_j^1 and ROA ($\beta = -61.888$, $p < .05$). Geographic dispersion of the buyer's internal network also negatively moderates the relationship between physical proximity at the network-level and the firm's ability to generate cash from sales, i.e., the relationship between variables P_j^N and CFSR ($\beta = -107.399$, $p < .05$). We did not observe this moderation effect of geographic dispersion for the relationship between physical proximity, either at the parent company level or the network-level, and operating efficiency of the focal firm as measured by its profit margins. Thus, we found partial support for hypothesis 2.

-- INSERT FIGURE 3 AND FIGURE 4 HERE --

Figures 3 and 4 provide a closer look at the two significant results. In Figure 3, the supply network is captured in the way it has traditionally been captured by past research, in that, it considers the relationship between the focal firm and the supply network at the parent company level (Bray *et al.,* 2019). In this case, when the geographic dispersion of the internal network of the buying firm is high, ROA is much lower when the firm has a high level of physical proximity to its supply network as compared to the case of a low level of physical proximity (ΔROA = 8.97). On the contrary, for firms that have a low level of geographic dispersion, the drop in ROA is much lower as their physical proximity to suppliers increases, with ΔROA = 2.13.

Figure 4 shows the results when the focal firm's internal network of subsidiaries as well as the suppliers' subsidiaries are considered. In this case, when the geographic dispersion of the internal network of the focal firm is high, the drop in CFSR is much higher when there is high physical proximity to its supply network as opposed to when there is low physical proximity (ΔCFSR = 12.05), as compared to the case of low geographic dispersion (ΔCFSR = 2.76). These results are in line with our hypothesis 2.

6- Discussion and Implications

While the manifold benefits of physical proximity to suppliers such as reduced asset intensity, eased coordination and control or improved supplier relationships have been discussed in the literature (Dou *et al*., 2018; Bray *et al.,* 2019), the effect of internal geographic dispersion on the relationship between physical proximity to suppliers and financial performance remains still unexplored. A more comprehensive understanding of this effect, however, is vital for the

increasingly complex and global structures large firms operate in (Lorentz *et al.*, 2012). As shown by our results, spatial characteristics of the focal buying firm's internal operations may not only demand for simultaneous consideration of a firm's external supply network and its internal network as highlighted by the dual embeddedness literature, but it also requires assessing the financial implications of different external and internal network structures as complexity in the form of geographic dispersion can alleviate the benefits attainable from physical proximity to suppliers.

Previous studies on the performance impact of physical proximity have found that supply chain proximity is positively associated with the formation of strategic alliance programs and in turn, exerts a significant impact on the firm's ROA (Narasimhan and Nair, 2005). Our results, however, reveal that physical proximity between the parent companies does not improve ROA for geographically dispersed focal firms, on the contrary, the cumulative effect is negative. This can be explained by the diminishing marginal profitability of the firm's total assets. While the operating revenue tends to increase with increasing global dispersion of operations, the operational cost related to inventory holding, warehousing and logistics are also increasing (cf. Lorentz *et al.*, 2012) as are the firm's total assets. Given that we do not find any significant effect with regard to PMP, the overall effect is predominantly driven by a disproportionate increase in total assets (note that ROA can be decomposed in two interdependent factors, profit margin and asset turnover) which, in turn, reduces the asset productivity of the focal firm and, in consequence, its ROA. The disproportionate increase in assets can be traced back to the increase in the firm's global infrastructure of fixed assets that cannot be utilised as productively to leverage the benefits from physical proximity of the parent companies in terms of utilisation of suppliers' assets or knowledge spill-over. This is consistent with the assertion that lessened integration in highly dispersed internal networks hinders the effective processing of information which, in turn, compromises effective decision making

with regard to the deployment of resources and the alignment of plans (Swink and Schoenherr, 2015). Similarly, in increasingly dispersed internal networks coordinating production schedules with suppliers and collaboratively managing the flow of materials and information at the firm-level becomes much more challenging, which is likely to alleviate the benefits of physical proximity of the parent companies in terms of current assets. Consequently, geographically dispersed focal firms experience comparatively higher levels of current assets within the internal network, mainly in the form of inventories held across an increasing number of locations to balance less effective production coordination and less synchronised material and information flows (Johnson and Templar, 2011).

Considering firm performance through cash flow to sales ratio, we can observe the same negative moderation effect for the proximity of supplier and focal buyer networks as a whole, accounting for the focal firm, its suppliers and all their subsidiaries. Thus, physical proximity between the suppliers' and internal networks does not benefit geographically dispersed focal firms as much in terms of CFSR which can be explained in a similar way as the ROA effect. An increasingly global internal network of the focal firm that exhibits a high level of physical proximity to the supply networks requires a larger amount of infrastructure in terms of fixed assets. This, in turn, affects the firm's capital expenditures necessary to acquire and maintain these assets. According to our results, the necessary capital expenditures of globally dispersed internal networks cannot be compensated by a comparable increase of the focal firm's operating revenue which leads to a lower CFSR. Thus, even when there is physical proximity to suppliers at the network-level, the attainable benefits do not seem to pay off when the level of dispersion is too high. Moreover, given that the overall effect seems to be driven by investing activities and more precisely the capital expenditures (note that we do not observe a similar effect for the cash flows from operating activities), negative moderation effect of internal

global dispersion seems to be predominantly caused by the amount of fixed assets required (as compared to current assets).

Previous literature has mainly highlighted that physical proximity to suppliers seems to be essential to guarantee the coordination of physical and information flows between the supply chain activities and to acquire shared resources that allow for an efficient solution of the day-to-day problems (Narasimhan and Nair, 2005; Cousins *et al*., 2008). An increasing dispersion of the internal network, however, may counterbalance these efficiency effects at the network-level. Colotla *et al.* (2003) suggested the existence of interdependencies between plant level and network-level capabilities and demonstrated that factory and network capabilities may complement or offset one another, depending on the international manufacturing structure adopted by the firm. In line with this, our results show that when spatial complexity of the internal network continues to grow, the relative benefits of physical proximity to the supply network are impeded, and in turn, the efficiency of activities is reduced. One of the driving forces of subsidiaries is to increase access to markets (Rugman *et al.,* 2011) but they could also play an important role in the company's efforts to access the suppliers' resources and capabilities (Demeter *et al.,* 2016). An increased spatial dispersion of the buying firm's internal network of subsidiaries could thus offer location advantages at the output side by fostering sales through the subsidiary network as well as at the input side by mediating the firm's access to supplier's knowledge and capabilities and improving communication and coordination through the subsidiaries' proximity to their suppliers. At the same time, however, the increased structural complexity at the network level will eventually exhaust managerial capacity leading the firm to face difficulties and increasing expenses (Lu and Shang, 2017). Operating a globally dispersed network, the focal firm's supply chain management needs to be capable of bundling location advantages of a larger number of countries with internal resources controlled by the subsidiaries and of coordinating a more granular value chain across specialised subsidiaries

located in different countries (Rugman *et al*., 2011). If there is not sufficient managerial capacity and expertise to handle these increasing requirements, established processes and schedules can no longer be maintained and the efficiency decreases. Moreover, decisions related to internal and supply networks are often made independently at different times and by different people which imposes additional challenges in terms of integration and alignment.

This is not trivial. Companies that take advantage of the physical proximity with their suppliers through increased knowledge flows are also those that tend to be more geographically dispersed (Whittington *et al*., 2009). Not taking into account that trait of the firm ignores the pressure on investing in getting a benefit from the physical proximity with suppliers while at the same time operating in a global context. This point is particularly salient in our sample of computer and electronics manufacturers. Our results also relate to the concept of structural embeddedness which indicates that the network configuration might allow for important new information to reach the network (Uzzi, 1997). However, a complex configuration can invite more ambiguities than benefits (Kim *et al*., 2011). Therefore, it is important for multinational companies to be aware of potential high levels of internal complexities and to actively manage their networks to avoid negative effects.

This study offers two theoretical contributions. With respect to research on supply networks, this study has helped move the discussion beyond the impact of supply network complexity on performance. Supply network complexity has negative consequences on responsiveness (Choi and Krause 2006), delivery speed (Vachon and Klassen, 2002) and frequency of supply chain disruptions (Bode and Wagner, 2015). However, when studying supply network complexity, previous studies have not considered the geographically dispersed internal network of the focal firm that captures the internal complexity. In our study, this consideration has allowed us to draw a more complete picture of these networks because internal networks do not only play a key role in managing the supply network but also, can complicate the overall coordination of

material and information flows with suppliers. Our study has shown that, for multinational companies, proximity to the supply network may be matched by an internal network spatial complexity that negatively impacts firm-level performance as the marginal profitability of the additional subsidiaries decreases.

With respect to dual embeddedness, we have shown that the improved subsidiary performance, that has been shown in previous studies, may be offset by the increased spatial complexity of the subsidiary network at the firm-level. By using a large secondary dataset, our research is the first empirical study that examines the firm-level effects of this dual embeddedness considering firm-level financial performance, thus extending previous findings of operational performance in the literature (e.g., Stock *et al.,* 2000; Kim, 2014; Demeter *et al.,* 2016) and relational embeddedness of the subsidiaries (e.g., Golini *et al.,* 2016; Achcaoucaou *et al.,* 2014; Demeter *et al.,* 2016).

Also, the reducing financial returns that we found reveal an explanation for the conflicting results of the effects of embeddedness on performance in the past literature. From our standpoint, the seemingly inconsistent findings can be reconciled as follows: a buyer's internal spatial dispersion can slow down the expected returns from collocating with suppliers. In other words, the complexity emerging from dual embeddedness in supply and internal networks can lead to actual financial repercussions at the firm-level. The costs to manage business complexity can greatly affect the focal firm's operations and hurt its financial performance. Thus, our results warrant further investigation of embeddedness across various contexts of supply chain relationships and networks.

From a managerial perspective, our results invite managers to carefully weigh the advantages of having physical proximity to suppliers, including those through their subsidiaries, and the challenges of having an extensive internal network of subsidiaries. Our results suggest a need for strategic planning that consider the interaction of internal and supply

network. Moreover, managers should think of the firm-level impact of dual embeddedness, in addition to subsidiary-level performance as a result of it. This paper, therefore, provides insights into aligning supply and internal networks more effectively.

Another interesting issue highlighted by the results is one that, in our view, is not discussed enough in the operations and supply chain management literature, which is the extent to which multinational companies, whether buyers or suppliers or any entity in the supply chain, must bear in mind the challenges of internal complexity and the associated consequences on performance. Managers must be aware of the source of complexity in order to identify complexity reduction tools to simplify their strategies and processes. As visibility of the supply and internal networks as well as of the interconnections between them is essential in order to identify and reduce complexity, managers need to systematically obtain information about their upstream and internal operations.

By understanding the spatial complexity of internal networks and managing them consciously, firms can benefit from physical proximity to their network partners and put into practice successful mechanisms to an efficient interaction with them (Dyer and Nobeoka, 2000). This is useful not only for the focal firm, but for supply network partners as well, as it may enhance their own performance. In line with this, our paper offers an understanding of supply chain management challenges when network complexities increase.

7- Conclusion

This study has demonstrated the importance of considering a multinational corporation's supplier and internal networks simultaneously to understand their impact on financial performance. The complexity of the subsidiary network may overwhelm the benefits gained from the physical proximity of the firm with its suppliers. This is perhaps even a bigger issue when subsidiaries help the firm connect to its suppliers. Although several past papers have

studied the relationship between proximity of the firm with its suppliers and performance, the internal networks of subsidiaries have mostly been ignored. The possible interaction between the internal and supply network has been acknowledged in dual embeddedness research. Yet, the structural embeddedness of this subsidiary network and even further the firm-level impact of dual embeddedness has not been explored. Our research has investigated this discord. This study has empirically shown the interaction between supply and internal network and its effect on firm-level financial performance in the supply chain context. It also has offered new insight into the impact of dual embeddedness at the firm, rather than the subsidiary-level. Our results proved that a firm has to consider the spatial complexity of its internal network beyond just building relationships and collocating with suppliers.

While the findings in this paper are insightful, we recognize that our study has limitations. One limitation is that it did not consider the issue of absorptive capacity since we are not measuring knowledge or information transfer between internal and supply networks. Therefore, our results are conservative implying a potential for knowledge flow and transfer when networks are collocated but whether knowledge is successfully shared is also dependent on additional factors such as absorptive capacity, communication channels and joint innovations. Future studies can examine the aspects of the interaction between the two networks by measuring absorptive capacity of subsidiaries and dig further into other characteristics that may impact a subsidiary's ability to grasp knowledge from internal and supply networks.

In addition, other contextual factors were not taken into consideration in our study. In this respect, this study underscores the need for further investigations of internal and supply network complexity and further considerations of the multi-dimensional nature of complexity by looking at more or other measures such as product, cultural or subsidiary type complexity. Indeed, various types of subsidiaries can be found within a global network, future research could offer a more thorough examination by explicitly focusing on the type or level of

subsidiaries per se. To obtain more insights on how to manage dual embeddedness at the firm-level, future research can use qualitative studies that map the processes and capabilities that MNCs need to ensure that the benefits of dual embeddedness are not offset by the complexity of an extensive subsidiary network.

Last but not least, we used cross-sectional data in this paper, which limited our ability to study a causal relationship among variables and infer the time lag between physical proximity, geographic dispersion, and changes in performance. Future empirical studies may conduct a longitudinal study that would allow researchers to understand the causal effect of embeddedness on desirable outcomes and outline the progress of a company. The use of longitudinal data would be a suitable starting point for generalizing the results of this study.

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Table 1: Description, mean and SD of all variables

Variable	Description	Mean	SD
Firm size	Number of employees	73156.32	103057.884
Firm age	2019 - Founding year	52.1	42.6547
Nbr of suppliers	Number of suppliers	50.28	63.180
P_j^1	Physical proximity at the parent company level	0.38242	0.2485
P_j^N	Physical proximity at the network-level	0.8001	0.2072
D_j	Geographic dispersion of subsidiaries	0.1912	0.1111
ROA	Return on asset	10.618	8.953
PMP	Profit Margin percentage	15.467	12.985
CFSR	Cash flow as percentage of sales	18.1724	14.014

Table 2: Models Specification

	Variables	Level
Model 1	P_j^1, D_j, P_j^1 x D_j, ROA	Parent-company-level
Model 2	P_j^N, D_j, P_j^N x D_j, ROA	Network-level
Model 3	P_j^1, D_j, P_j^1 x D_j, PMP	Parent-company-level
Model 4	P_j^N, D_j, P_j^N x D_j, PMP	Network-level
Model 5	P_j^1, D_j, P_j^1 x D_j, CFSR	Parent-company-level
Model 6	P_j^N, D_j, P_j^N x D_j, CFSR	Network-level

Table 3: The zero-order correlations for all the study variables.

No	Variable	1	2	3	4	5	6	7	8	9
1	Firm size	1								
2	Firm age	.343**	1							
3	Nbr of suppliers	.582**	.264**	1						
4	P_j^1	-.424**	-0.143	-.215*	1					
5	P_j^N	0.194	.310**	.214*	0.085	1				
6	D_j	.309**	.382**	.281**	-0.179	.502**	1			
7	ROA	-.295**	-.200*	-0.106	.197*	-0.020	-.202*	1		
8	PMP	-.357**	-.294**	-0.112	.240*	-0.008	-.283**	.851**	1	
9	CFSR	-.371**	-.275**	-0.133	0.167	-0.062	-.267**	.563**	.736**	1

** Pearson correlation coefficients significant at p =0.05 level*

*** Pearson correlation coefficients significant at p =0.01 level*

Table 4: Hierarchical regression for the interaction effect between physical proximity and geographic dispersion on performance

	ROA		PMP		CFSR	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control Variables						
Firm size	-4.73 (2.35)	-5.56** (2.22)	-9.30** (2.59)	-9.71** (2.38)	-10.495** (3.59)	-10.81** (3.29)
Firm age	-0.024 (0.023)	-0.023 (0.023)	-0.03 (0.025)	-0.037 (0.026)	-0.047 (0.034)	-0.053 (0.034)
Nbr of suppliers	0.017 (0.017)	0.017 (0.017)	0.022 (0.018)	0.022 (0.018)	0.036 (0.026)	0.036 (0.025)
Intercept	32.49** (10.26)	36.95** (9.70)	54.78** (11.28)	57.65** (10.37)	66.89** (15.67)	69.99** (14.36)
Predictor Variables						
D_j	-11.65 (8.70)	-10.64 (9.91)	-2.99 (9.58)	-4.83 (10.61)	-20.39 (13.29)	-17.92 (14.67)
P_j^1	0.67 (3.94)		1.75 (4.34)		-1.46 (6.02)	
P_j^1 x D_j	-61.89** (30.86)		-35.69 (43.25)		-38.74 (47.12)	
P_j^N		3.14 (5.46)		2.623 (5.83)		1.95 (8.07)
P_j^N x D_j		-40.99 (41.06)		-60.24 (43.89)		-107.40** (60.75)
R^2	15.70%	13.80%	22.50%	25.0%	19.80%	22.90%
Adjusted R^2	10.30%	8.20%	17.50%	20.10%	14.60%	18%
F statistic	2.895**	2.471**	4.457**	5.110**	3.832**	4.614**
Change in R2 related to moderator	3.60%	0.90%	0.10%	1.50%	0.60%	2.60%
F statistic for change	4.021**	0.997	0.681	1.858	0.676	3.126*
N	100	100	100	100	100	100

** $p<0.05$
* $p<0.10$

Figure 1: Dual embeddedness

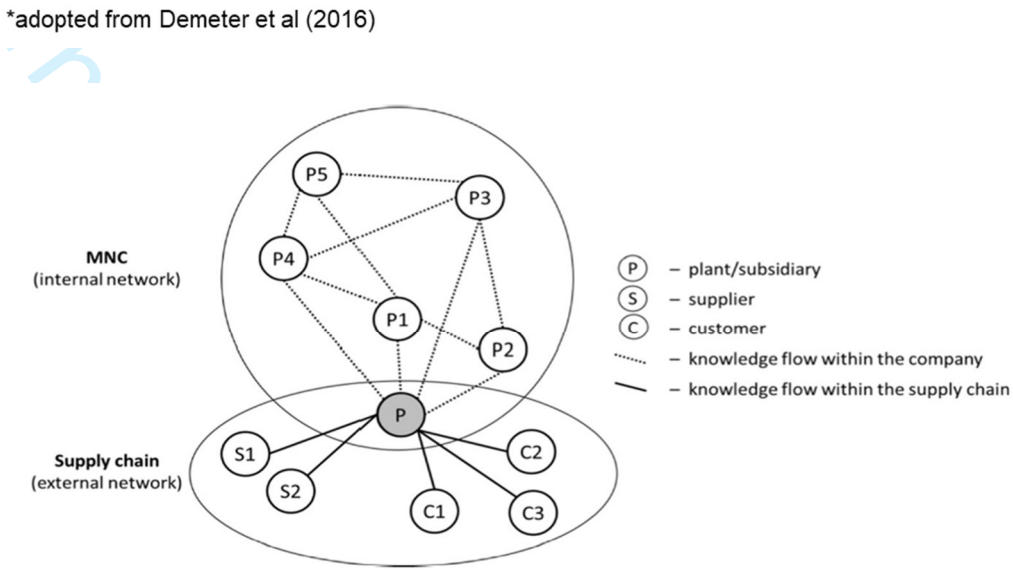
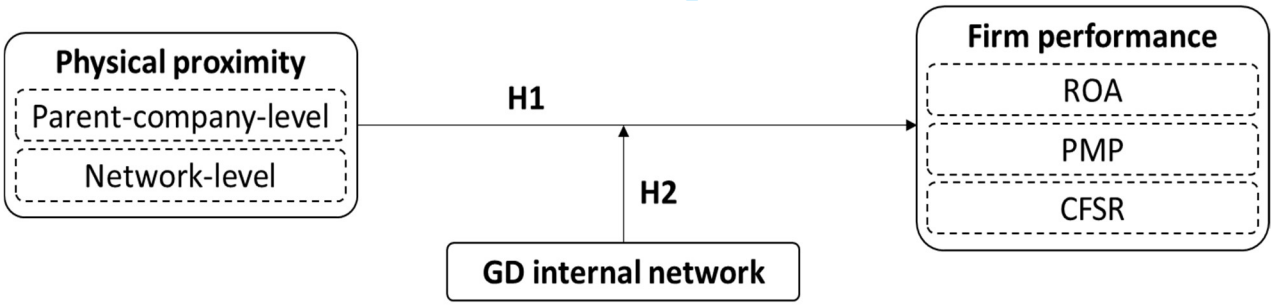


Figure 2: Research Model



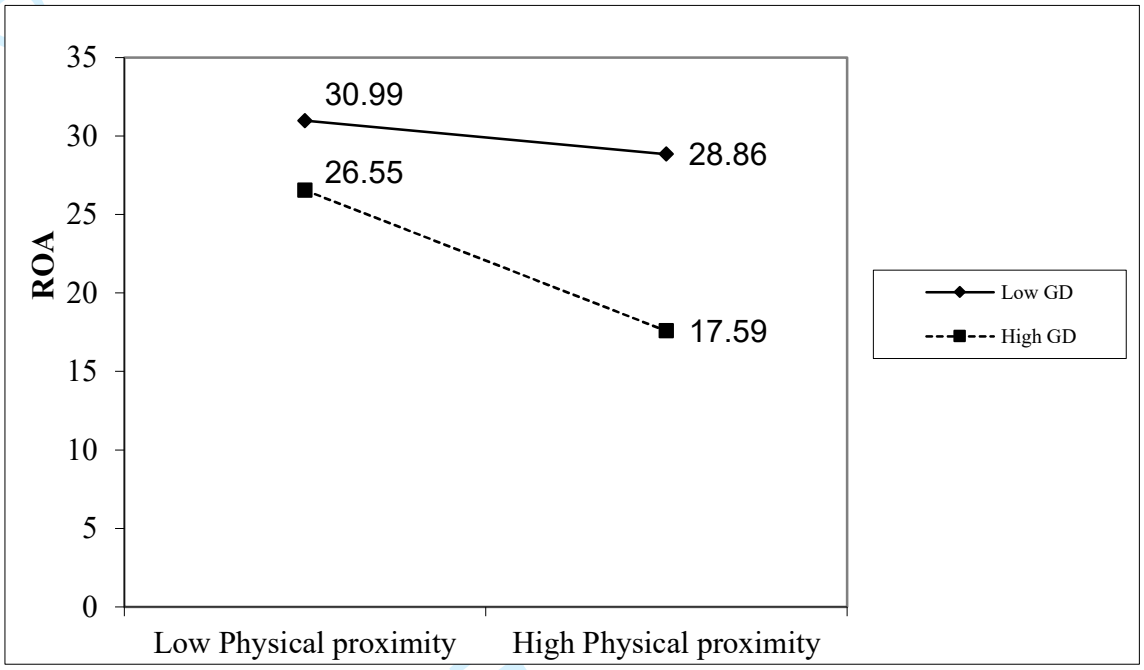


Figure 3: The moderation effects on ROA

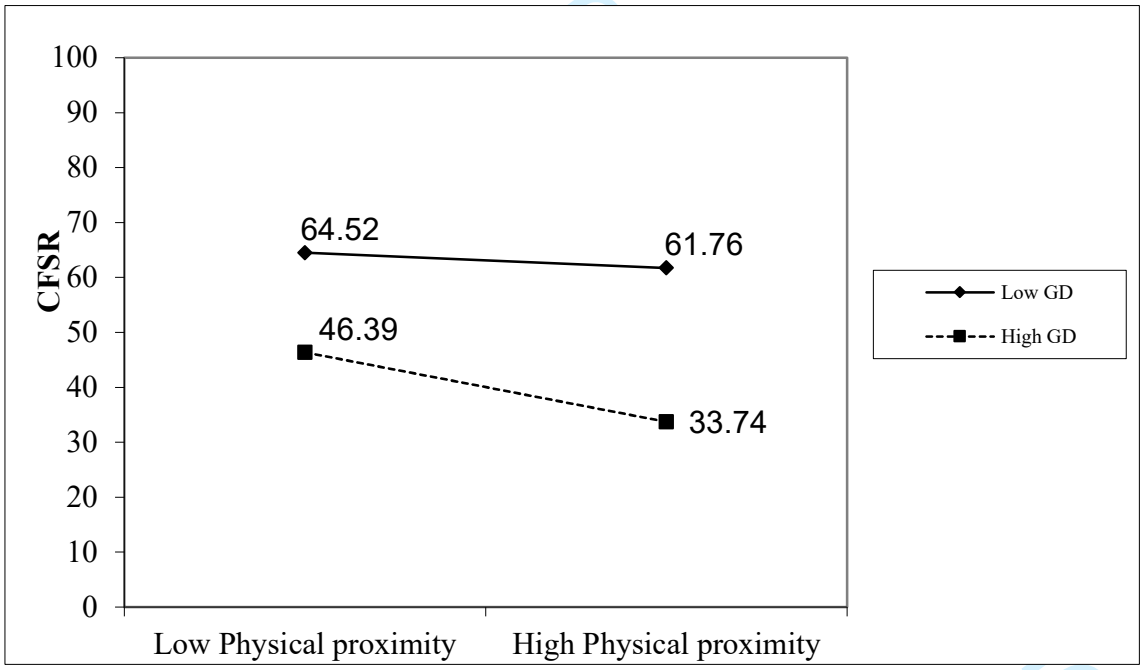


Figure 4: The moderation effects on CFSR