Asymmetrical Power Relationships in Supply Chain Networks

Anjali Singh

Supervisor:

Dr. Shantanu Dutta

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Telfer School of Management
University of Ottawa

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Abstract

Global supply chains have become increasingly complex and a critical source of competitive advantage, which makes the understanding of how supply chains create and distribute value an essential task. Prior literature on concentration risks has primarily focused on customer concentration and has overlooked the challenges posed by the major upstream supply chain partners. In addition, CEOs with an optimal mix of technical and behavioral abilities can shape the strategic decision-making process to obtain an advantage against the nonfinancial stakeholders. The existing literature has also overlooked the significant role of the CEO in reducing the impact of supplier-base/customer-base concentrations.

Utilizing objective supply chain relation data collected from Bloomberg SPLC and Compustat, we map the supplier base and the customer base for each electronic and chemical manufacturing firm publicly listed under S&P1500 for the fiscal year 2017. We then construct objective measures of supplier and customer concentrations and examine their impacts on the focal firm's financial performance measured by Tobin's Q, gross profit margin, and net profit margin. The performance metrics also include the focal firm's payable period (against the supplier-base) and receivable period (against the customer-base). We also collect information related to the CEOs appointed by the focal manufacturing firm, such as gender, age, and tenure from Execucomp, and consequently investigate their impacts on the supplier concentration and the customer concentration.

Our empirical analysis shows contradictory results in the context of supplier-base/customer-base concentrations: higher supplier-base concentration is observed to harm the focal firm’s financial performance, but higher customer-base concentration leads to an increase in the focal firm’s profitability. Although CEO characteristics such as tenure and age did not have any notable impact, female CEOs are found to reduce the adversarial impact of supplier-base concentration and are assumed to exercise a voluntary power restraint against the cooperative customer-base.

Keywords: Supplier-Base Concentration, Customer-Base Concentration, Profit Margin, Accounts Payable Period, Accounts Receivable Period, CEO characteristics

Chapter 1: Introduction

1.1 Overview of Supply Chain Complexity in General

Global supply chains are gradually being recognized as a critical source of competitive advantage and differentiation. Several academics and practitioners corroborate that today's supply chains are evolving ceaselessly to reflect the increased complexity in international trade flows. This escalating complexity in commodities, processes, and supply chain networks has been catalyzed by factors such as an increasingly volatile global environment, various alternatives, and declining manufacturing depth accompanied by ever shorter product life cycles (Beinhocker, 2007). Lee's (2010) visualization of supply chain networks competing for economic growth instead of the individual corporations (as cited in Aelker et al., 2013) has become apparent since such trends are primarily visible in institutions operating in value networks and at a global level. The upgradation from operating as a single entity to operating in an organized network structure causes an exponential increase in the perceived complexity for a firm's supply chain functions (Aelker et al., 2013).

There is broad acknowledgment about supply chain complexity (SCC) as a risk factor in global firms in recent years. The 2020 State of Supply Chain Complexity survey by Körber (2020) finds that only manufacturing and fulfillment complexities continue to grow, 91% of supply chain professionals cannot stay ahead of challenges caused by SCC, and 51% of businesses can only tackle one SCC at a time. The annual Gartner's Supply Chain research continues to highlight the trends firms integrate to cater to the complexity of their respective supply chain networks such as artificial intelligence, edge computing, and supply chain governance. Over the years, SCC has become significant enough to hinder decision making (Manuj & Sahin, 2011), foment disruptions (Chopra & Sodhi, 2014), and handicap day-to-day plant-level operations (Bozarth et al., 2009) if not planned strategically to maximize a firm's operational and financial performance. Further, the coronavirus disease of 2019 (COVID-19) crisis has drawn attention towards both the capability as well as the vulnerability of worldwide supply chains in meeting consumers' needs. Often time cost reductions and other strategies implemented at meeting high-performance targets have direct implications on the overall network structure of the firm. In such scenarios, supply chain decisions such as supply base reductions and outsourcing/offshoring of production can be made; hence reorganizing the firm's supply network's composition and structure

and significantly impacting its firm performance (Carnovale & Yenlyurt, 2015). In their recent article, Deloitte authors highlight that decades-long attention on supply chain optimization to minimize costs, reduce inventories and boost asset utilization has removed buffers and flexibility to absorb disruptions (Kilpatrick & Barter, 2020). Thus, the disruptions in the supply chain networks and sudden changes in consumers' behavior propose the need for renewed attention to the underlying operations involved in production and distribution.

1.2 Power Beyond the Supplier-Customer Dyadic Relationships

There is a series of research undertakings in the field of supply chain management (SCM) that explores the structural complexity characteristics of supply chains as salient determinants of firm performance (Kim, 2014). Supply chain structure and complexity are crucial for a focal firm since they can affect a firm's cost structure (Choi & Krause, 2006), innovation output (Bellamy et al., 2014), performance (Kim, 2014), and handling of the supply chain disruptions (Bode & Wagner, 2015; Craighead et al., 2007). A study conducted by A.T. Kearney (2007) sheds light on the fact that firms can increase earnings by 3%-5% if they are able to make improvements in the supply chain structure (as cited in Lu & Shang, 2017). Magutu et al. (2015) observed a strong significant relationship between supply chain technologies, supply chain structural framework, and firm performance, where both the explanatory strategies explain 88.2% of the changes in the firm's performance. A push for transparency is also encouraged so that firms can become more resilient by understanding their complete network of suppliers and identifying critical potential bottlenecks (Kilpatrick & Barter, 2020). Since SCC management has become increasingly vital to firms competing in today's global economy, the need for learning how supply chains create and distribute value has also grown.

In the past, some authors have explicitly discussed that successful SCM practices can improve the financial standing of all the chain members (Wisner & Tan, 2000; Tan, 2002). This indicates that chain members share the profits from the supply chain performance equitably. However, Ketchen & Giunipero (2004) support the claim that successful SCM potentially creates a rising tide that lifts some but not all the boats. In practicality, the intrinsic state for supply chain networks does not appear to be one of symmetry or equilibrium (Ogbonna & Wilkinson, 1996). According to Belaya et al. (2009), a well-branded firm represents a focal actor, whereas the other network actors are dependent on the focal firm because of long-established implicit or explicit

contracts. Thus, it can be emphasized that supply chain networks consist of asymmetrical power relationships. In the same train of thought, Crook & Combs (2007) mention that once a firm adopts SCM, other chain members become vital components of the firm's ecosystem. This increases the firm's dependence on the chain wherein the relative need to acquire resources shapes each member's motivation. Furthermore, organizational theories assert that a creator of competitive advantages may not necessarily be the recipient of those competitive advantages because profits in firm performance are not only determined by how large a pie is created but also by how a pie is appropriately shared (Barney, 1991; Coff, 1999). A conventional example of this scenario is when a firm dominates the other transactional collaborators to accomplish its desirable organizational goals through the influence of asymmetric dependence. Therefore, it becomes a quintessential task to study the relative bargaining power of the chain members, which has only been addressed by a few earlier studies.

1.3 Role of Key Personnel in Improving the Supply Chain Value

Over the last decade, the intricacies and challenges of managing global and outsourced supply chain networks in an intensely competitive environment have increased the number of firms having SCM functions represented on their respective top management teams (TMTs). According to Sandberg & Abrahamsson (2010), this team which typically includes a chief executive officer (CEO), chief operations officer (COO), chief financial officer (CFO), purchasing manager, production manager, logistics or warehouse manager, etc. has a position of the main enabler for SCM activities. The TMT takes the responsibility of coordinating "historically separated functions such as demand functions (e.g., marketing and sales) and supply" (Matchette & Lewinski, 2005), supervising knowledge-sharing across company borders, and developing stronger supply chain alliances (Moberg et al., 2003). The CEO, along with the board of directors, also helps in maintaining an appropriate level of working capital in the organization since they are responsible for formulating policies regarding cash management, accounts payable, accounts payable, inventory purchases, and maintenance (Gill & Bigger, 2013). Simultaneously, both the directors and the CEO are responsible for resource allocation and innovation performance. According to Daily & Johnson (1997), the power of a CEO increases when a board is composed of directors who have connections to, and who are appointed by the current CEO. Such intentional board appointments can guarantee prestige, status, and financial rewards, due to which directors become

loyal and socially obligated to grant more resources for R&D investments (Westphal, 1999). Thus, it can be implied that powerful CEOs provide a strategic flexibility which increases the firms' willingness and potential to innovate through R&D investments (Chen, 2014). Carmeli et al. (2012) concluded their study along similar lines and suggested that CEOs can improve the quality of strategic decisions of their TMTs by creating psychological conditions of trust and facilitating learning from failures. In conclusion, it can be discerned that a CEO with an optimal mix of technical and behavioral abilities can shape the process of making strategic decisions and attain a competitive advantage for their respective organizations.

An embryonic theme that stems from the particular stream of CEO characteristics and supply chain performance is the need for gender diversity in leadership roles. Lately, organizations across various industry sectors have recognized gender diversity in their corporate and supply chain operations, intimating that gender diversity, which strives to provide benefits for both employees and the firm, is a crucial issue on their current agenda (WEF, 2018). According to Gartner Inc.'s 2020 Women in Supply Chain survey among 177 supply chain professionals, 17% of chief supply chain officers in North America were women (the highest rate since the first edition of the survey), which is a 6% increase as compared to 2019. In 2015, approximately 60% of the total employees at Tesco, Walmart, and Carrefour were women; however, women represented between 31% and 42% of managers and only 23–25% of board members as part of the TMTs (WEF, 2018). Also, the recent findings of a literature review of academic and professional articles over three decades propose that there is a dearth of empirical research on gender diversity in the sustainability management of supply chains (Ruel et al., 2020). The review asserts that even though some studies have investigated gender diversity and SCM, the focus is directed primarily on the hurdles encountered by women in the supply chain field, portraying women as victims but not women as potential change-makers. The information mentioned above indicates that despite an increasing number of women finding supply chain careers, they are still under-represented in supply chain leadership.

1.4 Motivation

A supply chain can be represented as a complex system (Basole et al., 2011) with system components (i.e., nodes representing firms, suppliers, facilities, and customers, among many others), connectivity, firm-level (node-level) structural properties, flow type, centralization, the

strength of ties, etc. Prior studies have primarily employed social network analysis as a vantage point to understand, compute and analyze prominent structural and relational properties of interconnected firms (Kim et al., 2011; Bellamy et al., 2014). While any company's supply network structure is essential in determining how efficient its processes are, a detailed understanding of the supply base structure is also important (Lu & Shang, 2017). A supply base mostly consists of 1st tier suppliers directly managed by the focal firm. In many cases, the supply base is the most fundamental tier that directly and actively influences the focal firm's performance (Wilhelm et al., 2016). Regarding firm performance, long-term relationships with customers have also been essential for organizations in the competitive global market. Despite the conventional view that a concentrated customer base harms manufacturers' operating profits and hinders the overall supplier performance, genuine and dependable relations with customers are usually beneficial in the long run. Previous studies indicate that a concentrated customer base helps supplier firms become more innovative and achieve larger investments in R&D (Krolikowski & Yuan, 2017), inventory efficiencies (Ak & Patatoukas, 2016), and lower audit pricing and reduced probability of material restatements (Krishnan et al., 2019). With specific contractual agreements, suppliers and customers can create substantive business profits for each other. In summary, a nuanced comprehension of the base-level structural complexity is imperative for a focal firm to reduce risks and build core competencies such as fewer costs, better product quality, short lead time, and faster time to market.

A closer look at this growing area of SCC reveals that the extant research remains deficient in three ways. First, researchers have persistently designed studies to assess dyadic structures while overlooking the larger, more intricate structures representing complex supply chains, such as triads. According to Choi & Wu (2009), the triad is the fundamental unit of analysis for a network and one of many relevant subsets of a wider supply chain network. As a result, this study is in favor of triadic analysis as a means of addressing network dynamics. Here, we create a three-stage supply chain consisting of a supplier base, a focal firm, and a customer base and reveal important implications by conducting an in-depth analysis of asymmetrical power relationships.

Second, researchers have either examined the impact of supply network structure or supply network complexity on firm performance. However, limited evidence exists on investigating the power dynamics between a focal firm and its base-level supply chain partners, particularly in the

context of structural complexity. According to Serdarasan (2013), "complexity in a supply chain grows, as customer requirements, competitive environment and industry standards change, and as the companies in the supply chain form strategic alliances, engage in mergers and acquisitions, outsource functions to third parties, adopt new technologies, launch new products/services, and extend their operations to new geographies, time zones and markets" (p. 534). Therefore, our priority is to investigate both the impacts of supplier concentration and the customer concentration on every focal manufacturing firm involved in the sample[1].

Third, hitherto, very little empirical research has been conducted to study the impact of gender diversity on SCM practices and performance (Chin & Tat, 2015) and, more precisely, limited scientific work has been directed on how female CEOs tackle the hurdles posed by the power asymmetry in supply chain networks. According to Ruel et al. (2020), the influence of gender diversity has been studied more in other management-related fields, such as gender diversity in the boardroom (Kakabadse et al., 2015) or firm performance (Campbell & Mínguez-Vera, 2008). Additionally, gender diversity related to sustainable practices focuses more on upstream supply chains (Bell, 2013; Lahiri-Dutt, 2015). Hence, there is a requirement to have a more comprehensive overview of the impact of gender diversity on both upstream and downstream supply chain networks. Here, we have decided to address this additional research gap and investigate the effect of female CEOs appointed by the focal manufacturing firm on the supplier concentration as well as the customer concentration.

Some studies have previously discussed about the three triadic network conditions in the study of industrial networks viz: (1) one buyer sourcing from two suppliers (2) a supplier interacting with an intermediary and an end-user (3) one supplier interacting with two buyers (Choi et al., 2002; Dubois & Fredriksson, 2008). Since we aim to provide a systematic depiction of supplier-customer trade relations' complex and holistic nature, the empirical study aligns with the second condition. Here, the network model consists of a focal firm (or the intermediary) sitting on a structural hole between the supplier and the customer, indicating a lack of direct relationship

[1] Prior literature has extensively studied different dimensions of structural complexity on performance (Choi & Krause, 2006; Bozarth et al., 2009; Bode & Wagner, 2015; Carnovale & Yeniyurt, 2015; Lu & Shang, 2017; Basole et al., 2018; Carnovale et al., 2019; Sharma et al., 2019, Kumar et al., 2019; Li & Zobel, 2020). As a result, supplier-base/customer-base concentrations are the main complex explanatory variables in the study.

between the two supply chain levels. With the help of a proprietary dataset compiled from two data sources – Bloomberg and Compustat, we map the supplier base and customer base of several manufacturing companies within S&P1500[2]. Besides, we also collect information related to the current CEO such as gender, age, and tenure from Standard and Poor's Execucomp. We then construct objective measures of supplier and customer concentrations as well as structural complexity metrics for each side. With the explanatory variables in hand, we specifically address the following research questions in the study:

RQ1: What is the impact of supplier-base concentration on the focal firm performance?

RQ2: What is the impact of customer-base concentration on the focal firm performance?

RQ3:What is the impact of CEO characteristics on the supplier-base/customer-base concentrations?

1.5 Overview of the Empirical Study

The study has six chapters. The following figure offers a quick overview about the structure of the study.

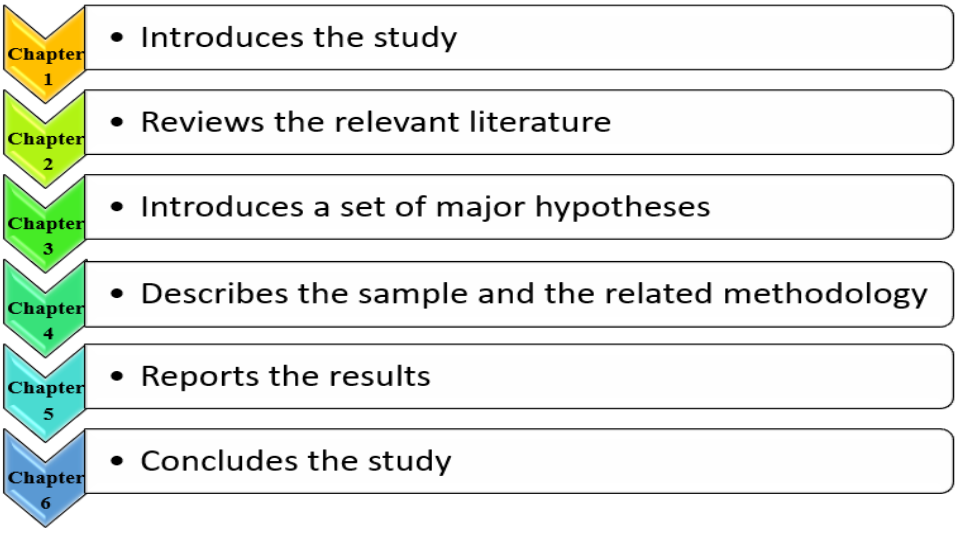

Figure 1. Six chapters of the study at a glance

[2] We have used structural complexity dimensions such as horizontal, vertical, and geographical complexity from Lu & Shang, (2017) to map the supplier and customer base for the focal firms involved in the sample. However, we do not include horizontal complexity (i.e., number of direct suppliers and customers) in the regression models due to interaction effects resulting from including a similar concentration variable.

This Chapter discusses the significance of SCC management for firms competing at the global level and the relevance of power dynamics between the supply chain allies in creating and maximizing the shared value. It also emphasizes the role of CEO characteristics, particularly gender, in influencing the critical decision-making of the focal manufacturing firm. Lastly, it addresses our personal motivation for studying power asymmetry in the context of supply chain networks. Chapter 2 begins with a review of SCC drivers and discusses prior literature related to identifying, classifying, and measuring the said complexity drivers. It also talks about the supplier-customer strategic partnerships and highlights the importance of supply chain finance as an essential tool to improve the working capital for all the supply chain members. In the end, it discusses how valuable CEO characteristics are in improving the focal firm performance against its supply chain partners. Chapter 3 introduces a set of significant hypotheses and the relevant rationales, which are later investigated in the empirical study. Chapter 4 talks about the involved sample and the variables. It also presents the appropriate methodology for the purpose of hypothesis-testing. Chapter 5 exhibits the basic descriptive statistics and the results from the analysis of the regression models. Finally, Chapter 6 discusses the findings explored in the previous section, directions for future research, and the study's contributions and limitations.

Chapter 2: Literature Review

2.1 Supply Chain Complexity

Since the aim of the study is to observe power asymmetry in the supply chain relationships, especially under the influence of SCC, this section reviews and discusses the literature related to defining SCC and its comprehensive impact on firm performance.

2.1.1 Defining Supply Chain Complexity

Technology shift, dynamic environmental conditions, varying consumer demands, globalization, competition, and market risk are some of the trends that manufacturing companies cannot avoid, which unfortunately induce an increasing amount of complexity in the supply chain (Vogel & Lasch, 2016). The complexity is further intensified through a shortage of coordination among supply chain partners that needs to be adaptive, resilient, and consistent. Hence, in addition to product design/modification and process development, it is imperative to enhance the SCM of the companies to reduce complexity (Skilton & Robinson, 2009). To maintain the stability of everyday operations and attain success in the long run, firms always need to monitor their supply networks on real time-basis (Khadem et al., 2017), especially to escape the occurrence of disruptions due to complexity (Bode & Wagner, 2015).

Complexity is extensively viewed as a major theme in supply chain literature, where there is a consensus that supply chains have become increasingly complex over the last decades. Wilding (1998) is one of the first few scholars to develop the concept of SCC by proposing a "supply chain complexity triangle." According to Wilding (1998), supply chains can be considered complex if they exhibit three aspects: deterministic chaos, parallel interactions, and amplifications. Vachon & Klassen (2002) developed their own two-dimensional definition of SCC where the degree of complexity is embedded in a supply chain along two major dimensions: (1) form of technology (2) nature of information processing. Here, technology is characterized using a standard operations strategy framework of structural and infrastructural components. Simultaneously, information processing captures both the level of complicatedness and uncertainty that exists in the supply chain. Together, these two dimensions create a two-by-two matrix that defines SCC and produces a strong theoretical background for investigating the impact of complexity on delivery performance. Choi et al. (2001) managed to offer a completely different perspective by

conceptualizing supply networks as “complex adaptive systems” (CAS), developed in the systems science literature (Holland, 1995).

Bozarth et al. (2009, p. 80) defined SCC in the context of “detail complexity and dynamic complexity that is exhibited by the products, processes, and relationships that form up a supply chain.” In particular, they present a conceptual model that classifies plant-level SCC into three distinct parts (downstream complexity, internal manufacturing complexity, and upstream complexity) and differentiates between the detail and dynamic complexity drivers. Detail complexity defines “the distinct number of components or parts that make up a system” (Bozarth et al., 2009, p. 79). Common drivers of detail complexity include the number of suppliers, customers, products, or parts in a firm’s supply chain network. On the other hand, dynamic complexity is related to uncertainty and defines “the unpredictability of a system’s response to a given set of inputs” (Bozarth et al., 2009, p. 79). Here, uncertainty can be correlated with time and randomness (Serdarasan, 2013), as well as ambivalence and incertitude (Isik, 2010). SCC can also be seen as whole operational, structural, and behavioral abnormalities existing within a supply chain that are generated by uncertainties and/or varieties that occur expectedly (predicted) and/or unexpectedly (unpredicted) through internal or external drivers within a supply chain system (Isik, 2011).

The evidence from the numerous empirical studies examining the impact of SCC in the supply chain literature helped Bode & Wagner (2015) to conclude that complexity is an undesirable feature. Within this area, two sub-streams perceive SCC in a new light (Bode & Wagner, 2015). One stream regards supply chains as complex adaptive systems that can learn and get accustomed to changes in the surrounding environment (Choi et al., 2001; Cagliano & Carlin, 2009). The other stream observes supply chains as complex social networks and uses SNA aspects to understand how relational ties are formed and how these ties influence social capital, resource access, and contagion in the supply chain networks (Borgatti & Li, 2009; Kim, 2014; Lomi & Pattison, 2006).

Previous empirical investigations conducted on SCC reveal that attempts to develop a definition are numerous and depend on individual outlooks. Therefore, there is no universal definition for SCC. The variations in theoretical frameworks used for modeling SCC indicate a lack of clarity and agreement regarding the complexity dimensions and the factors that underline

those dimensions. However, most of the empirical investigations have distinguished SCC as a multi-faceted, multi-dimensional phenomenon that is induced by several sources (Manuj & Sachin, 2011).

2.1.2 Effect of Supply Chain Complexity on Performance

A supply chain network consists of several business entities who work together directly or indirectly to support information, material, and financial flows. Uncertainty, variety, diversity, numerousness, etc., are some of the risk factors which lead to inconsistency between expected and actual flows. These flows sometimes lead to high complexity due to distorted or lack of information within the supply chain. The conceptualization of SCC as detail and dynamic complexity is well accepted in supply chain literature (Serdarasan, 2013; Bode & Wagner, 2015; Aitken et al., 2016). Detail and dynamic complexity can arise on different levels: from within an organization (internal complexity) or via the plant's connections with downstream and upstream partners (upstream and downstream complexity or external complexity) (Bozarth et al., 2009).

The association between internal and external complexity and performance has been an area of active research investigation. Firm-level financial performance that has been considered in complexity studies include such measures as return on investment, international return on asset, growth of sales, and overall business performance (Carnovale & Yeniyurt, 2015; Kumar et al., 2019; Basole et al., 2018; Lu & Shang, 2017). Several studies in the area employ operational performance as a single scale (Rungtusanatham et al., 2003; Bozarth et al., 2009; Kim et al., 2011; Bode & Wagner, 2015), while others include various dimensions for operational performance such as cost, responsiveness, recovery time, delivery, productivity, time to market and efficiency (Choi & Krause, 2006; Li & Zobel, 2020; Vachon & Klassen, 2002; Swink et al., 2007; Tracey, 2004; Saeed et al., 2005). Sharma et al. (2019) recently linked the complexity of supply chain network to a focal firm's innovation performance.

Traditionally, an SCC dimension has always been portrayed to harm operational performance (Hoole, 2005; Bode & Wagner, 2015). "An SCC driver is any property of a supply chain that increases its complexity" (Serdarasan 2013, p. 534). However, this perception of SCC as having only an adverse impact on a firm's performance has been disputed. Various studies (Skilton & Robinson, 2009; Aitken et al. 2016) have confirmed that if SCC can be managed

efficiently, it can lessen high costs and enhance supply chain performance. In reality, firms need to identify the drivers of complexity, understand the difference between "necessary" and "unnecessary" SCC, and accommodate them with appropriate responses to reap a competitive advantage (Serdarasan, 2013). For instance, Isik (2011) talked about four strategies that can effectively manage SCC : (1) identifying (2) measuring (3) analyzing (4) controlling (reducing and avoiding). Similarly, Piya et al. (2020) postulate that research on SCC management so far is centered mainly around three fundamental areas: identifying, classifying, and measuring the SCC drivers. As a result, modified business frameworks nowadays demand the necessity of complexity management as an integral strategy of SCM. Appendix B offers a detailed guideline for SCC management that has been previously employed in the literature.

2.2 Asymmetrical Power Allocation in Supply Chain Networks

This section expands on the inter-firm relationships of supply chain allies. It also provides a brief overview of the key concepts underlying the present literature on power asymmetry in supply chains.

2.2.1 Strategic Partnerships

Power in supply chain relationships can be perceived as one firm's potential to influence the other firm (Nyaga et al., 2013). Firms generally pursue an inter-organizational relationship to accumulate relevant resources and participants that can collectively devise long-term sustainability strategies viz: to facilitate faster access to technological innovations and skilled expertise with relatively lesser cost, create stakeholder value, or achieve a critical source of early financing through crowdfunding (Kaur et al., 2019; Das & Teng, 2000; Theokary et al., 2020). According to Oliver (1991), inter-firm relationships are fundamentally driven by the need to gain an advantage. In the light of different purposes, principles, resources, and knowledge of supply chain partners, each firm tries to sustain its competitive advantage, resulting in asymmetry of power (Hingley, 2005). In such a scenario, the dominant firm may use different sources of power to guarantee partnership governance in accord with its own interests whereas, the vulnerable firms may accept the imbalance and yield to the more powerful firm's intentions, as long as the relationship is profiting both sides (French & Raven, 1959).

The main purpose of an inter-firm partnership is to consolidate the assets of two separate entities to produce something of greater value. It facilitates two organizations to work together in a symbiotic relationship that does not require them to merge into a single entity. The resultant benefits can include cost reduction, economies of scale, risk and cost-sharing, access to foreign markets, product/service development, speed to market, flexibility, collective lobbying, and countering competition (Barringer & Harrison, 2000). Others assert that organizations enter into relationships to gain social, psychological (confidence), special treatment, functional, and image benefits (Beatty et al., 1996; Gwinner et al., 1998; Kelly & Scott, 2012; Sweeny & Webb, 2007). While firms may initiate a relationship in anticipation of these benefits, the maintenance of the relationship is often a determinant of how adequately the involved firms obtain the benefits compared to their expectations (Claycomb & Franwick, 2010). It is observed that some authors place considerable focus on equitable distribution of benefits to improve mutual dependence and commitment in such relationships. However, pure bilateral relationships are rarely seen (Hingley, 2005; Kumar, 2005). Conventionally, one firm reaps more benefits of a relationship and opportunism varies greatly among leading firms (Blossfled, 2009) . Therefore, the involved firms continuously assess the overall value and try to influence these outcomes in their favor (Cowan et al., 2015).

The theoretical lenses that have been previously used in the literature for focusing on the reasons behind inter-firm relationship formation are resource-based view (Barney, 1991; Das & Teng, 2000; Cho et al., 2019), transactional cost economies (Williamson, 1979), strategic choice (Powell, 1990), stakeholder theory (Freeman, 2010), learning theory (Zuo et al., 2016), and institutional theory (Glover et al., 2014). Here, resource-based view and learning theory explain that firms enter into a partnership with another firm to garner desired resources, including knowledge and competencies, which are rare, valuable, inimitable, and non-substitutable (Barney, 1991). Transactional cost economics state that firms form partnerships to reduce transaction-specific costs, which can be broadly categorized into information costs, negotiation costs, and monitoring costs (Hobbs, 1997). Other theories – strategic choice, stakeholder, and institutional theory – concentrate on the expectations and long-term desires of the firms and their stakeholders (Cowan et al., 2015).

2.2.2 Power in Partnerships

In supply chain relationships, power may be used to demand a higher share of the value created in the economic trade between two firms (Crook & Combs, 2007). If one firm manages to control resources that the other firm requires, it possesses the power. According to Casciaro & Piskorski (2005), power asymmetry is a consequence of one firm needing another firm's support more than the other way around. The more powerful firm (i.e., the firm benefiting from the dependence asymmetry) may use its power by selectively withholding or allowing access to its resources in exchange for favorable terms (Reimann & Ketchen, 2017). Despite the associated risks, firms invest considerable time and resources to develop and sustain their supply chain partnerships. Such partnerships offer promising benefits in terms of operational and financial performance (Nyaga et al., 2013).

French & Raven (1959) classified power into five types: (1) expert (2) referent (3) coercive (4) legal legitimate (5) reward. Based on the seminal work of French & Raven (1959), numerous studies further categorized the power bases into two groups: coercive (mediated) and non-coercive (nonmediated) (Wilkinson, 1996; Benton & Maloni, 2005; Yeung et al., 2009; Nyaga et al., 2013; Cowan et al., 2015). Nonmediated power sources consist of expert, referent, and informational power, which are considered to be more relational and positive (Benton & Maloni, 2005). The target or the recipient firm actively decides whether and how it will be influenced by the firm wielding power (Zhao et al., 2008). A firm is said to have expert power when it has specific expertise or knowledge that the other firm desires. Informational power is a specific variation of expert power, because as Maloni & Benton (2000, p. 9) argued, "expert power refers to the perception that one firm holds information or expertise (such as product or process leadership) that is valued by another firm." Referent power exists when one firm admires how another firm conducts its daily operations and therefore values being affiliated with it (Nyaga e al., 2013). Interacting and cooperating with a more competent firm usually increases the collective value and makes the relationship more important and worth investing in for the less competent firm (Palmatier et al., 2006). Past studies have been unanimous that non-coercive power is positively correlated with supply chain relationship mediators such as trust and commitment or outcomes investigated (Crook & Combs, 2007; Zhao et al., 2008; Maloni & Benton, 2000). It is implied that if a firm has high expertise in an industry, it also tends to be highly respected by its customers and

competitors. As its expertise becomes more reliable and reputed, the firm's power base often becomes more prominent (Nyaga et al., 2013).

Mediated power sources consist of coercive, legal legitimate, and reward power. Mediated power "represents the competitive and negative uses of power conventionally associated with the organizational theory" (Benton & Maloni, 2005, p. 4). Their utilization is consciously regulated by the firm exercising power; that is, the firm offering punishment determines whether, when, and how to use its power (Zhao et al., 2008). Coercive power is said to exist when one firm has the potential to use punishment to influence another firm's actions. Coercive power sources include practices like imposing financial penalties, withholding important support or reward, or threatening to withdraw an earlier promise (Molm, 1997; Yeung et al., 2009). Reward power is where one firm has the potential to extend rewards dedicated to influencing the target firm's behavior. Legal legitimate power exists when one firm intimidates another firm with the help of its judiciary right based on contractual stipulations (Nyaga et al., 2013). The impact of mediated power sources on relationship mediators and outcomes has been inconsistent – positive, negative, or negligible in different studies. However, this category of power bases might still be effective in enforcing short-term compliance with demands (Handley & Benton, 2012). Coercive power consistently hinders relationships, legal legitimate power has a negative or no impact, and reward power has a positive impact in most studies (Benton & Maloni, 2005; Maloni & Benton 2000; Zhao et al., 2008). While coercive and legal legitimate power sources exhibit explicit forms of intimidation or punishment, reward power can reflect both coercive and noncoercive effects (Siemieniako & Mitręga, 2018). A reward system may be viewed as an inconspicuous form of coercion as withholding reward can be interpreted as an act of punishment for noncompliance or failure to achieve set performance targets. Parallelly, it can also be viewed as a positive incentive to promote performance improvements where both parties profit – the benefactor gets better results, and the beneficiary firm gets the reward (Nyaga et al., 2013).

2.2.3 Systematic Use of Power

A high level of power in an inter-firm partnership is likely to encourage its wielder to act opportunistically (Frazier & Rody, 1991). Therefore, a more powerful buyer or supplier will tend to exercise its power to coerce more favorable terms and stipulations (Terpend & Ashenbaum, 2012). However, the conceptual frameworks of mutual dependence and social exchange theory

have disputed this assumption by suggesting that stronger relationship partners might forbear using power to support collaborative ties.

The theory of mutual dependence hypothesizes that the shared amount of dependence also needs to be acknowledged in addition to the asymmetry of dependence between buyers and suppliers (Reimann & Ketchen, 2017). If the weaker party still has some hold over the stronger party, the stronger party would be less willing to use its power aggressively and jeopardize the access to necessary resources. (Terpend & Krause, 2015). Similarly, social exchange theory views business relationships as a "socio-political system with complex and dynamic interactions and tradeoffs between partners" (Cowan et al., 2015, p. 141). The theory implies that firms in the supply chain relationships seek rewards and avoid punishment (Nyaga et al., 2013). Moreover, relationships between firms are fostered not only by economic motives but also by social norms such as reciprocity and integrity. Suppose the stronger party uses its available power to a large extent. In that case, this may lead to thoughts of unfairness, resentment, and ultimately disengagement from the relationship initiated by the weaker supply chain partner (Pulles et al., 2014).

Interestingly, the resource dependence theory also possesses reasonable affinity with notions of mutual dependence and social exchange theory. The conceptual framework postulates that long-term supply chain relationships do not necessarily show signs of unhealthy power dynamics. Buyers and suppliers in a supply chain network will generally avoid becoming reliant on each other (Bensaou, 1999). Buyers can multi-source and then play suppliers in the long run. On the other hand, suppliers can serve multiple customers to avoid becoming overly dependent on a single customer. Gradually, the regular interactions between buyers and suppliers will inevitably create a sense of mutual dependence where managers on both sides will take measures to avoid it becoming an asymmetrical relationship where they are the more dependent party (Xiao et al., 2019). Kumar et al. (1995) described total interdependence as the intensity of a relationship. A high level of interdependence is an indicator of a healthy, cooperative long-term relationship in which both parties have invested. Mutual trust and mutual commitment will characterize those relationships (Geyskens et al., 1996). Concurrently, when total interdependence is high, both partners are also faced with high exit barriers (Geyskens et al., 1996), as well as a high risk of retaliation (Ramsay, 1996).

2.3 Supply Chain Finance

This section briefly overviews fundamental notions underlying the present literature on supply chain finance (SCF). Then, it introduces two major SCF perspectives to understand how SCF helps a customer in maximizing its trade credit for a longer average payable period or helps a supplier expedite the collections related to its accounts receivables.

2.3.1 Defining Supply Chain Finance

Over the last decades, global firms have heavily invested in opportunities to enhance their business operations. Low-cost country sourcing, labor arbitrage, and global trade agreement optimization are all strategies employed by firms to increase profits and sustain growth. However, the asset and mortgage-backed markets' breakdown have exhausted liquidity from industries (Cornett et al., 2011). In such difficult scenarios, weaker firms try to extend trade credit from suppliers to supplement other forms of financing, whereas more stable firms assume liquidity providers' role in exchange for an increase in payment terms (Coulibaly et al., 2013; Garcia-Appendini & Montoriol-Garriga, 2013). The trend has highlighted the need for solutions and schemes that optimize working capital, including SCF being integrated with operations. According to Carnovale et al. (2019), the majority of SCF definitions focus on the planning, managing, and regulating of supply chain cash flows since they have been observed to directly and significantly impact the firm's revenue, cost, balance sheet, customer service, risk mitigation, and regulatory strategies. Despite the lack of a standard definition, Stemmler (2002) noticed SCF as an integral part of SCM, facilitating the integration of financial flows into the physical supply chain. Pfohl & Gomm (2009) define SCF as the inter-firm strategic utilization of financing and the integration of financing processes with customers, suppliers, and service providers to improve the collective value. Gomm (2010) viewed SCF as a process to optimize financing across supply/demand interface to decrease the cost of capital and boost cash flow.

2.3.2 Finance-Oriented Perspective Vs. Supply Chain-Oriented Perspective

Two major schools of thought emerge from the analysis of prior literature on SCF viz: finance-oriented perspective and supply chain oriented perspective (Gelsomino et al., 2016). The finance-oriented perspective views SCF as a set of short-term solutions provided by financial institutions (or, more generally, lenders) and focussed on accounts payable and/or receivable

(Chen & Hu, 2011; Li et al., 2019). Trade credit, factoring, and reverse factoring are all specific solutions based on a finance-oriented perspective. Trade credit is defined as a short-term loan between firms that is tied in both timing and value to the exchange of goods between them (Ferris, 1981). Factoring is a form of supplier financing in which firms independently sell their creditworthy invoices at a discount to a third party (the factor) to meet their present and immediate cash needs (Klapper, 2006). Reverse factoring is a financial arrangement in which a corporation, such as a bank, acts as an intermediary between a company and its suppliers and commits to paying the firm's invoices to the suppliers at an expedited rate in exchange for a discount (Tanrisever et al., 2012). Each financial intervention (e.g., financing, risk mitigation, or payment) in the supply chain economic transaction is induced by an event or "trigger" in the physical supply chain. These triggers (e.g., purchase orders, pre-shipment inspections, payable due date, or invoice raised by the seller) are considered the most important events in the trade process (Lamoureux & Evans, 2011). In a similar spirit, More & Basu (2013) classify SCF into three phases viz: pre-shipment, in-transit, and post-shipment financing solutions. The "buyer-driven" perspective is a stricter subset of the finance-oriented perspective, which promotes buyer-driven financial solutions (Wuttke et al., 2013). It is modeled as an evolved form of reverse factoring where the improvement lies mainly in the technological advancement of the solution, which aids in providing capital to a higher number of suppliers at a lower rate, increasing transparency and flexibility, and including new agents such as logistic providers (Chen & Hu, 2011; Wuttke et al., 2013).

The supply chain-oriented perspective elucidates the role of collaboration amongst supply chain partners, with a particular focus on inventory management (Gelsomino et al., 2016). This perspective extends the scope of SCF beyond financial solutions provided by a lender and appreciates optimization strategies for inventories, supply chain processes, or collaborative solutions for fixed asset financing (Pfohl & Gomm, 2009). For instance, Randall & Farris (2009) analyzed dyadic supply-chain relationships and demonstrated how all of the different elements of the cash-to-cycle can be managed collaboratively through a generic shifting of inventory (e.g., shifting inventories from a supplier to a customer). The supply chain-oriented perspective also focuses on fixed assets financing among supply chain members for working capital optimization (Gomm, 2010; Zhao & Huchzermeier, 2018). Fixed asset finance provides borrowers with term loans secured by a firm's fixed assets (i.e., tangible assets or real estate, including property, facilities, and equipment) (Zhao & Huchzermeier, 2018).

2.4 CEO Characteristics

According to Burney et al. (2021), the CEO of a firm has a significant role in developing the TMT's general orientation towards policymaking, which in turn impacts the firm's day-to-day operations. The CEOs habitually take deliberate actions over their career through repeated dealings with capital market participants (Fama, 1980). These actions (e.g., secure funds at a more favorable price) increase their firms' growth as well as shareholder value. Simultaneously, they also implicitly apprise the labor and capital markets of their abilities. Kale & Meneghetti (2014) assert that researchers have lately acknowledged the importance of nonfinancial stakeholders in the firm's financial decision-making. These nonfinancial stakeholders are economically associated and include suppliers, customers, competitors, and labor. Since the objective of the study is to analyze power asymmetry in the context of supply chain relationships, we only consider nonfinancial entities from product markets, i.e., a firm's suppliers and customers. Furthermore, we investigate whether the CEO characteristics (i.e., CEO age, CEO tenure, and CEO gender) have any effect on the actual bargaining measures of both the supplier and customer bases.

2.4.1 CEO Gender

Prior empirical investigations in psychology and management claim that women differ in their choices and temperaments from men and tend to be less overconfident, less aggressive, and more risk-averse. However, the evidence in the extant literature is not consistent. Some research studies have long argued that women who hold positions in the executive suite are at least equally risk-taking and competitive as their male counterparts (Adams & Funk, 2012; Berger et al., 2014; Ting et al., 2015; Farag & Mallin, 2018), while others do not document any significant relationship between board gender diversity and firm risk-taking (Sila et al., 2016; Garcia Lara et al., 2017). Moreover, Matsa & Miller (2013) examine the effect of gender quotas introduced in Norway on corporate leverage as an indicator of corporate risk-taking and do not find any change in firm leverage. They argue that this insignificant association with corporate leverage indicates risk aversion of not being an inherent approach of female executives while making corporate decisions. As a result, when examining gender differences at the top of organizations, studies fail to constantly find risk aversion as a stable trait of female leaders.

The upper echelons theory asserts that CEOs' backgrounds shape their interpretation of information and thus shape their strategic decision-making (Hambrick & Mason, 1984). Moreover,

contextual determinants such as crisis or instability further modify CEO decision-making. There is considerable evidence in the prior literature portraying that female executives and directors are more prudent and sagacious regarding corporate policies and outcomes, such as higher level of corporate cash holdings (Zeng & Wang, 2015), lower stock price crash risk (Li & Zeng, 2019), less volatile earnings (Faccio et al., 2016), more conservative financial reporting procedures (Srinidhi et al., 2011; Francis et al., 2015) and a lower probability to perpetrate corporate fraud (Cumming et al., 2015), or manipulate financial statements (Gupta et al., 2020). This suggests that female executives are seemingly better at scanning, filtering, and interpreting information while making corporate decisions. They believe in prudent leadership, which is the ability to analyze a situation thoroughly and make strategic judgments based on external circumstances. Unfortunately, it has always been confused with being less courageous or risk-averse.

CEOs perform in the upper echelon of the organizations they lead and hold one of the most important and influential roles. Glick (2011) argues that CEOs have the potential to influence the course of their companies, employees, and markets, and in some cases, influence the course of entire companies and regions of the world. Hence, we can assume that the association between gender-specific differences in managerial risk-taking and their impacts on organizational outcomes is more complex, and female CEOs may lead companies with extremely significant economies. In a similar spirit, this study investigates the impact of female CEOs on the base-level customer and supplier concentrations.

2.4.2 CEO Age

Career concerns can generate strong incentives for CEOs to place substantial importance on current performance for existing and future benefits such as compensation and general career opportunities. According to Burney et al. (2021), younger CEOs face added intense pressure since the labor market has a weaker ex-ante belief about their capabilities. Consequently, they are more likely to be replaced due to the perception of incompetence. Therefore, younger CEOs always strategize towards increasing the enterprise value in the initial stages of their careers. Burney et al. (2021) show that younger CEOs often concentrate on the working capital policies since it tends to have long-term implications for both the firms and shareholder value. For instance, younger CEOs may choose to manage working capital more aggressively by maintaining a lower working capital (Aggressive strategy).On the other hand, younger CEOs can also choose to hold a higher level of

working capital (Conservative strategy) to avoid the negative impact on the firm performance from the loss of sales due to potential stock-outs or tight credit policies. Conventionally, older executives invest more in working capital, take longer to convert inventories to cash, and pay their suppliers sooner (Adhikari et al., 2021).

According to Li et al. (2017), younger CEOs undertake riskier investment decisions and favor growing aggressively through acquisitions, R&D, and capital expenditure. Conversely, Serfling (2014) posits that older CEOs invest less in R&D, diversify their firms and maintain lower operating leverage. He also concluded that stock return volatility and financial leverage increase when firms hire CEOs that are much younger than incumbent CEOs since younger CEOs may adjust firm risk to match their own risk preferences closely. Generally, firms that want to increase their risk hire younger CEOs with higher risk preferences. Sometimes, younger CEOs may also be motivated to avoid bolder business decisions due to the fear of hurting future earnings. However, when younger executives with a long prospective career behave conservatively and underinvest, there can be a decline in the firm growth which can adversely affect the labor market's perception of their abilities (Lamont, 2002).

2.4.3 CEO Tenure

A thorough review of the extant empirical studies investigating the effects of CEO tenure on firm outcomes has shown inconclusive results. On the one hand, authors in support of long-tenured CEOs argue that a positive correlation exists between CEO tenure and a firm's financial performance and that the willingness to embrace strategic risks develops over the course of their time in office (Eisenhardt, 1989; Simsek, 2007; Shammari, 2018; Zhou et al., 2020). According to Eisenhardt (1989), the information asymmetry between long-tenured CEOs and shareholders is likely to diminish as the shareholders can learn more and possibly predict the CEOs' behavior. In addition, long-tenured CEOs familiarize themselves with the business risk and other industry-related practices to benefit the shareholders' interests (Zhou et al., 2020). Simsek (2007) also finds that long-tenured CEOs enhance the TMT's risk-taking propensity and thus increase financial performance. In their recent study, Zhou et al. (2020) provide a robust result showing that long-tenured CEOs tend to make better M&A decisions and consequently create more shareholder value than their younger counterparts. Lastly, Barker & Mueller (2002) posit that long-tenured CEOs

show a prominent interest in shaping R&D spending, which increases firms' long-term performance.

However, the dominant perspective in the relevant literature argues that long-tenured CEOs are likely to be entrenched, become more risk-averse, myopically commit to archaic ideas, and are unable to adapt to the external environment, which in turn hurts the financial performance as well as the shareholder value (Miller, 1991; Miller & Shamsie, 2001; Walters et al., 2007). According to Cao et al. (2021), the misalignment between the CEOs and shareholders is more likely to increase in a long-term relationship as CEOs stay long enough in their position to have more power and exert over the board for their opportunistic interests. For instance, long-term CEOs may not acknowledge essential requests from the stakeholders (Miller, 1991), nominate favored board members to curb dissent (Westphal, 1999), or weaken the relationship between CEO pay and firms' stock return (Hill & Phan, 1991). It is also suggested that long-tenured CEOs often refuse to take inevitable strategic risks because of fear of damaging their prestige (Miller, 1991). Such CEOs are overprotective of their existing position and might demand a higher risk premium to align their interests with those of shareholders effectively (Hou et al., 2017). Therefore, long-tenured CEOs abstain from taking risky but potentially profitable investments that hinder firms' financial performance in the long run.

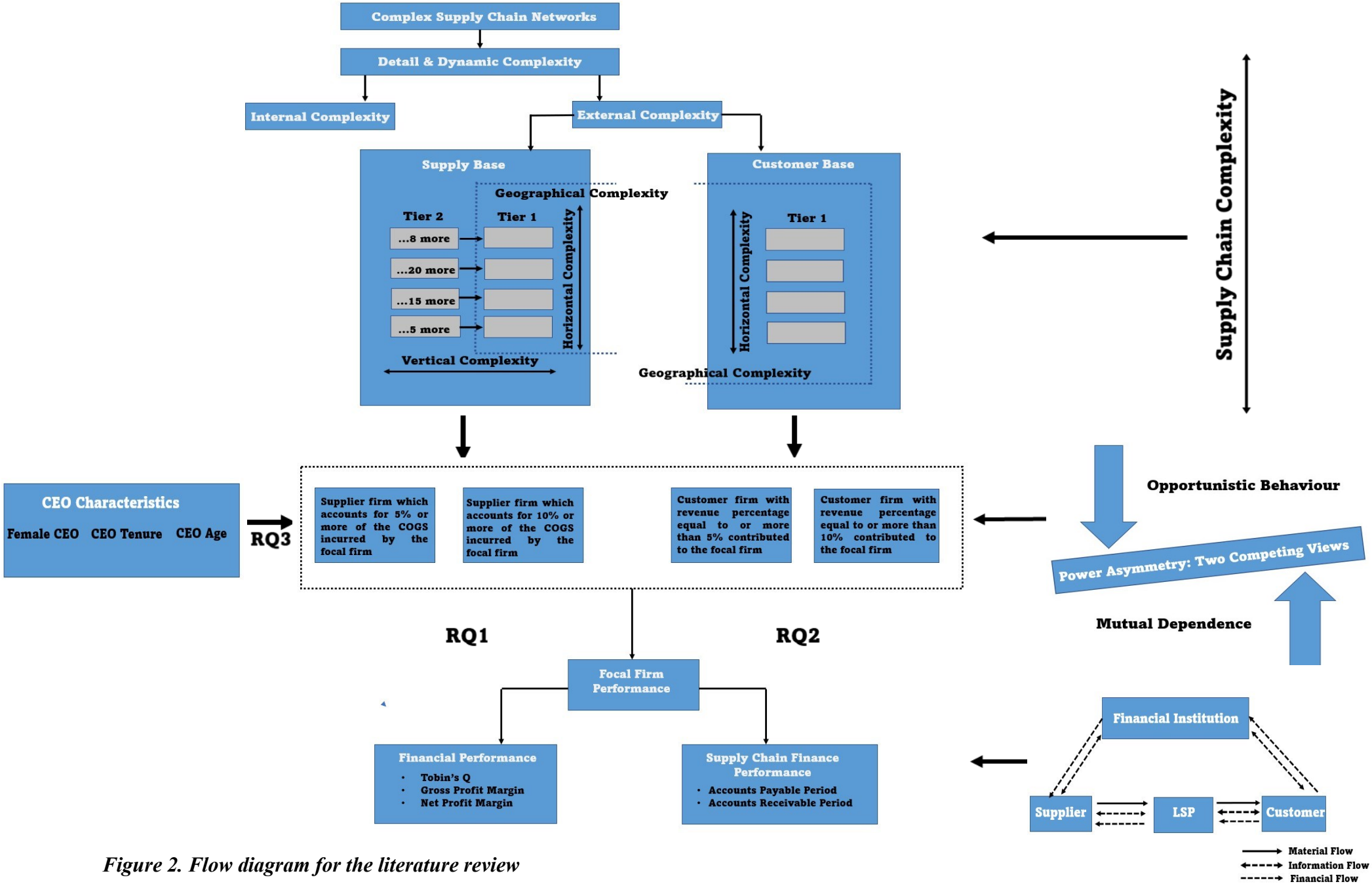

Figure 2. Flow diagram for the literature review

Chapter 3: Hypothesis Development

In light of the above discussion, we present a set of hypotheses for the research questions mentioned in Chapter 1. The study's main objective is to study asymmetrical power relationships in the context of supply chain networks. Hence, we examine the effect of base-level supplier concentration as well as customer concentration on the focal firm's financial performance. In addition, we investigate whether CEO characteristics impact the relative bargaining power of the nonfinancial stakeholders (suppliers and customers). The following research questions are formulated to guide the study.

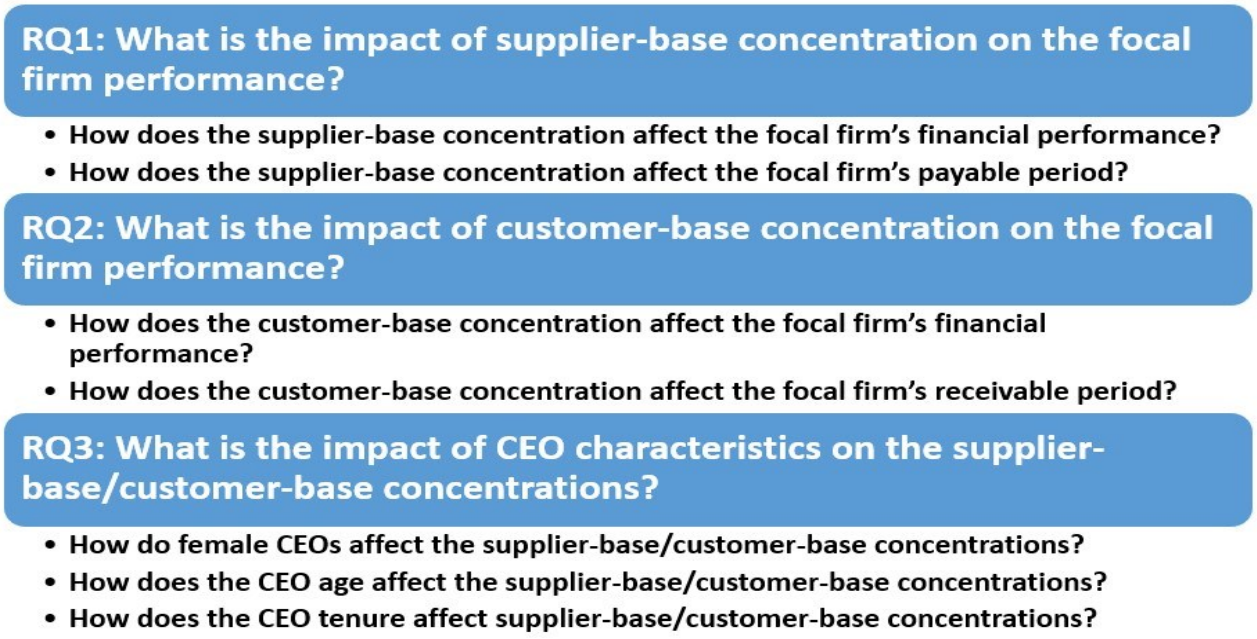

Figure 3. Three research questions and their sub-research questions

3.1 Supplier-Base Concentration & Focal Firm Financial Performance

Choi & Krause (2006) assert that modern globalized supply chains employ multisourcing for the same product or service to avoid supply chain risks. Engaging with a large number of suppliers is also believed to give better access to diversified resources (Dong et al., 2020). With a constant increment in the number of suppliers, a focal firm can reduce the dependency on a single supplier and achieve cost savings through inventory reduction (Holocomb & Hitt, 2007). A firm can also exploit several other competitive benefits through partnership sourcing, such as lead time

reduction, stock time reduction, and cash flow increases (Lock, 1998). Based on the supply chain-oriented perspective of SCF, suppliers can also assume the role of financial intermediaries to support and expedite the joint operations. However, relying on a high degree of supplier concentration (mostly base-level) can be challenging.

Handfield & Nichols (1999) argue that interacting with a broader supply base is a laborious task in terms of contract negotiation, management, and process execution. This increases the communications and monitoring costs as well as harms the optimal coordination level required to achieve efficiency in operations. Bode & Wagner (2015) suggest that a broader supply base can reduce the severity of disruptions but remain ineffective in reducing the frequency. Being trapped in tedious and lackluster trade relationships lowers the supplier's vested interest in the focal firm, decreasing its responsiveness, especially in times of a crisis. This further increases the mitigation costs. Lastly, offering a supplier lower volumes reduces the focal firm's bargaining power leading to more expensive contracts and less favorable terms.

According to Chod et al. (2019), competition among suppliers impacts their willingness to provide informal financing or trade credit financing. An increase in the number of base-level suppliers is more likely to reduce the respective or individual shares of the focal firm's purchases represented by the said suppliers except for a few major ones. A supplier that signifies a smaller share of the focal firm's purchases will internalize a smaller portion of the benefits incurred from the focal firm's profits, and as a result, will reduce its trade credit which is more relevant to its sales (Chod et al., 2019). Sometimes, the base-level supplier firms will tend to mimic their peers in formulating trade credit policies in highly competitive product markets. However, the benefits of mimicking peers' trade credit policies diminish faster as the intensity of mimicking increases (Gyimah et al., 2020). Also, the growing financial restraints render the firm's equity financing capacity ineffective, which leads to an increase in corporate cash holdings (Bates et al., 2009; Zhang et al., 2020). Lastly, a focal firm with a smaller supply base can reduce its transaction costs through less mediation, fewer communication channels, less order placing, and better monitoring (Choi & Krause, 2006). Instead, the focal firm can develop a more efficient buyer-supplier interface through a more cost adequate inventory or order control.

When the supply base's relative bargaining power increases, it affects the focal firm's ability to serve its target market in several ways. Higher relative bargaining power of the supply

base indicates that suppliers may sell at raised prices or pass on the hidden logistics costs (e.g., regulatory and compliance costs, increased warehousing expenses, or insurance fees) (Duchin, 2010). In the case of the target market not supporting the higher prices for the same products, the focal firm has to swallow that extra costs and reduce its profitability. The high-leverage position can also motivate the supply base to reduce the quantity it produces or skimp on quality to increase its profits. Often, some of the suppliers may choose to undercut the focal firm and sell directly to its customers (Kim, 2014). A focal firm's profitability can still be reduced if it decides to seek new sourcing alternatives due to switching costs. Therefore, we propose that,

Hypothesis 1: An increase in the supplier-base concentration will lead to negative financial performance for the focal firm.

3.2 Supplier-Base Concentration & Focal Firm Payable Period

Several firms utilize trade credit to finance their accounts payable as well as offer financing to their customers (Fabbri & Klapper, 2016). Recent accounting theories argue that suppliers are favored as financial mediators in comparison to standard banking or factoring institutions due to better information (Biais & Gollier, 1997), lower borrower's opportunism (Burkat & Ellingsen, 2004), and higher liquidity (Fabbri & Menichini, 2010). Wilner (2000) posits that a supplier offers a higher trade credit when the focal firm's purchases count for a larger share of the supplier's profit. However, a higher supplier concentration can also gain convenient contract terms (e.g., reducing the credit limit, shortening the payment period, or charging for transportation and insurance fees), consequently decreasing the commercial credit and deteriorating financing restraints for the focal firm (Duchin, 2010). Further, banks introduce more stringent loan terms to firms with higher supplier concertation (Kalwani & Narayandas, 1995). Banks may perceive the higher supplier concentration as a risk because once the focal firm's suppliers encounter hostile business shocks, the firm's normal operations can be disrupted and suffer losses (Zhang et al., 2020). Hence it can be implied that a major supplier in a powerful position can aim to achieve a shorter CCC by transferring the risks and capital costs to the focal firm. Hence, we hypothesize that,

Hypothesis 2: An increase in the supplier-base concentration will lead to a shorter payable period for the focal firm.

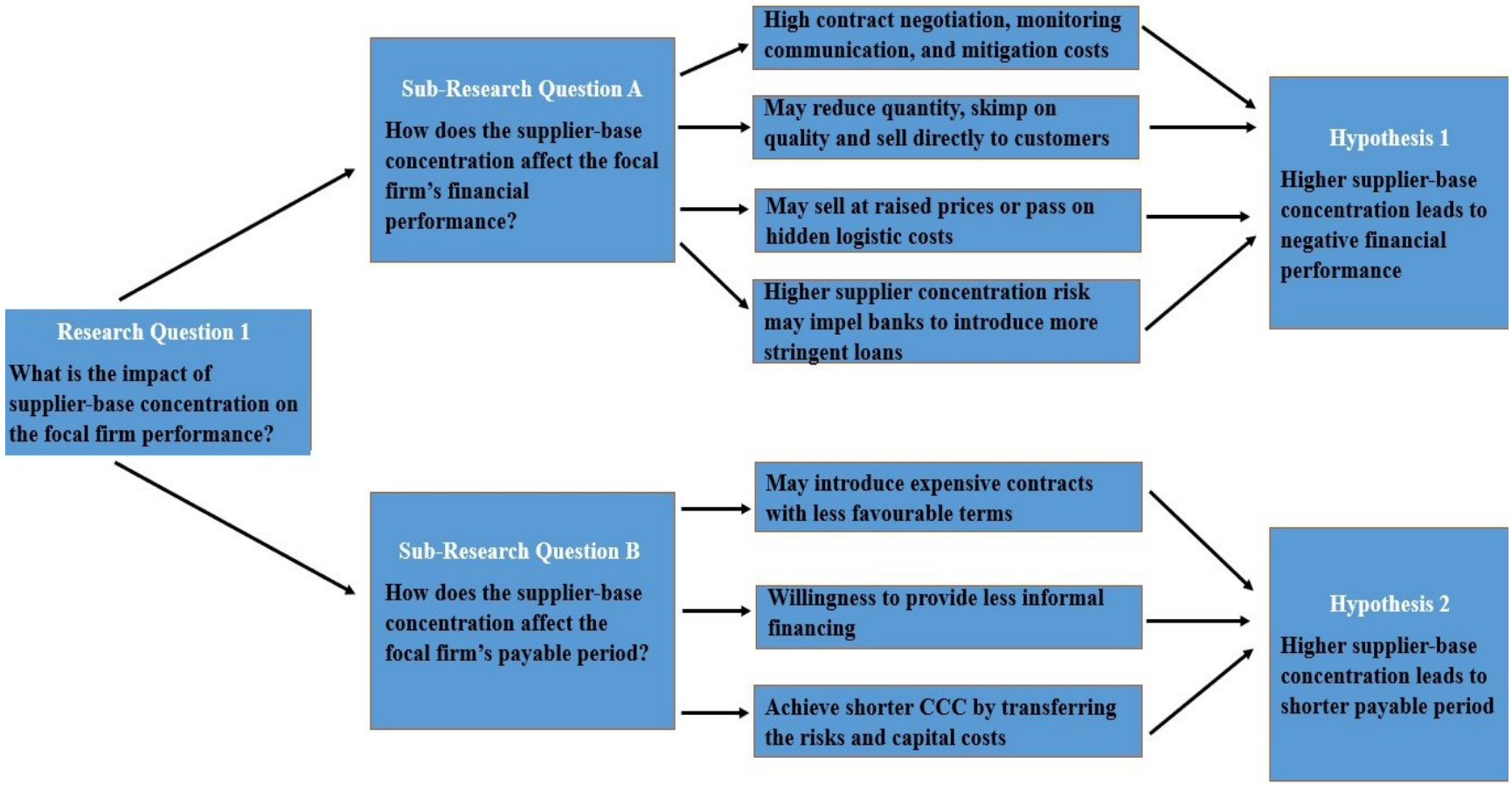

Figure 4. Schematic diagram of the hypotheses for research question 1

3.3 Customer-Base Concentration & Focal Firm Financial Performance

Achieving a certain level of success, a firm always looks into innovative ways of expanding into new markets. The most popular medium of expanding business is reaching out to new customers, especially if this expansion involves introducing new products or services. Expanding a business into new markets can also make the suppliers more incentivized to provide discounts and trade credits due to economies of scale. However, previous organizational studies provide two different schools of thought regarding the economic behavior of relationships with the customer concentration.

In the competitive domain, some researchers define the concentrated exchanges with major customers in the context of power and competition and argue that the suppliers and customers compete for economic profits. Classic theory portrays a high customer concentration wielding higher bargaining power and threatening a manufacturer's operating profits (Lustgarten, 1975). Major customers often realize their higher bargaining position and engage in ex-post renegotiation over contractual terms at the expense of the supplier firm. Once the focal firm commits resources to production for a significant customer, there is a possibility that the firm cannot recover the customer-specific investments unless it maintains the trade relationship (Irvin et al., 2016). Balakrishnan et al. (1996) found that suppliers with a diffuse customer base have a higher profitability subsequent to just-in-time (JIT) adoption relative to their competitors with high customer concentration. Snyder (1996) argues that customer power can intensify the price wars between the suppliers, which often leads to suppliers bidding below the average selling price. Other common instances of customers exercising their power include direct influence over informal financing (Peng et al., 2019), transaction volume (Landeros & Monczka, 1989), and higher quality products (Balakrishnan et al., 1996).

On the other hand, recent accounting studies document cooperative behavior between the supply chain partners through the principle of embeddedness, wherein opportunism can be overpowered by trust and commitment (Kim, 2017). In collaborative supply chain networks, a more concentrated customer base extends operational collaboration (e.g., cost-sharing) to the supplier, profiting all the supply chain members. According to Uzzi (1996), suppliers in concentrated relationships with customers are more likely to survive market uncertainty. From the perspective of operating efficiency, it is suggested that long-established and mature relationships

with major customers can achieve significant operating efficiency, which ultimately leads to supplier profitability (Patatoukas, 2012; Irvin et al., 2016). Moreover, such mature relationships can facilitate information sharing, building trust, and joint problem solving and generate more confidence and cooperation towards a partnership (Palmatier, 2008; Yli-Renko & Janakiraman, 2008). Kwak & Kim (2020) also hypothesize that once major customer concentration exceeds a certain threshold, the benefit of operating efficiency increases exponentially, whereas the cost of bargaining power only rises marginally.

It can be observed that a customer base concentration can exhibit both positive and negative influences in the context of supplier firm profitability. According to Kim (2017), concentrated relationships maintained with major customers can enhance the supplier firm's value-creating potential through extensive collaboration (e.g., pooled resources and shared knowledge). However, from the value-capturing viewpoint, the extant literature indicates that the division of profits between supply chain partners relies more on their relative bargaining powers than their resource contribution. In summary, higher relative bargaining power of the customer base does not hinder the supplier firm's value creation process but weakens its ability to capture equitable profits. After taking both the competitive and collaborative influence of a customer concentration into consideration, we decided to go along with the traditional viewpoint and hypothesize that:

Hypothesis 3: An increase in the customer-base concentration will lead to negative financial performance for the focal firm.

3.4 Customer-Base Concentration & Focal Firm Receivable Period

Giannetti et al. (2011) posit that influential customers prefer using trade credit in bankrolling their purchases since the process is more affordable and more accessible than bank loans. Also, high customer concentration is collectively powerful enough in setting the transaction terms (Peng et al., 2019). A supplier firm with significant customers may indicate a bank of its superior status (Cen et al., 2016). However, major customers demand deferred payments and lengthen the upstream firms' receivable cycles, which are then forced to cut investments to tackle liquidity constraints (Murfin & Njoroge, 2015). Often, there is also an increase in corporate cash holdings since severely dependent firms suffer measurable opportunity costs due to downstream partners' bankruptcy filings and financial distress (Hertzel & Officer, 2012). Furthermore, Dhaliwal et al. (2016) demonstrate that a supplier firm with a more concentrated customer base

has a higher cost of equity. In summary, it can be established that high customer concentration can demand relationship-specific investments and cause unnecessary liquidity issues, price pressures, and cashflow restrictions, which can consequently create a higher probability for a focal firm to default on its debt obligations, or worse, suffer poor working capital conditions. In addition, since we did not observe a similar trend of the dual effect of customer concentration on CCC in the extant literature, we propose that,

Hypothesis 4: An increase in the customer-base concentration will lead to a longer receivable period for the focal firm.

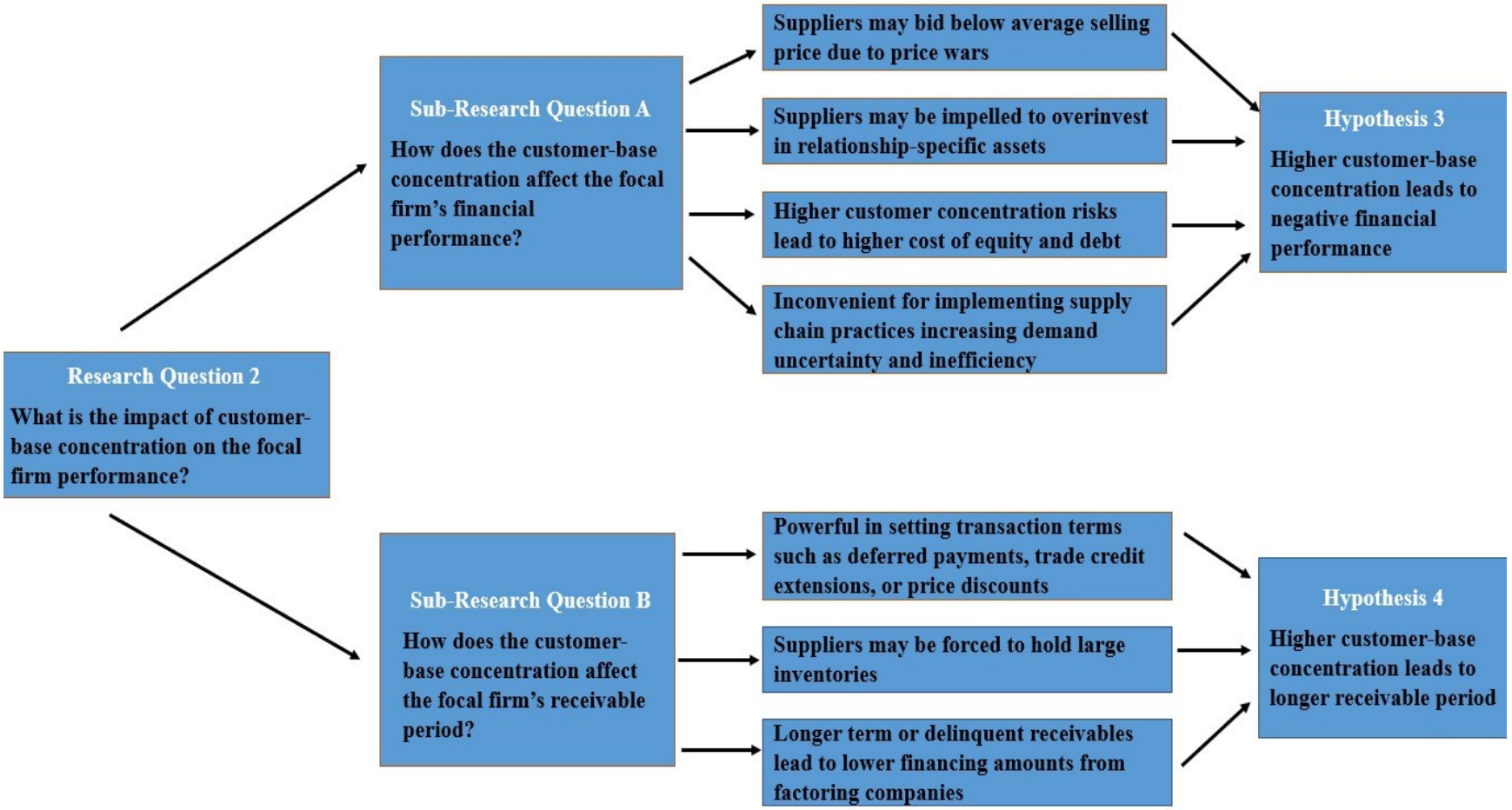

Figure 5. Schematic diagram of the hypotheses for research question 2

3.5 CEO Characteristics & Supplier-Base/Customer-Base Concentrations

3.5.1 CEO Gender

Hendriks et al. (2020) present a set of core leader qualities (prudence, temperance, justice, courage, and humanity) that strongly overlaps between contemporary frameworks of virtuous leadership. They define prudence as "being disposed to make the right judgments to achieve virtuous goals using appropriate means in a given situation" (p. 954). Taking the discussion under **section 2.4.1 (CEO Gender)** into account, it can be ascertained that female CEOs are prudent leaders who do not suffer from any analysis paralysis. Instead, they are better at selecting, assessing, and executing the strategic risk-taking processes and more likely to make the tough call once they are confident in the way forward after weighing all the options. Therefore, in light of the previous arguments which hypothesize about the negative impact of supplier-base/customer-base concentrations on focal firm's financial performance, we propose that,

Hypothesis 5a: Female CEOs reduce the supplier-base concentration.

Hypothesis 5b: Female CEOs reduce the customer-base concentration.

3.5.2 CEO Age

Taking the discussion under **section 2.4.2 (CEO Age)** into consideration, it can be expected that younger CEOs have greater incentives to accelerate firm growth so as to display their superior decision-making ability to the labor market. Therefore, we hypothesize that,

Hypothesis 6a: Younger CEOs reduce the supplier-base concentration regardless of its impact on the focal firm financial performance.

Hypothesis 6b: Younger CEOs reduce the customer-base concentration regardless of its impact on the focal firm financial performance.

3.5.3 CEO Tenure

Given the competing viewpoints under **section 2.4.3 (CEO Tenure),** it is not clear ex-ante whether long-tenured CEOs are willing to take a strategic risk to overcome the influence of their supply chain partners. According to Wu et al. (2005), CEOs during their early tenure seasons, tend to learn rapidly and are willing to take risks. This motivation might come from the threat of CEO

turnover or a decrease in pay slice. However, in the later years, CEOs become entrenched in the obsolete paradigms (Miller, 1991; Miller & Shamsie, 2001; Walters et al., 2007). In such a scenario, the relationship between CEO tenure and firm performance over the CEO's life cycle can be visualized as an "inverted U" (Henderson et al., 2006). Hence, we assume that there is a non-linear relationship between CEO tenure and financial performance which helps us to hypothesize that

Hypothesis 7a: A non-linear correlation can be anticipated between long-tenured CEOs and the supplier-base concentration.

Hypothesis 7b: A non-correlation can be anticipated between long-tenured CEOs and the customer-base concentration.

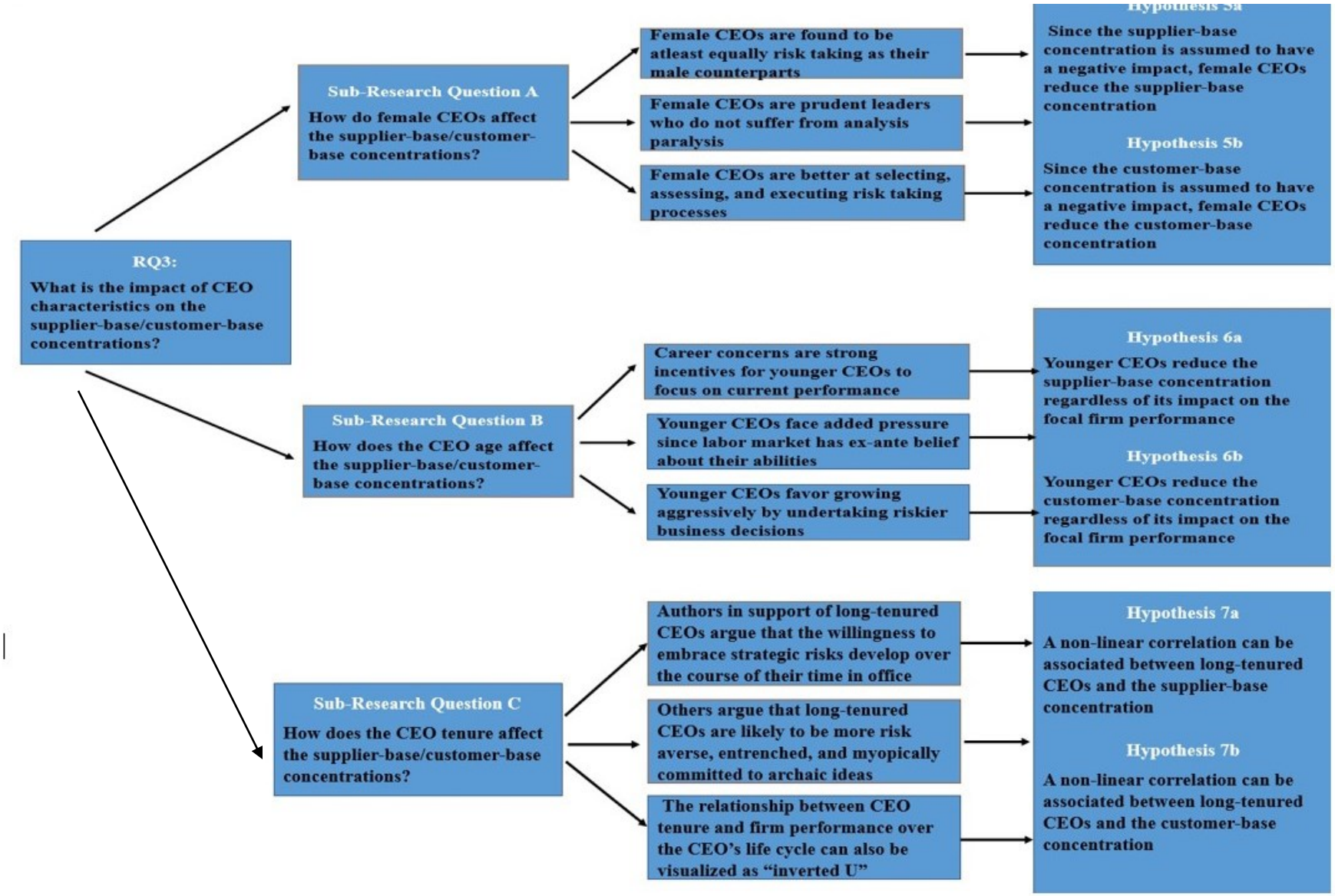

Figure 6. Schematic diagram of the hypotheses for research question 3

Chapter 4: Data & Methodology

4.1 Data Sources

The empirical study focuses on public companies listed under S&P1500, an index that covers approximately 90% of the market capitalization of U.S. stocks for the fiscal year of 2017. Similar to the sample data from Lu & Shang (2017), the attention is particularly on the chemical (including pharmaceutical) and electronic manufacturers in five two-digit SIC codes (28, 35, 36, 37, and 38) for the fiscal year 2017. SIC 35 (Industrial Machinery & Equipment), SIC 36 (Electronic & Other Electrical Equipment & Components), SIC 37 (Transportation Equipment), and SIC 38 (Instruments & Related Products) come under the general category of manufacturing and tend to have similar high-tech characteristics. The study also includes SIC 28 (Chemical & Allied Products) as supply base structural characteristics are of significance in this industry (Hoffman, 1999). The resulting sample includes 625 unique firms.

The supply chain network data and the financial transaction information are hand-collected from Bloomberg L.P. SPLC. Unlike Compustat, which only covers significant relationships where a customer contributes more than 10% of the revenue to the supplier firm, Bloomberg SPLC provides high coverage and accurate relationship values of less than .01%. Since the scope of the study is restricted to the base level value chain, we only collect relevant data of suppliers and customers comprising the tier 1 network of the 625 focal firms. Due to missing financial transaction data or removal of the focal firms without any base-level suppliers or customers, the sample is reduced to 356 focal firms exhibiting the required vendor-specific data and 394 focal firms exhibiting the buyer-specific data. Furthermore, the other focal firm-specific information is extracted from the CRSP/ Compustat Merged database provided by the WRDS website. After matching the Bloomberg supply chain relationship data with the Compustat financial information, we observe no change in the main sample. Lastly, information related to the current CEO, such as gender, age, and tenure, is obtained from Standard and Poor's Execucomp and merged with the main sample file. In the end, we are left with a final sample of 325 focal firms with base-level supplier data and 394 focal firms with base-level customer data.

4.2 Methodology

The empirical study employs OLS regression analysis to study the influence of supplier-base/customer-base concentrations on the focal firm's financial performance using a sample of chemical and electronic manufacturing companies publicly listed under S&P1500 for the fiscal year 2017. We intend to perform the regression analysis separately for the supplier base and the customer base since relevant supply chain literature examines upstream complexity and downstream complexity separately. We also investigate the impact of some of the conventional CEO characteristics in reducing the relative bargaining power of base-level supply chain partners. Appendix A presents a brief overview of all the relevant variables used in this study. Also, Figure 5 depicts the theoretical model for the study at then end of the chapter. Now, we organize the empirical analysis as follows:

4.2.1 To examine the influence of supplier-base concentration on the focal firm financial performance

From a practical perspective, accounting-based measures reflect the management action outcome and are conventionally preferred over market-based measures in multiple regression analysis (Hutchinson & Gul, 2004). In contrast, stock-based measures are less sensitive to earning manipulation and captures long-run market valuation as well as tangible assets (Dechow & al., 1996). Theoretically, the accounting-based measures display the company's profitability in a given year, whereas the market-based measures provide an insight into the shareholders' expectations concerning the company's future performance (Villalonga, 2004; Modi & Mishra, 2011). Thus, for Hypothesis 1, the empirical study approximates focal firm financial performance using three variables: Tobin's Q, net profit margin, and overall gross profit margin.

Table 1 demonstrates a variety of measures for the upstream and downstream concentrations employed by the previous studies. It can be observed that there is a dearth of supplier concentration measures as well as the literature does not provide a consistent way of measuring the customer concentration. For a similar purpose, the empirical study utilizes the SPLC database on the Bloomberg Terminal, which provides detailed insights into a firm's supply chain alliances as depicted in Figure 4.

Table 1. Upstream/Downstream Concentration Measures

Study	Definition	Relative Bargaining Power Measurement
Patatoukas (2012)	Customer concentration based on the Herfindahl-Hirschman (HH) index	Customer Concentration$_i$ = $\sum_{j=1}^{J}\left(\frac{Sales_{ij}}{Sales_i}\right)^2$ where Sales$_{ij}$ represents supplier i's sales to customer j, and Sales$_i$ represents supplier i's total sales in a fiscal year
Dhaliwal et al. (2016)	Customer concentration	An indicator variable that is set to one if a supplier discloses at least one corporate customer that accounts for 10% or more of its annual revenues and zero otherwise
Banerjee et al. (2008)	Customer Sales: Sum of the percentage sales coming from the set of customers the firm reports as "major customers"(i.e., those with at least 10% of total sales)	Customer Sales$_i$ = $\sum_{j=1}^{n_i} \%Sales_{ij}$ where n_i is the number of firm i's major customers, and %Sales$_{ij}$ is the percentage sales from firm i to customer j over i's total sales
Campello & Gao (2017)	Customer Size: Firm's percentage sales to major customers weighted by the size of those customers	Customer Size$_i$ = $\sum_{j=1}^{n_i} \%Sales_{ij} * Size_j$ where Size$_j$ is the size (defined by log of total assets) of customer j
Cho et al. (2019)	An indicator of buyer power over the focal firm due to diversification and customer portfolio	Number of major customers which contribute more than 10% of a focal firm's revenue
Song & Wang (2019)	Customer concentration	Standard deviation of the percentage of sales revenue of top five customers to the total revenue
Zhang et al. (2020)	Supplier concentration	Purchasing ratio from the largest supplier and from the top 5 suppliers
Wen et al. (2021)	Customer concentration	Proportion of a supplier's total sales to its largest customer and top 5 customers

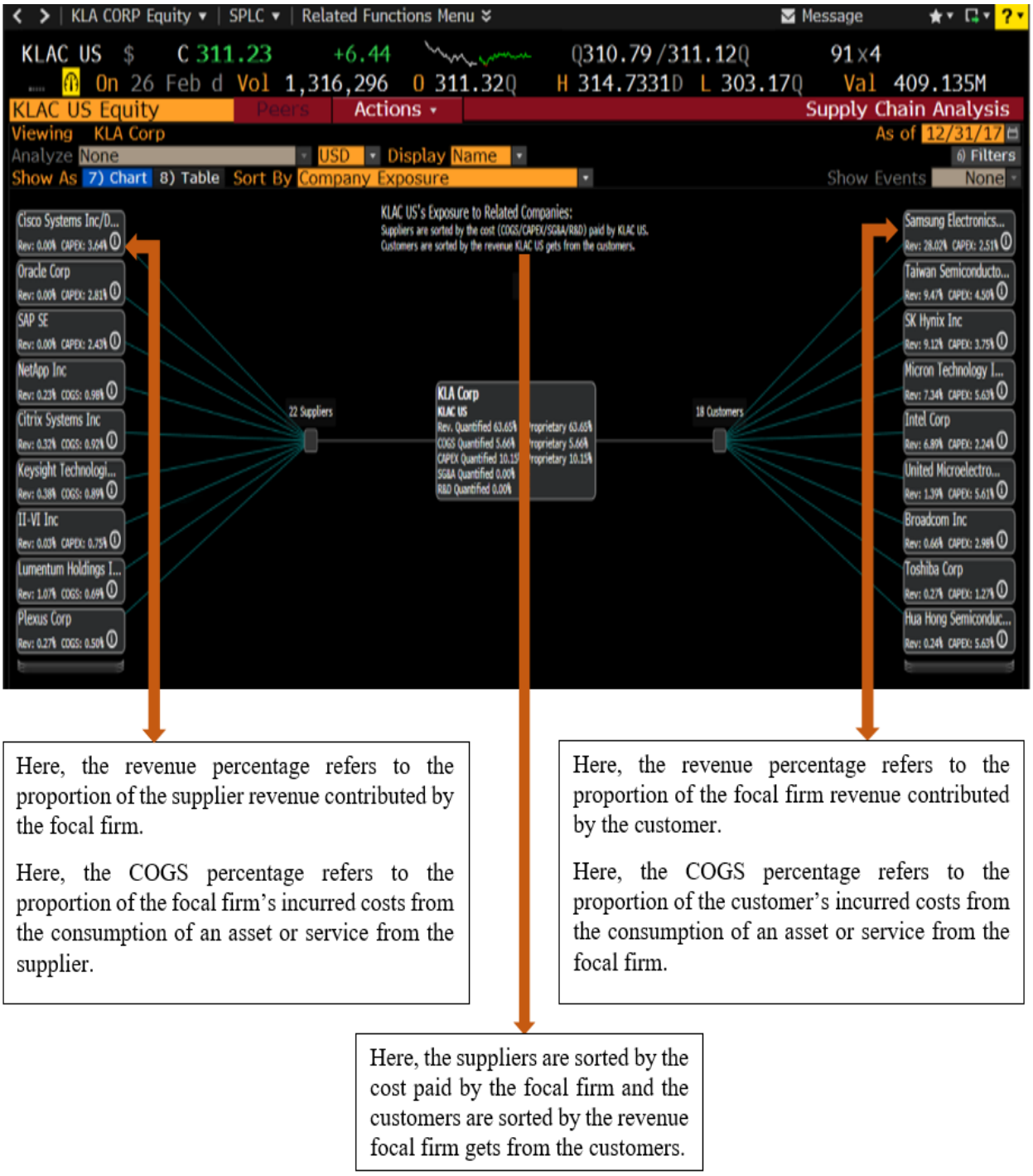

Figure 7. Bloomberg SPLC representation of a supply chain network

Bloomberg uses a complex algorithm that assigns quantified values to supply chain relationships for which no quantification is publicly known (Wetzel & Hofmann, 2019). Here, the base-level suppliers are sorted in descending order according to the costs of goods sold (COGS) that get incurred by a central company. Correspondingly, the base-level customers are sorted in descending order according to the percentage of sales (REV) that they account for at the central company. Therefore, based on the view "to whom is the central company most exposed?" the most important base-level suppliers and customers are shown at the top of the list. With the help of the transaction metrics present in the Bloomberg SPLC database, we compute the objective measure of relative bargaining power for the supplier-base concentration:

$$\frac{\sum_{i_k=1}^{n} i_k}{\sum_{s_k=1}^{n} s_k}$$

$$= \frac{Total\ number\ of\ base\ suppliers\ accounting\ for\ 10\%\ or\ more\ COGS\ sustained\ by\ the\ focal\ firm}{Total\ number\ of\ base\ suppliers}$$

Here, k = Focal firm

s_k = Supplier in the supply base (i.e. first tier) of focal firm k

i_k = Supplier firm which accounts for 10% or more of the COGS incurred by the focal firm k

n = Total number of 1st tier suppliers of focal firm k

Here, we assume that as the number of suppliers that account for 10% or more of the COGS incurred by the focal firm increases, the relative bargaining power of the supplier-base concentration increases. We also introduce a more nuanced version of the objective measure of relative bargaining power for the supplier-base concentration. It is computed by dividing the number of suppliers which account for 5% or more of the COGS incurred by the focal firm over the total number of base-level suppliers.

The regression models for finding the nature of the association between supplier-base concentration levels and focal firm financial performance are given in equations (1) and (2). All variables are described in Appendix A.

$$
\begin{aligned}
&Focal\ Firm\ Financial\ Performance \\
&\quad = Alpha + Beta1 * Supplie\_Conc\_5 + Beta2 \\
&\quad * Vertical\ Complexity\ Supplier + Beta3 \\
&\quad * Geographical\ Complexity\ Supplier + Beta4 * Firm\ Size + Beta5 \\
&\quad * Capital\ Intensity + Beta6 * Operating\ Cash\ Flow + Beta7 \\
&\quad * Leverage + Beta8 * Sales\ Growth\ + Beta9 * R\&D\ Intensity + \varepsilon
\end{aligned}
\tag{1}
$$

$$
\begin{aligned}
&Focal\ Firm\ Financial\ Performance \\
&\quad = Alpha + Beta1 * Supplier\_Conc\_10 + Beta2 \\
&\quad * Vertical\ Complexity\ Supplier + Beta3 \\
&\quad * Geographical\ Complexity\ Supplier + Beta4 * Firm\ Size + Beta5 \\
&\quad * Capital\ Intensity + Beta6 * Operating\ Cash\ Flow + Beta7 \\
&\quad * Leverage + Beta8 * Sales\ Growth\ + Beta9 * R\&D\ Intensity + \varepsilon
\end{aligned}
\tag{2}
$$

4.2.2 To examine the influence of supplier-base concentration on the focal firm payable period

For Hypothesis 2, we selectively choose a vendor-specific variable (i.e., accounts payable period) that primarily affects the cash liquidity of a focal firm while dealing with a supplier concentration. The regression models for investigating the effect of supplier-base concentration levels on the focal firm payable period are given in equation (3) and (4). All variables are described in Appendix A.

$$
\begin{aligned}
&Accounts\ Payable\ Period \\
&\quad = Alpha + Beta1 * Supplier\_Conc\_5 + Beta2 \\
&\quad * Vertical\ Complexity\ Supplier + Beta3 \\
&\quad * Geographical\ Complexity\ Supplier + Beta4 * Firm\ Size + Beta5 \\
&\quad * Capital\ Intensity + Beta6 * Operating\ Cash\ Flow + Beta7 \\
&\quad * Leverage + Beta8 * Sales\ Growth\ + Beta9 * R\&D\ Intensity + \varepsilon
\end{aligned}
\tag{3}
$$

$$
\begin{aligned}
&Accounts\ Payable\ Period \\
&\quad = Alpha + Beta1 * Supplier\_Conc\_10 + Beta2 \\
&\quad * Vertical\ Complexity\ Supplier + Beta3 \\
&\quad * Geographical\ Complexity\ Supplier + Beta4 * Firm\ Size + Beta5 \\
&\quad * Capital\ Intensity + Beta6 * Operating\ Cash\ Flow + Beta7 \\
&\quad * Leverage + Beta8 * Sales\ Growth\ + Beta9 * R\&D\ Intensity + \varepsilon
\end{aligned}
\tag{4}
$$

4.2.3 To examine the influence of customer-base concentration on the focal firm financial performance

Similar to the methodology utilized for analysing the effect of supplier-base concentration on financial performance, we use the same set of key profitability ratios (i.e., Tobin's Q, net profit margin and overall gross profit margin) for Hypothesis 3. Here, we also compute an objective measure of relative bargaining power for the customer-base concentration:

$$\frac{\sum_{j_k=1}^{n} j_k}{\sum_{c_k=1}^{n} c_k}$$

$$= \frac{Total\ number\ of\ base\ customers\ with\ 10\%\ or\ more\ revenue\ contributed\ to\ the\ focal\ firm}{Total\ number\ of\ base\ customers}$$

Here, k = Focal firm

c_k = Customer in the consumer base (i.e. first tier) of the focal firm k

j_k = Customer firm with revenue percentage equal to or more than 10% contributed to the focal firm k

n = Total number of 1st tier customers of focal firm k

We assume that as the number of customers with revenue percentage equal to or more than 10% contributed to the focal firm increases, the relative bargaining power of the customer-base concentration increases. Another version of the objective measure of relative bargaining power for the customer-base concentration is computed by dividing the number of customers with revenue percentage equal to 5% or more contributed to the focal firm over the total number of base-level customers.

The regression models for finding the nature of the association between customer-base concentration levels and focal firm financial performance are given in equations (5) and (6). All variables are described in Appendix A.

$$Focal\ Firm\ Financial\ Performance = Alpha + Beta1 * Customer\_Conc\_5 + Beta2 * Geographical\ Complexity\ Customer + Beta3 * Firm\ Size + Beta4 * Capital\ Intensity + Beta5 * Operating\ Cash\ Flow + Beta6 * Leverage + Beta7 * Sales\ Growth + Beta8 * R\&D\ Intensity + \varepsilon \quad (5)$$

$$Focal\ Firm\ Financial\ Performance = Alpha + Beta1 * Customer\_Conc\_10 + Beta2 * Geographical\ Complexity\ Customer + Beta3 * Firm\ Size + Beta4 * Capital\ Intensity + Beta5 * Operating\ Cash\ Flow + Beta6 * Leverage + Beta7 * Sales\ Growth + Beta8 * R\&D\ Intensity + \varepsilon \quad (6)$$

4.2.4 To examine the influence of customer-base concentration on the focal firm receivable period

For Hypothesis 4, we concentrate only on the buyer-specific variable (i.e. accounts receivable period) which showcases how efficiently and effectively the flow of goods, information, and payments is maintained while dealing with a customer concentration. The regression models for investigating the impact of customer-base concentration levels on the focal firm receivable period are provided in equations (7) and (8). All variables are described in Appendix A.

$$Accounts\ Receivable\ Period = Alpha + Beta1 * Customer\_Conc\_5 + Beta2 * Geographical\ Complexity\ Customer + Beta3 * Firm\ Size + Beta4 * Capital\ Intensity + Beta5 * Operating\ Cash\ Flow + Beta6 * Leverage + Beta7 * Sales\ Growth + Beta8 * R\&D\ Intensity + \varepsilon \quad (7)$$

$$
\begin{aligned}
&Accounts\ Receivable\ Period \\
&\quad = Alpha + Beta1 * Customer\_Conc\_10 + Beta2 \\
&\quad * Geographical\ Complexity\ Customer + Beta3 * Firm\ Size \\
&\quad + Beta4 * Capital\ Intensity + Beta5 * Operating\ Cash\ Flow \\
&\quad + Beta6 * Leverage + Beta7 * Sales\ Growth\ + Beta8 \\
&\quad * R\&D\ Intensity + \varepsilon
\end{aligned}
\tag{8}
$$

4.2.5 To examine the influence of CEO characteristics on the supplier-base/customer-base concentrations

Unlike the earlier regression models where we examined the effect of base-level supply chain partners on the financial performance, henceforth, we examine whether some of the CEO characteristics have the potential to reduce the relative bargaining power of the same nonfinancial stakeholders in order to increase firm growth. Table 2 reports the different situations where the supplier-base/customer-base concentrations act as explanatory variables or performance variables.

Table 2. Dual Role of Supplier-Base/Customer-Base Concentrations

	Independent Variable	Dependent Variable
Supplier-Base Concentration	Hypothesis 1; Hypothesis 2	Hypothesis 5a; Hypothesis 6a; Hypothesis 7a
Customer-Base Concentration	Hypothesis 3; Hypothesis 4	Hypothesis 5b; Hypothesis 6b; Hypothesis 7b

Bearing in mind that female executives exhibit a heightened level of awareness and have a discerning eye while making vital corporate decisions, we assume that female CEOs participate in strategic risk-taking rather than utilizing an aggressive strategy against competitors. We also hypothesize that younger CEOs are highly incentivized or face extreme pressure to increase the enterprise value. They operate in ways to signal the labor market of their superior abilities and secure future career prospects simultaneously. Lastly, due to the inconsistent and contradictory conclusions concerning the risk-taking behavior of long-tenured CEOS, we believe that there is a non-linear relationship between CEO tenure and the relative bargaining power of the supply chain allies. In anticipation of a potential non-linear relation between CEO tenure and a series of output

variables, we also include CEO tenure squared, calculated as the square of CEO tenure, in most of our regressions. Suitable regression models are provided below. All variables are presented in Appendix A.

$$Supplier\_Conc\_5 = Alpha + Beta1 * Female\ CEO + Beta2 * CEO\ Age + Beta3 * CEO\ Tenure + Beta4 * CEO\ Tenure\ Squared + Beta5 * Firm\ Size + Beta6 * Capital\ Intensity + Beta7 * Operating\ Cash\ Flow + Beta8 * Leverage + Beta9 * Sales\ Growth + Beta10 * R\&D\ Intensity + \varepsilon \quad (9)$$

$$Supplier\_Conc\_10 = Alpha + Beta1 * Female\ CEO + Beta2 * CEO\ Age + Beta3 * CEO\ Tenure + Beta4 * CEO\ Tenure\ Squared + Beta5 * Firm\ Size + Beta6 * Capital\ Intensity + Beta7 * Operating\ Cash\ Flow + Beta8 * Leverage + Beta9 * Sales\ Growth + Beta10 * R\&D\ Intensity + \varepsilon \quad (10)$$

$$Customer\_Conc\_5 = Alpha + Beta1 * Female\ CEO + Beta2 * CEO\ Age + Beta3 * CEO\ Tenure + Beta4 * CEO\ Tenure\ Squared + Beta5 * Firm\ Size + Beta6 * Capital\ Intensity + Beta7 * Operating\ Cash\ Flow + Beta8 * Leverage + Beta9 * Sales\ Growth + Beta10 * R\&D\ Intensity + \varepsilon \quad (11)$$

$$Customer\_Conc\_10 = Alpha + Beta1 * Female\ CEO + Beta2 * CEO\ Age + Beta3 * CEO\ Tenure + Beta4 * CEO\ Tenure\ Squared + Beta5 * Firm\ Size + Beta6 * Capital\ Intensity + Beta7 * Operating\ Cash\ Flow + Beta8 * Leverage + Beta9 * Sales\ Growth + Beta10 * R\&D\ Intensity + \varepsilon \quad (12)$$

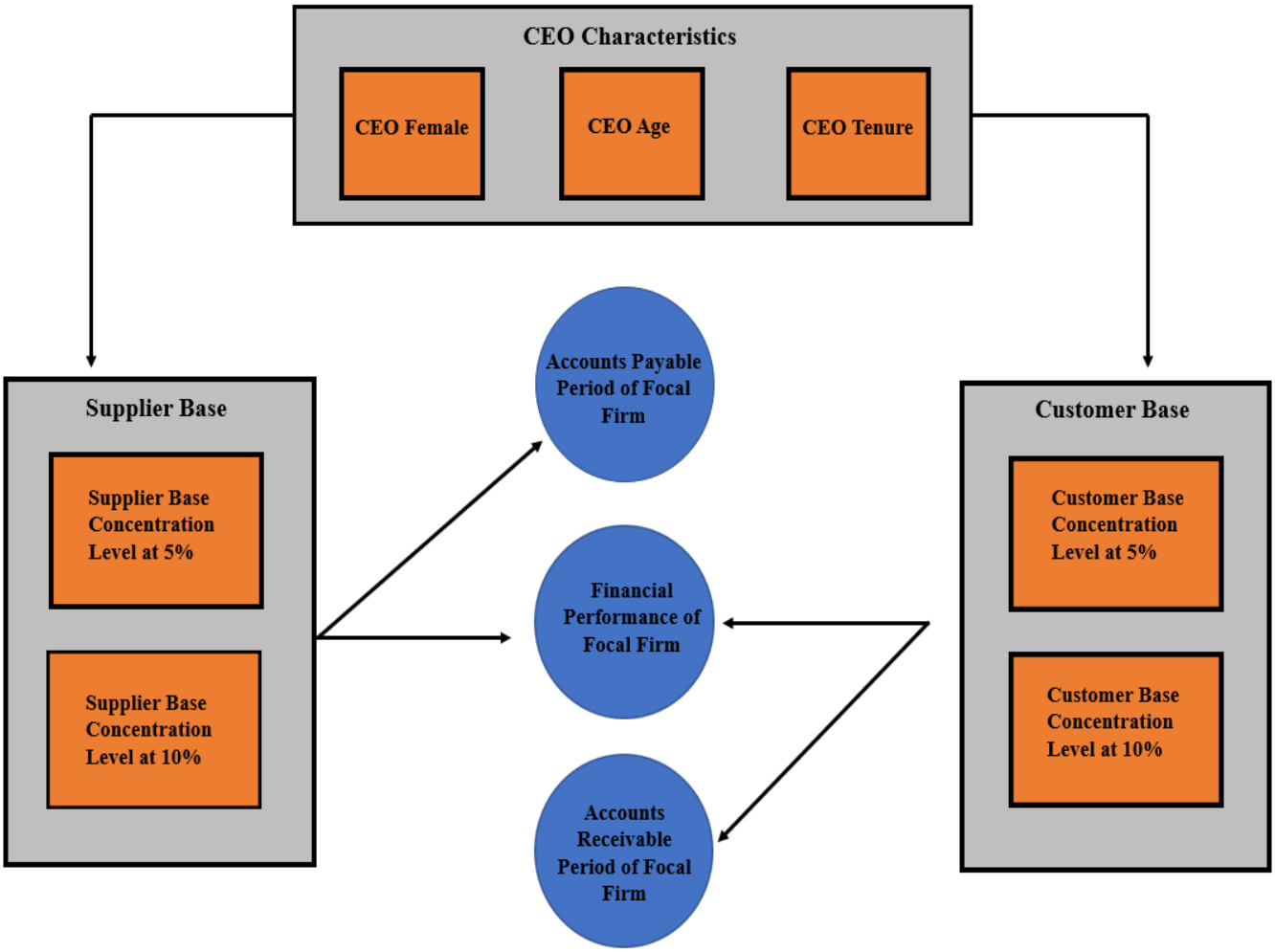

Figure 8. Theoretical framework for the study

Chapter 5: Analysis & Results

5.1 Descriptive Statistics

Table 3 summarizes the empirical distributions of the main variables utilized in the study in the context of the supplier base-focal firm dyadic relationship for the fiscal year of 2017. Similarly, Table 4 summarizes the main variables used in the study considering the focal firm-customer base dyadic relationship for the same time period. Also, the number of observations reported in the first column indicates that data availability requirements lead to different sample sizes for different variables.

In Panel A of Table 3, we present the descriptive summaries for all the focal firm related dependent variables employed in the study viz: Tobin's Q, gross profit margin, net profit margin, payable period, and the receivable period. Relative to the US sample-based analysis by Lu & Shang (2017), the average Tobin's Q in our sample is larger (2.4415 in our sample versus 1.7). This might be because Lu & Shang (2017) employed a larger set of focal firms, although the magnitude of our sample reduction due to data cleaning is comparable with the prior literature using Bloomberg SPLC[3]. The firms sampled have an average gross profit margin of .4548 and an average net profit margin of .0239. Lastly, for a focal firm involved in our sample, customers, on average, take 67.3363 days to settle their payments (maximum duration for collection: 441.2614 days; minimum duration for collection: 4.6901 days). Also, a focal firm from our sample, on average, takes 64.761 days to pay its dues (maximum duration until payment: 347.8907 days; minimum duration until payment: 8.1584 days).

Panel B of Table 3 demonstrates the summary statistics for the supplier-base related explanatory variables. The supplier-base concentration level at 5% (Supplier_Conc_5) averages 3.5248% for the 325 focal firms in the sample with a standard deviation of 12.7163%. Also, The supplier-base concentration level at 10% (Supplier_Conc_10) averages 1.9639% for the 325 observations in the sample with a standard deviation of 7.494%. In both cases, the latter statistics

[3] The magnitude of sample reduction due to the steps of data cleaning is comparable with prior literature using Bloomberg SPLC. For example, Dong et al. (2020, p. 777) collected 1611 unique firms after merging raw supply chain relation data from Bloomberg with Compustat. After removing observations with missing revenue share and other supply base information, they retained 865 (53.7%) firms with non-missing values. As shown in section 4.1, we had an initial sample of 625 focal firms and retained 325 focal firms (52%) with non-missing supply-base information and 394 focal firms (63%) with non-missing customer-base information.

suggest that there is a sizeable cross-sectional variation in the impact of supplier concentration on the focal firm. Here, we can observe that a focal firm in the sample, on average, interacts with 17.6676 suppliers in its supply base (smallest supply base comprises of only 1 supplier whereas the largest supply base has 209 suppliers) and engages in international sourcing from an average of 5.8492 countries. The firms sampled also have an average vertical complexity of 23.9894.

Finally, Panel C of Table 3 summarizes the distributions of CEO characteristics employed by the study. Here, we note that the average CEO tenure has a value of 7.9906 years and ranges from 1 year to a maximum of 36 years in this sample. On the other hand, the average age of a CEO employed by a focal firm in our sample is 56.8099 years. The summary statistics of other control variables are visible in Panel D for your reference.

Table 4 reports the descriptive statistics of the similar primary variables used in the study for the focal firm-customer base dyad for the fiscal year of 2017. Apart from the variables already observed in the previous category of dyad, Panel B demonstrates that the customer-base concentration level at 5% (Customer_Conc_5) averages 21.9172% for the 394 observations in the sample with a standard deviation of 33.2412%. Also, the customer-base concentration level at 10% (Customer_Conc_10) averages 17.9331% with a standard deviation of 32.3461%. Unlike the supplier-base concentration, we do not observe much cross-sectional variation in the impact of customer-base concentration on the focal firm performance. We can also observe that a focal firm from our sample has an average of 22.0389 customers in the consumer base (the smallest consumer base comprises only 1 customer whereas the largest consumer base has 116 customers) and has international clients from an average of 8.0761 countries.

Table 5 presents the pairwise correlation of the key variables used in Tables 3 and 4. Here, Panel A includes the supplier-base/customer-base concentration levels at 5%, whereas Panel B solely focuses on the supplier-base/customer-base concentration levels at 10%. A summary of the following hypothesis testing is given at the end of the chapter in Table 16.

Table 3. Descriptive Statistics for the Supplier Base-Focal Firm Dyad

Panel A: Focal Firm Specific Dependent Variables

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
Tobin's Q	304	2.441514	.5289513	9.214712	1.487922
Gross Profit Margin	325	.454844	-.0395681	.8986706	.1912014
Net Profit Margin	325	.0239835	-9.20765	.4504261	.5430733
Payable Period	325	64.76106	8.158408	347.8907	39.10235
Receivable Period	325	67.33638	4.690126	441.2614	33.872

Panel B: Supplier Base Specific Explanatory Variables

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
Supplier_Conc_5	325	.0352484	0	1	.1271636
Supplier_Conc_10	325	.0196396	0	.5	.0749491
Horizontal Complexity Supplier	325	17.66769	1	209	35.52456
Vertical Complexity Supplier	319	23.98948	.5	140	25.07182
Geographical Complexity Supplier	325	5.849231	1	29	6.31567

Panel C: CEO Characteristics

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
CEO Tenure	321	7.990654	1	36	6.83076
CEO Tenure Squared	321	110.3645	1	1296	192.517
CEO Age	321	56.80997	42	78	6.473844

	Observations	Count	Percentage	Standard Deviation
Female CEO	325	15	4.62	.2101417

Panel D: Control Variables

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
Firm Size	325	7.864176	3.32651	11.64233	1.489597
Capital Intensity	325	.1589508	.0021943	.8527189	.1221688
Operating Cash Flow	324	.0565358	-1.09686	.2797157	.1148437
Leverage	325	.2412711	0	.993315	.1778621
Sales Growth	319	.0347802	-.5332785	.9445769	.1906304
R&D Intensity	325	.0963796	0	3.089375	.1976791

Notes: This table presents the descriptive statistics of the main variables used in the study. * p < .10, ** p < .05, *** p <.01 (two-tailed). See Appendix A for detailed variable definitions.

Table 4. Descriptive Statistics for the Focal Firm-Customer Base Dyad

Panel A: Focal Firm Specific Dependent Variables

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
Tobin's Q	334	2.457535	.5495993	11.62565	1.717314
Gross Profit Margin	352	.3975315	-8.339019	.9724876	.5767619
Net Profit Margin	352	-.038185	-15.81578	.906002	1.04702
Payable Period	352	66.02078	2.509019	352.6839	43.94531
Receivable Period	352	68.38143	2.750142	441.2614	35.4589

Panel B: Customer-Base Specific Explanatory Variables

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
Customer_Conc_5	394	.2191727	0	1	.3324128
Customer_Conc_10	394	.1793318	0	1	.3234617
Horizontal Complexity Customer	394	22.09898	1	116	28.18013
Geographical Complexity Customer	394	8.076142	1	32	6.920434

Panel C: CEO Characteristics

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
CEO Tenure	344	7.787791	1	35	6.748612
CEO Tenure Squared	344	106.061	1	1225	189.207
CEO Age	344	56.92733	40	77	6.695628

	Observations	Count	Percentage	Standard Deviation
CEO Female	394	16	4.06	.1976339

Panel D: Control Variables

Variables	Observations	Mean Value	Minimum Value	Maximum Value	Standard Deviation
Firm Size	352	7.568585	1.618199	11.30719	1.647913
Capital Intensity	352	.1597757	.0012084	.8625087	.1282149
Operating Cash Flow	350	.0522951	-1.09686	.2909882	.1178453
Leverage	352	.2314321	0	.9904107	.1760092
Sales Growth	342	.0582396	-.8491006	3.653704	.3692954
R&D Intensity	352	.1266969	0	6.754638	.4468717

Notes: This table presents the descriptive statistics of the main variables used in the study. * p < .10, ** p < .05, *** p <.01 (two-tailed). See Appendix A for detailed variable definitions.

Table 5. Pairwise Correlation

Panel A: Supplier-Base/Customer-Base Concentration Levels at 5%

	Correlation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Tobin's Q	1															
2	Gross Profit Margin	0.00448	1														
3	Net Profit Margin	-0.156***	0.683***	1													
4	Payable Period	0.0752***	0.170***	-0.168***	1												
5	Receivable Period	-0.0327**	-0.108***	-0.183***	0.292***	1											
6	Hor Complex Supplier	-0.0456	-0.115*	0.0500	0.0783	0.244***	1										
7	Vert Complex Supplier	0.0697	0.0824	-0.0392	0.0939	-0.00648	-0.0471	1									
8	Geog Complex Supplier	-0.0554	0.0398	-0.0140	0.317***	0.161**	0.761***	0.000423	1								
9	Supplier_Conc_5	-0.00141	0.0284	-0.392***	0.0200	-0.00489	-0.0601	0.0768	-0.0514	1							
10	Hor Complex Customer	-0.0628	0.0512	0.0592	0.0609	-0.106*	0.238***	-0.0567	0.185**	-0.0150	1						
11	Geog Complex Customer	-0.0649	0.0996	0.0334	0.195***	-0.0440	0.338***	-0.00593	0.448***	-0.0285	0.810***	1					
12	Customer_Conc_5	0.166**	0.133*	-0.165**	0.164**	-0.0717	-0.179**	0.0434	-0.0957	0.182**	-0.380***	-0.349***	1				
13	CEO Female	0.0195	0.0166	0.0353**	-0.0116	-0.0210	0.169**	0.187***	0.101	-0.0488	0.0310	0.0221	-0.0320	1			
14	CEO Tenure	0.139***	0.0320	0.00546	-0.0301	-0.0331	-0.102	-0.00648	-0.115*	0.00229	-0.0327	-0.0595	0.00632	-0.0844***	1		
15	CEO Tenure Squared	0.125***	0.0225	-0.00787	-0.0326	-0.0349*	-0.103	-0.00324	-0.115*	-0.0133	-0.0354	-0.0594	-0.00164	-0.0749***	0.941***	1	
16	CEO Age	0.0383*	-0.0222	0.0215	-0.0393*	-0.00739	0.0132	-0.0537	0.0213	-0.0237	-0.0922	-0.0808	0.0375	-0.0341	0.478***	0.455***	1

Panel B: Supplier-Base/Customer-Base Concentration Levels at 10%

	Correlation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Tobin's Q	1															
2	Gross Profit Margin	0.00448	1														
3	Net Profit Margin	-0.156***	0.683***	1													
4	Payable Period	0.0752***	0.170***	-0.168***	1												
5	Receivable Period	-0.0327**	-0.108***	-0.183***	0.292***	1											
6	Hor Complex Supplier	-0.0456	-0.115*	0.0500	0.0783	0.244***	1										
7	Vert Complex Supplier	0.0697	0.0824	-0.0392	0.0939	-0.00648	-0.0471	1									
8	Geog Complex Supplier	-0.0554	0.0398	-0.0140	0.317***	0.161**	0.761***	0.000423	1								
9	Supplier_Conc_10	0.00154	0.0306	-0.331***	-0.00355	-0.0356	-0.0606	0.0750	-0.0583	1							
10	Hor Complex Customer	-0.0628	0.0512	0.0592	0.0609	-0.106*	0.238***	-0.0567	0.185**	-0.0253	1						
11	Geog Complex Customer	-0.0649	0.0996	0.0334	0.195***	-0.0440	0.338***	-0.00593	0.448***	-0.0424	0.810***	1					
12	Customer_Conc_10	0.205***	0.185***	-0.131*	0.194***	-0.0572	-0.153*	0.0228	-0.0620	0.152*	-0.350***	-0.326***	1				
13	CEO Female	0.0195	0.0166	0.0353**	-0.0116	-0.0210	0.169**	0.187***	0.101	-0.0435	0.0310	0.0221	-0.0215	1			
14	CEO Tenure	0.139***	0.0320	0.00546	-0.0301	-0.0331	-0.102	-0.00648	-0.115*	0.0185	-0.0327	-0.0595	0.0194	-0.0844***	1		
15	CEO Tenure Squared	0.125***	0.0225	-0.00787	-0.0326	-0.0349*	-0.103	-0.00324	-0.115*	0.00962	-0.0354	-0.0594	0.0141	-0.0749***	0.941***	1	
16	CEO Age	0.0383*	-0.0222	0.0215	-0.0393*	-0.00739	0.0132	-0.0537	0.0213	0.00407	-0.0922	-0.0808	0.0271	-0.0341	0.478***	0.455***	1

Notes: This table presents the pairwise correlation matrix of the key variables of interest. * p < .10, ** p < .05, *** p <.01 (two-tailed). See Appendix A for detailed variable definitions.

5.2 Regression Results for Supplier-Base Concentration

5.2.1 Impact on the Focal Firm's Market-Based Financial Performance

Table 6 presents the results of the OLS regression analyses that examine the effect of supplier-base concentration levels on the market-based financial performance (i.e., Tobin's Q). Here, Model (1) investigates the influence of supplier-base concentration level at 5% (Supplier_Conc_5) on Tobin's Q, while Model (2) investigates the effect of supplier-base concentration level at 10% (Supplier_Conc_10).

Model (1) demonstrates that a higher concentration of base-level suppliers that account for 5% or more of the COGS incurred by the focal firm has a highly negative impact (coefficient=-2.1297; p-value=.005) on the focal firm's market-based financial performance. Similarly, Model (2) shows that Supplier_Conc_10 has a highly negative influence (coefficient=-2.8768; p-value=.001) on Tobin's Q. Both the regression models indicate that the focal firm's book value is relatively higher than its market value which implies that the cost to replace the focal firm's assets is far greater than the value of its stock or that the stock is undervalued. Since the manufacturing industries involved in our sample depend on highly specialized services or skills, the vendor concentration risk becomes more significant to the market and other nonfinancial stakeholders. Zhang et al. (2020) strongly supported this viewpoint, which argues that the high supplier concentration of a firm can result in a decline of the trade credit and an increase in the difficulty of equity financing. Also, Kolay et al. (2016) display that a high supplier-base concentration can have a cascading effect as suppliers' bankruptcy announcement causes the stock price of the downstream firms to decline. Firms with a high supplier-base concentration are more likely to face inflexible loan terms from banks (Kalwani & Narayandas, 1995), which leads to an increase in financial constraints and compels firms to hold more cash and take less advantage of emerging opportunities (Zhang et al., 2020).

It can also be seen that neither the vertical SCC nor the geographical SCC impacts the market-based financial performance in both the regression models. In this case, further research is required when a dataset that includes more focal firms is available. Amongst the control variables, we observe that an increase in ratios such as operating cash flow, sales growth, and R&D intensity leads to a noticeable increase in the market-based financial performance in both the regression

models since they prove to be the key indicators against the focal firm facing any financial distress. Meanwhile, a higher debt level is shown to reduce financial performance.

Table 6. OLS Regression of Supplier-Base Concentration on Market-Based Financial Performance

Table 6 presents the OLS regressions of supplier concentrations, supply-base complexities, and other firm-specific control variables on focal firm financial performance (Tobin's Q). The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) presents the effect of supplier-base concentration level at 5%, while Model (2) presents the effect of supplier-base concentration level at 10% as we are primarily interested in investigating the influence of the relative bargaining power of the supply-base. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)** **Tobin's Q**	**Model (2)** **Tobin's Q**
Supplier_Conc_5	-2.1297***	
	(0.757)	
Supplier_Conc_10		-2.8768***
		(0.873)
Vertical Complexity Supplier	0.0025	0.0024
	(0.003)	(0.003)
Geographical Complexity Supplier	0.0037	0.0052
	(0.018)	(0.018)
Firm Size	-0.0494	-0.0564
	(0.086)	(0.087)
Capital Intensity	-0.7089	-0.7376
	(0.576)	(0.578)
Operating Cash Flow	4.5966***	4.5925***
	(1.375)	(1.422)
Leverage	-1.1599**	-1.2383**
	(0.493)	(0.502)
Sales Growth	1.5298**	1.5335**
	(0.601)	(0.606)
R&D Intensity	3.1952***	3.0177***
	(0.820)	(0.836)
Constant	2.5899***	2.6651***
	(0.635)	(0.640)
Observations	293	293

R-squared	0.241	0.235

5.2.2 Impact on the Focal Firm's Accounting-Based Financial Performance

Table 7 presents the results of the OLS regression analyses that investigate the impact of Supplier_Conc_5 and Supplier_Conc_10 on both the focal firm's net profit margin and gross profit margin.

Model (1) and Model (3) show that higher Supplier_Conc_5 leads to a decrease in the net profit margin (coefficient=-.4248; p=.041) and a decrease in the gross profit margin (coefficient=-.2433; p=.009), respectively which is consistent with the literature review. Also, Model (2) and Model (4) demonstrate that higher Supplier_Conc_10 has a negatively significant impact on the net profit margin (coefficient=-.4689; p=.068) and on the gross profit margin (coefficient=-.3253; p=.011), respectively. A high supplier concentration has the leverage to demand a large cost increase or cut back on production due to non-compliance. Duchin (2010) & Zhang et al. (2020) reinforce this view by asserting that firms with a high supplier concentration are often pressurized to provide spot payment, pre-payment, and other hidden costs, which in turn reduces commercial credit. Also, the unexpected breakdown of the supplier-customer relationship involves supplementary costs in relationship-specific investments and creating a new supply chain relationship (Banerjee et al., 2008; Tran & Zikos, 2017). Hence, the regression results and the empirical evidence mentioned above support our Hypothesis 1 which states that interacting with a higher supplier-base concentration leads to negative financial performance.

In the context of SCC variables, only the vertical complexity shows a positive effect on the net profit margin in Models (1) (coefficient=.0008; p=.052) and (2) (coefficient=.0008; p=.054). We assume that the vertical complexity does not significantly impact the gross profit margin since the main intention behind vertical integration is to reduce the transaction and material handling costs when independent firms control two or more production stages (Teece, 2018). Focal firms initiate direct relationships beyond the first tier when product complexity advances (Sharma et al., 2019). A company manufacturing integrated or finished products can significantly reduce expenses on advertising, sales promotions, or market research and work with little or no sales force (Buzzell, 1983) compared to a company selling to independent customers. Vertical integration also provides supply assurance of critical materials to integrating firms (Bolton & Whinston, 1993). As

a result, it prevents integrating firms from experiencing erratic and unpredictable material costs, which otherwise can be extremely damaging in the case of material shortage in industries characterized by high fixed costs.

Lastly, except for the firm size overall and debt level in Models (3) and (4), all the control variables significantly affect the focal firm's financial performance.

Table 7. OLS Regression of Supplier-Base Concentration on Accounting-Based Financial Performance

Table 7 presents the OLS regressions of base-level supplier concentrations, supply-base complexities, and other firm-specific control variables on focal firm financial performance (Net Profit Margin & Gross Profit Margin). The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Models (1) and (3) present the effect of supplier-base concentration level at 5%, while Models (2) and (4) presents the effect of supplier-base concentration level at 10% as we are primarily interested in investigating the influence of the relative bargaining power of the supply-base. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)** **Net Profit Margin**	**Model (2)** **Net Profit Margin**	**Model (3)** **Gross Profit Margin**	**Model (4)** **Gross Profit Margin**
Supplier_Conc_5	-0.4248**		-0.2433***	
	(0.207)		(0.093)	
Supplier_Conc_10		-0.4689*		-0.3253**
		(0.256)		(0.127)
Vertical Complexity Supplier	0.0008*	0.0008*	0.0003	0.0003
	(0.000)	(0.000)	(0.000)	(0.000)
Geographical Complexity Supplier	0.0043	0.0049	0.0034	0.0037
	(0.003)	(0.003)	(0.003)	(0.003)
Firm Size	-0.0023	-0.0041	-0.0106	-0.0119
	(0.017)	(0.017)	(0.011)	(0.011)
Capital Intensity	-0.3956***	-0.3947***	-0.4849***	-0.4855***
	(0.121)	(0.123)	(0.089)	(0.089)
Operating Cash Flow	0.9526***	0.9506***	0.3893***	0.3922***
	(0.243)	(0.254)	(0.126)	(0.132)
Leverage	-0.2676***	-0.2817***	0.0720	0.0648
	(0.100)	(0.105)	(0.056)	(0.056)
R&D Intensity	-2.0778***	-2.1260***	0.3109**	0.2911*
	(0.447)	(0.464)	(0.144)	(0.150)
Sales Growth	0.3458***	0.3511***	0.1921***	0.1939***
	(0.128)	(0.131)	(0.064)	(0.064)
Constant	0.2724*	0.2869*	0.5195***	0.5297***

	(0.147)	(0.150)	(0.080)	(0.081)
Observations	312	312	312	312
R-squared	0.840	0.837	0.262	0.257

5.2.3 Impact on the Focal Firm's Payable Period

Table 8 presents the regression models which examine the effect of Supplier_Conc_5 and Supplier_Conc_10 on the focal firm's payable period. In Model (1), an increase in the Supplier_Conc_5 does not impact the focal firm's payable period (coefficient=-33.5288; p=.164). Similarly, in Model (2), higher Supplier_Conc_10 is shown to have no influence on the payable period as well (coefficient=-56.6318; p=.134). Hence, Hypothesis 2 which postulates about the negative effect of higher supplier-base concentration on focal firm's payable period is not supported in the study. However, it can be seen that even though the supplier-base concentration levels do not have a significant impact, there is definitely a negative trend observed in the payable period with an increase in the supplier-base concentration level. This negative trend in the focal firm's payable period is also consistent with the regression results obtained from Tables 6 and 7.

Interestingly, in this case, we find that SCC variables manage to have a more significant albeit opposite influence on the focal firm's payable period than the relative bargaining power of the supply chain partners. In Model (1), vertical complexity (coefficient=.1188; p=.032) and geographical complexity (coefficient=1.3012; p=.031) have a positive influence on the payable period. Similarly, in Model (2), an increase in the vertical complexity (coefficient=.1192; p=.031), as well as geographical complexity (coefficient=1.3407; p=.025), leads to an increase in the focal firm's payable period.

According to Walker et al. (1997), firms gain access to a vast pool of unique resources and the ability to generate more powerful connections through network collaborations. Such activities facilitate reductions in CCC (Carnovale et al., 2019). Also, Grosse-Ruyken et al. (2011) found that CCC reduction opportunities cannot be generated by a single firm but can be achieved through collaboration with tier 1 and tier 2 suppliers. Consequently, Monto (2013) found that collaborative management approaches can reduce the financing costs of working capital on a network level. The aforementioned arguments reiterate our recent result which shows a positive impact of vertical complexity on the focal firm's payable period.

However, we also find a few counterarguments which have the perception that higher level of vertical complexity can be detrimental to the focal firm's performance in the long run. For instance, some authors postulate that there will be a diminishing growth in the financial performance as the density/depth of the connections (i.e., vertical integration) increases (Cohen & Cohen, 2003; Burt, 2004). Yeniyurt et al. (2009) assert that coordination with an extensive supplier portfolio may induce administrative complexities and challenges with maintaining cash flows, consequently worsening the relationship management. Also, increasing the cohesion density can lead to overlapping, potential superfluous resources, which might pressure the management to seek alternative, new sources (Carnovale et al., 2019).

Regarding the geographical complexity, Peterson & Rajan (2002) posit that location is not a critical determinant of lending and borrowing as the technology improvement mitigates the information asymmetry and monitoring issues. Similarly, Carling & Lundberg (2005) could not find any evidence of information asymmetry increasing with the distance or existence of geographical credit rationing on behalf of the bank. The results show that the changes are due to the higher technological standard, easier and more impersonal communication, higher availability of borrowers' credit records, and the growing easiness of processing loans (Li & Wang, 2018). However, credit flows systematically diminish in uncertain times. Alessandri & Bottero (2020) corroborate the reluctance to lend and borrow in economic uncertainty by finding three main results in their study. First, there is a decline in the supply of new credit as a rise in aggregate uncertainty lowers the probability that firms' applications will be successful. Second, economic uncertainty impedes the flow of funds to the real economy, even for successful applicants. Third, firms are less likely to be rejected if they apply to the financial intermediaries located in their vicinity. From a firm's perspective, proximity to its potential lenders is a better hedge against uncertainty shocks than a good credit rating. Hence, the decline in the credit market also discourages other supply chain partners from actively financing cross-border trading.

Here, we can assume that the geographical complexity has the potential to hinder financial performance or the general supply chain financing in cases of high uncertainty or crisis. Similarly, vertical complexity can exhibit the same negative influence on financial performance when operating in collaboration with further tiers. As a result, additional research is required to develop a conclusive statement about their respective impacts. Also, amongst the control variables, only

R&D intensity seems to increase the payable period for the focal firm in both models. Under the general accounting principles, a firm must always record the costs of developing a new product as expenses on its income statement in the period in which it incurs them instead of capitalizing them on its balance sheet. Thereby, this action might have an impact on its overall accounts payable.

Table 8. OLS Regression of Supplier-Base Concentration on Payable Period

Table 8 presents the OLS regressions of base-level supplier concentrations, supply-base complexities, and other firm-specific control variables on focal firm payable period. The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) presents the effect of supplier-base concentration level at 5%, while Model (2) presents the effect of supplier-base concentration level at 10% as we are primarily interested in investigating the influence of the relative bargaining power of the supply-base. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)** **Payable Period**	**Model (2)** **Payable Period**
Supplier_Conc_5	-33.5288	
	(24.042)	
Supplier_Conc_10		-56.6318
		(37.680)
Vertical Complexity Supplier	0.1188**	0.1192**
	(0.055)	(0.055)
Geographical Complexity Supplier	1.3012**	1.3407**
	(0.602)	(0.596)
Firm Size	3.2956	3.0659
	(2.838)	(2.807)
Capital Intensity	-22.3830	-22.7044
	(16.234)	(16.247)
Operating Cash Flow	-26.5692	-25.3133
	(17.997)	(17.942)
Leverage	5.8586	5.0704
	(14.199)	(14.310)
Sales Growth	11.4318	11.4215
	(12.775)	(12.912)
R&D Intensity	64.2208*	63.1172*
	(35.084)	(34.917)
Constant	26.3430	28.1095
	(20.629)	(20.473)

Observations	312	312
R-squared	0.226	0.227

5.3 Regression Results for Customer-Base Concentration

5.3.1 Impact on the Focal Firm's Market-Based Financial Performance

Table 9 presents the results of the OLS regression analyses that examine the effect of customer-base concentration levels on the market-based financial performance (i.e., Tobin's Q). Here, Model (1) investigates the influence of customer-base concentration level at 5% (Customer_Conc_5) on Tobin's Q, while Model (2) investigates the effect of customer-base concentration level at 10% (Customer_Conc_10).

Model (1) demonstrates that a higher concentration of base-level customers with revenue percentage equal to 5% or more contributed to the focal firm has a positive impact (coefficient=.6712; p-value=.068) on the focal firm's market-based financial performance. Similarly, Model (2) shows that Customer_Conc_10 has a highly positive influence (coefficient=.9430; p-value=.015) on Tobin's Q. Thus, these results resonate with the stream of empirical studies which emphasize the benefits of collaborative relationships with customers (Uzzi, 1996; Patatoukas, 2012; Irvin et al., 2016; Kwak & Kim, 2020). Perhaps the ability to maintain long-term relationships with fewer significant customers facilitates developing contractual agreements that can be tailored to each client as well as gives the focal firm several opportunities to enjoy equitable profits across the supply chain operations. Simultaneously, more resources can be utilized to get to know and meet each customer's needs better, thereby improving customer service. Furthermore, long-established and mature business relationships with major customers promote information sharing, building trust, and valuable input to a supplier for improving products or services because of a vested interest in supplier success (Palmatier, 2008; Yli-Renko & Janakiraman, 2008).

It can also be witnessed that most of the control variables and the geographical complexity do not significantly influence the focal firm's market-based financial performance. However, we see that capital intensity leads to a decline in the financial performance in both the regression models. Shapiro & Titman (1986) support a similar viewpoint and promote the notion that highly

capital-intensive firms observe significant fluctuations in an operation's profitability. Being a more capital-intensive firm may increase firm risk because a business with more fixed assets engages a high level of fixed costs in deriving its profitability. After all, the high volume of fixed cost does not vary according to the sales volume and thus causes higher fluctuations of profits (Brealey & Myers, 1984). Also, high operating cash flow has a positive impact on Tobin's Q in Models (1) and (2) since it indicates to the market that a firm has generated more cash in a period than is required to pay off its current liabilities.

Table 9. OLS Regression of Customer-Base Concentration on Market-Based Financial Performance

Table 9 presents the OLS regressions of base-level customer concentrations, customer-base complexities, and other firm-specific control variables on focal firm financial performance (Tobin's Q). The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) presents the effect of customer-base concentration level at 5%, while Model (2) presents the effect of customer-base concentration level at 10% as we are primarily interested in investigating the influence of the relative bargaining power of the customer-base. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1) Tobin's Q**	**Model (2) Tobin's Q**
Cutomer_Conc_5	0.6712*	
	(0.367)	
Customer_Conc_10		0.9430**
		(0.384)
Geographical Complexity Customer	0.0076	0.0103
	(0.012)	(0.012)
Firm Size	-0.0479	-0.0453
	(0.074)	(0.072)
Capital Intensity	-1.7128***	-1.7006***
	(0.555)	(0.555)
Operating Cash Flow	3.2716**	3.2272**
	(1.512)	(1.490)
Leverage	-0.6739	-0.6266
	(0.742)	(0.737)
R&D Intensity	0.2888	0.2496
	(0.532)	(0.515)
Sales Growth	0.8108	0.7948
	(0.665)	(0.668)
Constant	2.7781***	2.7072***

	(0.531)	(0.512)
Observations	325	325
R-squared	0.144	0.157

5.3.2 Impact on the Focal Firm's Accounting-Based Financial Performance

Table 10 presents the results of the OLS regression analyses that investigate the impact of Customer_Conc_5 and Customer_Conc_10 on both the focal firm's net profit margin and gross profit margin.

Models (1) and (2) demonstrate that neither the Customer-Conc_5 nor the Customer_Conc_10 has any effect on the focal firm's net profit margin. However, Model (3) shows that the Customer_Conc_5 has a direct and positive influence (coefficient=.2741; p-value=.003) on the focal firm's gross profit margin. Also, it can be witnessed in Model (4) that an increase in Customer_Conc_10 leads to a significant and positive increase (coefficient=.3174; p-value=.001) in the focal firm's gross profit margin. Here, we can witness that the positive association between base-level customer concentrations and focal firm's gross profit margin is consistent with the results obtained from the regression analyses in Table 9. In a similar spirit, Patatoukas (2012) documented those suppliers with more concentrated customer bases experience higher profit margins and enhanced asset utilization.

Interestingly, we also observe that an increase in the geographical proximity leads to an increase in the focal firm's gross profit both in Model (1) (coefficient=.0085, p-value=.001) and Model (2) (coefficient=.0088, p-value=.000). Therefore, we assume that interacting with an international customer base is beneficial for the focal firm's gross profit. In this era of peak economic globalization, it is more common than ever to work with international clients. Firms heavily invest in cross-border expansion to gain entry to new markets or easy access to location-specific assets at affordable rates. A focal firm's performance is driven not only by a firm's own R&D practices but also by those that are conducted by other organizations (Cassiman & Veugelers, 2006; Andersson et al., 2016). Together, the R&D activities can lead to the generation of new technologies, products, services, and processes that may diminish cost, generate revenue and improve firm competitiveness (Gao et al., 2008; Andersson et al., 2016). Higher geographic

dispersion also enables firms to protect their technologies and fosters value capture by enabling them to fragment their technologies across manufacturing stages in a way that makes imitating globally dispersed technologies challenging and costly (Zhao, 2006).

However, due to the technology gap between countries, supply delivery risks like delivery failures, inability to meet quantity demand, and irregular supply occur (Zsidisin, 2003). Moreover, suppliers' long supply lead times to manufacturers result in manufacturers passing on the long supply lead times to customers. As a result, customers will be unwilling to integrate with manufacturers, which reduces operational visibility (Zhao et al., 2013). Lack of visibility accompanied by variable forecasting and variable lead times at both the plant and customer level consequently cause demand variability. When the demand variability for a product or service is high, the manufacturing firm might have to change the product from time to time and suffer from holding costs or the bullwhip effect. Hence, apart from the vulnerability introduced due to trade credit risks, agency costs, and other geopolitical uncertainties, geographical distance also has a pivot role in influencing one of the most critical functions of global souring and purchasing practices. Furthermore, trust and cooperation between customers and the manufacturing firm also get negatively affected. Taking the above contradictory arguments into consideration, we come to the conclusion that further research is required with a sample that includes more focal firms. Lastly, regarding the controls, R&D investments are observed to be negatively correlated with the focal firm's net profit margin as well as gross profit margin.

Table 10. OLS Regression of Customer-Base Concentration on Accounting-Based Financial Performance

Table 10 presents the OLS regressions of base-level customer concentrations, customer-base complexities, and other firm-specific control variables on focal firm financial performance (Net Profit Margin & Gross Profit Margin). The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Models (1) and (3) present the effect of customer-base concentration level at 5%, while Models (2) and (4) presents the effect of customer-base concentration level at 10% as we are primarily interested in investigating the influence of the relative bargaining power of the customer-base. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)** **Net Profit Margin**	**Model (2)** **Net Profit Margin**	**Model (3)** **Gross Profit Margin**	**Model (4)** **Gross Profit Margin**
Customer_Conc_5	-0.2040		0.2741***	
	(0.189)		(0.090)	
Customer_Conc_10		-0.1334		0.3174***
		(0.195)		(0.091)
Geographical Complexity Customer	0.0021	0.0032	0.0085***	0.0088***
	(0.003)	(0.002)	(0.003)	(0.002)
Firm Size	0.0090	0.0116	-0.0086	-0.0090
	(0.019)	(0.021)	(0.015)	(0.015)
Capital Intensity	-0.2288	-0.2222	-0.7411***	-0.7407***
	(0.149)	(0.146)	(0.116)	(0.116)
Operating Cash Flow	2.0597**	2.0568**	-0.1701	-0.1819
	(0.822)	(0.837)	(0.359)	(0.338)
Leverage	-0.4519	-0.4388	0.0679	0.0727
	(0.362)	(0.364)	(0.135)	(0.135)
Sales Growth	0.5908	0.5826	-0.1578	-0.1588
	(0.481)	(0.483)	(0.199)	(0.200)
R&D Intensity	-1.8131***	-1.8151***	-1.0744***	-1.0843***
	(0.516)	(0.517)	(0.234)	(0.228)
Constant	0.1511	0.0978	0.5907***	0.5958***
	(0.172)	(0.192)	(0.120)	(0.124)
Observations	340	340	340	340
R-squared	0.720	0.718	0.712	0.718

5.3.3 ***Impact on the Focal Firm's Receivable Period***

Table 11 presents the regression models which examine the effect of Customer_Conc_5 and Customer_Conc_10 on the focal firm's receivable period. Unfortunately, we do not observe the explanatory variables having any influence on the receivable period. Therefore, Hypothesis 4 is not supported in our study. However, the focal firm's receivable period and Customer_Conc_5 are negatively correlated (albeit not significantly) (coefficient=-8.2863, p-value=.143) in Model (1), a finding that is consistent with the results obtained from Tables 9 and 10 depicting the collaborative nature of association with major customers. We also notice a significant and negative correlation between the geographical complexity and the focal firm's receivable period in Model (1) (coefficient=-.6112, p-value=.026) and Model (2) (coefficient=-.5766; p-value=.034) which is somewhat in support of pursuing business relationships with international clients. Also, amongst the control variables, only capital intensity is found to be negatively correlated to the focal firm's receivable period in both the regression models.

Table 11. OLS Regression of Customer-Base Concentration on Receivable Period

Table 11 presents the OLS regressions of base-level customer concentrations, customer-base complexities, and other firm-specific control variables on focal firm receivable period . The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) presents the effect of customer-base concentration level at 5%, while Model (2) presents the effect of customer-base concentration level at 10% as we are primarily interested in investigating the influence of the relative bargaining power of the customer-base. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)** **Receivable Period**	**Model (2)** **Receivable Period**
Customer_Conc_5	-8.2863	
	(5.644)	
Customer_Conc_10		-6.1339
		(5.942)
Geographical Complexity Customer	-0.6112**	-0.5766**
	(0.273)	(0.270)
Firm Size	2.0385	2.1282
	(1.963)	(1.977)
Capital Intensity	-27.7416**	-27.5215**
	(10.846)	(10.892)
Operating Cash Flow	-27.5190	-27.5541
	(19.858)	(19.879)
Leverage	-16.1215	-15.7045
	(10.369)	(10.387)
Sales Growth	1.3845	1.1109
	(7.455)	(7.512)
R&D Intensity	-4.9239	-4.9430
	(4.222)	(4.215)
Constant	69.7296***	67.9104***
	(13.102)	(13.191)
Observations	340	340
R-squared	0.033	0.031

5.4 Regression Results for CEO Characteristics

5.4.1 Impact on the Supplier-Base Concentration Level at 5%

Table 12 presents the results of the OLS estimations that examine the effect of CEO characteristics on Supplier_Conc_5. In Model (1), we can observe that CEO female has a significant and negative influence (coefficient=-.0272; p-value=.012) on Supplier_Conc_5. Earlier, we observed that Supplier_Conc_5 negatively impacts the focal firm's financial performance in Tables 6 and 7. As a result, we can argue that female CEOs are better at matching their firms' strategy and structure to the challenges posed by the environment. Hence, they participate in strategic risk-taking by reducing the adversarial influence of the supplier-base concentration. Model (4) shows supportive evidence for this effect.

Model (2) demonstrates that even though the linear term for CEO tenure has no influence on Supplier_Conc_5, the quadratic or the higher order term is shown to decrease the relative bargaining power of the supplier-base concentration (coefficient=-.0002; p-value=.080). These results suggest that CEOs with different tenures tend to behave differently. Moreover, the results are in congruence with the rationale provided by Shammari (2018), which discusses the three reasons behind the value-creating ability of long-tenured CEOs. First, with an increase in past experience in dealing with strategic risks, CEOs develop an improved selection process that can help them identify those risky actions with the highest probability of success. Second, long-tenured CEOs tend to have more influence on the board and can confidently justify their actions that might have seemed too risky in the absence of experience. Lastly, greater CEO experience can always support the streamlined execution of risky yet profitable investments. As a result, CEOs are less likely to engage in risk-seeking behavior until they acquire a more profound firm and environment knowledge, sufficient experience, and necessary leverage through solid networks with key stakeholders (Shammari, 2018). However, instead of a nonlinear impact, the CEO tenure has a diminishing effect on the Supplier_Conc_5 in our study.

In Model (3), we can observe that CEO age has an insignificant impact on Supplier_Conc_5. This insignificant influence is also supported by the evidence gathered from Model (4). Prior theoretical literature predicts that a CEO's age impact their risk-taking behaviour and preference for certain corporate policies, but predictions are mixed. This might be because only people with proven experience of running complex businesses, irrespective of age, are

appointed as CEOs. This particular study to examine the impact of CEO age on the supplier-base/customer-base concentrations can also be carried forward with the help of other moderator or mediator variables.

Table 12. OLS Regression of CEO Characteristics on Supplier-Base Concentration Level at 5%

Table 12 presents the OLS regressions of CEO characteristics (i.e., gender, age, and tenure) on the supplier-base concentration level at 5%. The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) demonstrates the effect of CEO Female, Model (2) demonstrates the effects of CEO Tenure and CEO Tenure Squared, Model (3) demonstrates the effect of CEO Age, and finally Model (4) includes all 4 dimensions. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	Model (1) Supplier_Conc_5	Model (2) Supplier_Conc_5	Model (3) Supplier_Conc_5	Model (4) Supplier_Conc_5
CEO Female	-0.0273**			-0.0281**
	(0.011)			(0.011)
CEO Tenure		0.0035		0.0037
		(0.003)		(0.002)
CEO Tenure Squared		-0.0002*		-0.0002*
		(0.000)		(0.000)
CEO Age			-0.0006	-0.0005
			(0.001)	(0.001)
Firm Size	-0.0050	-0.0055	-0.0053	-0.0056
	(0.004)	(0.004)	(0.004)	(0.004)
Capital Intensity	-0.0211	-0.0112	-0.0219	-0.0107
	(0.031)	(0.034)	(0.030)	(0.034)
Operating Cash Flow	0.1037*	0.0795	0.1013*	0.0797
	(0.056)	(0.061)	(0.057)	(0.061)
Leverage	0.0559	0.0442	0.0539	0.0481
	(0.047)	(0.046)	(0.047)	(0.044)
Sales Growth	-0.0359	-0.0342	-0.0363	-0.0339
	(0.041)	(0.041)	(0.041)	(0.041)
R&D Intensity	0.2622***	0.2623***	0.2625***	0.2612***
	(0.054)	(0.050)	(0.054)	(0.050)
Constant	0.0326	0.0268	0.0668	0.0547
	(0.032)	(0.032)	(0.062)	(0.068)
Observations	318	315	315	315
R-squared	0.199	0.204	0.198	0.207

5.4.2 Impact on the Supplier-Base Concentration Level at 10%

Table 13 presents the results of the OLS estimations that examine the effect of CEO characteristics on Supplier_Conc_10. In Model (1), we can observe that CEO female has a significant and negative influence (coefficient=-.0143; p-value=.029) on Supplier_Conc_10. Since, we have observed Supplier_Conc_10 negatively impacting the focal firm's financial performance in Tables 6 and 7, and female CEOs reducing Supplier_Conc_5 in Table 12 on the account of their harmful effect, Hypothesis 5a is supported which states that female CEOs will tend to reduce the impact of supplier-base concentration through their prudent leadership. Model (4) also shows supportive evidence for this effect.

However, both the first and second order terms for CEO tenure as well as CEO age are shown to have an insignificant effect on Supplier_Conc_10. Since the dimension comprises major customers with revenue percentage equal to or more than 10% contributed to the focal firm, CEOs can be compelled to adopt more conservative investment policies. In such a scenario, younger CEOs are more risk-averse because they do not yet have reputations as high quality managers (Scharfstein & Stein, 1999; Zweibel, 1995) or they can be punished more harshly through reduced future career prospects. Therefore, Hypothesis 6a and 7a are not supported in empirical study.

Table 13. OLS Regression of CEO Characteristics on Supplier-Base Concentration Level at 10%

Table 13 presents the OLS regressions of CEO characteristics (i.e., gender, age, and tenure) on the supplier-base concentration level at 10%. The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) demonstrates the effect of CEO Female, Model (2) demonstrates the effects of CEO Tenure and CEO Tenure Squared, Model (3) demonstrates the effect of CEO Age, and finally Model (4) includes all 4 dimensions. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**
	Supplier_Conc_10	**Supplier_Conc_10**	**Supplier_Conc_10**	**Supplier_Conc_10**
CEO Female	-0.0143**			-0.0148**
	(0.007)			(0.007)
CEO Tenure		0.0014		0.0013
		(0.002)		(0.002)
CEO Tenure Squared		-0.0001		-0.0001
		(0.000)		(0.000)
CEO Age			0.0000	0.0001
			(0.001)	(0.001)
Firm Size	-0.0046*	-0.0048*	-0.0047*	-0.0048*
	(0.003)	(0.003)	(0.003)	(0.003)
Capital Intensity	-0.0188	-0.0159	-0.0201	-0.0160
	(0.021)	(0.023)	(0.021)	(0.023)
Operating Cash Flow	0.0748	0.0667	0.0752	0.0674
	(0.050)	(0.055)	(0.051)	(0.055)
Leverage	0.0191	0.0145	0.0176	0.0157
	(0.026)	(0.026)	(0.027)	(0.026)
Sales Growth	-0.0225	-0.0223	-0.0230	-0.0220
	(0.025)	(0.025)	(0.025)	(0.025)
R&D Intensity	0.1385***	0.1385***	0.1388***	0.1383***
	(0.025)	(0.024)	(0.025)	(0.025)
Constant	0.0361	0.0335	0.0367	0.0319
	(0.024)	(0.028)	(0.041)	(0.044)
Observations	318	315	315	315
R-squared	0.155	0.157	0.154	0.159

5.4.3 Impact on the Customer-Base Concentration Levels at 5% & 10%

Tables 14 and 15 present the results of the OLS estimations that examine the effect of CEO characteristics on Customer_Conc_5 on Customer_Conc_10, respectively.

First, from the evidence gathered in Model (1) from Tables 14 and 15, it is observed that CEO female does not affect Customer_Conc_5 and Customer_Conc_10 significantly which is also reinforced by the evidence captured in Model (4). However, we also witnessed the synergistic interaction of customer-base concentration and focal firm's profitability in Tables 9 and 10. Here, we can assume that female CEOs exhibit a heightened level of awareness of their industry environment and strategically opt to focus more on the upstream complexities which were earlier observed to harm the focal firm's financial performance.

Also, we are unable to observe any significant results concerning the effects of CEO tenure (first and second order terms) and CEO age on Customer_Conc_5 and Customer_Conc_10. These results can emerge due to two plausible scenarios. The lack of action against the cooperative nature of association with customer-base concentration can be a well-thought corporate policy to hold on to market share. The other scenario includes the study of investigating the impact of CEO tenure and CEO age on the supplier-base/customer-base concentrations comprising other moderator and mediator variables for an in-depth analysis.

Table 14. OLS Regression of CEO Characteristics on Customer-Base Concentration Level at 5%

Table 14 presents the OLS regressions of CEO characteristics (i.e., gender, age, and tenure) on the customer-base concentration level at 5%. The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) demonstrates the effect of CEO Female, Model (2) demonstrates the effects of CEO Tenure and CEO Tenure Squared, Model (3) demonstrates the effect of CEO Age, and finally Model (4) includes all 4 dimensions. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	Model (1) Customer_Conc_5	Model (2) Customer_Conc_5	Model (3) Customer_Conc_5	Model (4) Customer_Conc_5
CEO Female	-0.0069			-0.0154
	(0.083)			(0.085)
CEO Tenure		0.0005		-0.0010
		(0.007)		(0.008)
CEO Tenure Squared		-0.0001		-0.0001
		(0.000)		(0.000)
CEO Age			0.0007	0.0023
			(0.003)	(0.003)
Capital Intensity	-0.0734	-0.0330	-0.0464	-0.0343
	(0.156)	(0.158)	(0.158)	(0.159)
Firm Size	-0.0550***	-0.0549***	-0.0536***	-0.0546***
	(0.012)	(0.012)	(0.012)	(0.012)
Operating Cash Flow	0.1662	0.1133	0.1520	0.1154
	(0.192)	(0.199)	(0.196)	(0.198)
Leverage	-0.1312	-0.1339	-0.1120	-0.1381
	(0.117)	(0.122)	(0.118)	(0.121)
Sales Growth	0.1164**	0.1239**	0.1243**	0.1243**
	(0.054)	(0.054)	(0.055)	(0.054)
R&D Intensity	0.0471	0.0418	0.0431	0.0432
	(0.078)	(0.078)	(0.078)	(0.078)
Constant	0.6663***	0.6715***	0.6070***	0.5502***
	(0.098)	(0.106)	(0.184)	(0.188)
Observations	340	335	335	335
R-squared	0.135	0.133	0.130	0.135

Table 15. OLS Regression of CEO Characteristics on Customer-Base Concentration Level at 10%

Table 15 presents the OLS regressions of CEO characteristics (i.e., gender, age, and tenure) on the customer-base concentration level at 10%. The regressions are performed on a sample of S&P1500 listed manufacturing firms for the fiscal year of 2017. Model (1) demonstrates the effect of CEO Female, Model (2) demonstrates the effects of CEO Tenure and CEO Tenure Squared, Model (3) demonstrates the effect of CEO Age, and finally Model (4) includes all 4 dimensions. All variables are defined in Appendix A and are winsorized at 1% to remove any outliers. Notes: * p < .10, ** p < .05, *** p <.01 (two-tailed). Robust standard errors are provided in the parentheses. Observations denote the number of cases for which we have complete data and were used in the corresponding regression models.

Independent Variables	**Model (1)**	**Model (2)**	**Model (3)**	**Model (4)**
	Customer_Conc_10	**Customer_Conc_10**	**Customer_Conc_10**	**Customer_Conc_10**
CEO Female	0.0044			-0.0011
	(0.077)			(0.078)
CEO Tenure		0.0002		-0.0006
		(0.007)		(0.007)
CEO Tenure Squared		-0.0001		-0.0001
		(0.000)		(0.000)
CEO Age			0.0004	0.0013
			(0.003)	(0.003)
Capital Intensity	-0.0646	-0.0379	-0.0457	-0.0388
	(0.156)	(0.158)	(0.157)	(0.159)
Firm Size	-0.0479***	-0.0478***	-0.0470***	-0.0476***
	(0.012)	(0.012)	(0.012)	(0.012)
Operating Cash Flow	0.1857	0.1585	0.1808	0.1601
	(0.175)	(0.186)	(0.176)	(0.186)
Leverage	-0.1269	-0.1281	-0.1153	-0.1309
	(0.117)	(0.122)	(0.118)	(0.122)
Sales Growth	0.1046*	0.1112**	0.1114**	0.1113**
	(0.056)	(0.056)	(0.056)	(0.057)
R&D Intensity	0.0705	0.0672	0.0679	0.0681
	(0.081)	(0.082)	(0.082)	(0.082)
Constant	0.5645***	0.5679***	0.5330***	0.4999***
	(0.097)	(0.103)	(0.182)	(0.187)
Observations	340	335	335	335
R-squared	0.125	0.124	0.123	0.125

Table 16. Summary of Hypothesis Testing

Research Hypotheses	Explanatory Variables	Results			Comments
Hypothesis 1: An increase in the supplier-base concentration will lead to negative financial performance for the focal firm.	Supplier_Conc_5	Tobin's Q	Gross Profit Margin	Net Profit Margin	Hypothesis 1 is supported in our study
		Yes***	Yes***	Yes**	
	Supplier_Conc_10	Tobin's Q	Gross Profit Margin	Net Profit Margin	
		Yes***	Yes**	Yes*	
Hypothesis 2: An increase in the supplier-base concentration will lead to a shorter payable period for the focal firm.	Supplier_Conc_5	Accounts Payable Period			Hypothesis 2 is rejected in our study. The results are not significant but a negative trend in the payable period is observed with an increase in the supplier concentration level
		No			
	Supplier_Conc_10	Accounts Payable Period			
		No			
Hypothesis 3: An increase in the customer-base concentration will lead to negative financial performance for the focal firm.	Customer_Conc_5	Tobin's Q	Gross Profit Margin	Net Profit Margin	Hypothesis 3 is partly accepted in our study
		Yes* (Positively Correlates)	Yes*** (Positively Correlated)	No	
	Customer_Conc_10	Tobin's Q	Gross Profit Margin	Net Profit Margin	
		Yes** (Positively Correlated)	Yes*** (Positively Correlated)	No	
Hypothesis 4: An increase in the customer-base concentration will lead to a longer receivable period for the focal firm.	Customer_Conc_5	Accounts Receivable Period			Hypothesis 4 is rejected in our study. However, Customer_Conc_5 is almost negatively correlated to receivable period (albeit not significantly)
		No			
	Customer_Conc_10	Accounts Receivable Period			
		No			
Hypothesis 5a: Female CEOs reduce the supplier-base concentration.	Female CEOs	Supplier_Conc_5	Supplier_Conc_10		Hypothesis 5a is supported in our study
		Yes**	Yes**		
Hypothesis 5b: Female CEOs reduce the	Female CEOs	Customer_Conc_5	Customer_Conc_10		Hypothesis 5b is rejected in our study . However, we can postulate that female CEOs

customer-base concentration.		No	No	prudently opt to avoid any strategic actions against the customer base since both the customer concentration levels are observed to increase the focal firm's financial performance.
Hypothesis 6a: Younger CEOs reduce the supplier-base concentration regardless of its impact on the focal firm financial performance.	CEO Age	Supplier_Conc_5	Supplier_Conc_10	Hypothesis 6a is rejected in our study
		No	No	
Hypothesis 6b: Younger CEOs reduce the customer-base concentration regardless of its impact on the focal firm financial performance.	CEO Age	Customer_Conc_5	Customer_Conc_10	Hypothesis 6b is rejected in our study
		No	No	
Hypothesis 7a: A non-linear correlation can be anticipated between long-tenured CEOs and the supplier-base concentration.	CEO Tenure	Supplier_Conc_5	Supplier_Conc_10	Hypothesis 7a is rejected in our study. However, a diminishing effect of CEO tenure is observed
		No	No	
	CEO Tenure Squared	Supplier_Conc_5	Supplier_Conc_10	
		Yes*	No	
Hypothesis 7b: A non-correlation can be anticipated between long-tenured CEOs and the customer-base concentration.	CEO Tenure	Customer_Conc_5	Customer_Conc_10	Hypothesis 7b is rejected in our study due to two scenarios: strategic corporate policy to not disturb the collaborative aspect of relationship with consumer base OR lack of other moderator or mediator variables
		No	No	
	CEO Tenure Squared	Customer_Conc_5	Customer_Conc_10	
		No	No	

Chapter 6: Conclusion

6.1 Implications of Our Evidence

According to Pfeffer & Salancik (1978), corporate relationships or coalitions are generated between trading partners to tackle the uncertainty in the task environment. Furthermore, there are some "social-legal apparatus" that establish and control the limits of the relationship between an organization and other trading allies in the environment (Pfeffer & Salancik, 1978). However, instances where innovative resources a firm lacks but its supply chain partners hold create inequality in dependence between organizations. The internal scarcity of strategic resources necessitates a firm to rely on external support to ensure its ongoing viability. As a result, dominant firms often tend to change the terms and conditions of their business exchanges or influence the outcome of a particular negotiation through the medium of relative bargaining (Hicks, 1932). Relative bargaining power enables more substantial firms to exploit favorable exchange terms against their weaker partners such as diminishing its capital costs through convenient cash flow, ample trade credit, and shorter CCC (Klapper et al., 2012; Fabbri & Klapper, 2016; Cho et al., 2019). Meanwhile, the power literature has also backed the controlled exercise of power due to the embedded mutual interdependence. Our empirical results suggest that each of these views, ostensibly contrary to one another, should be utilized harmoniously to adequately explain variances in inter-organizational performance.

Our motivation to study the power asymmetry in the context of structural complexity relies on the theoretical contributions of social network analysis theory which stresses that an actor's economic decisions can be explained by its individual motive and non-economic features such as structural position, social power, and sociability. Prior studies in SCM have acknowledged the methodological potential of social network analysis. It is a well-accepted phenomenon to study supply chain networks utilizing social network perspective since supply chain systems also comprise social actors (i.e., supply members) like "upstream suppliers and downstream customers, as well as the material logistics and information flows among supply chain members" (Cheng et al., 2014, p. 2329). Researchers (Freeman, 1978; Wasserman & Faust, 1994; Marsden, 2002; Kim et al., 2011) have also conceptualized a range of network metrics at two levels – the node level (which includes degree, closeness, and betweenness centrality) and the network level (which

includes network density, network centralization, and network complexity) to evaluate structural characteristics of social networks.

We now want to step back and discuss the implications of the evidence in Tables 7-16 a bit further. First, we find evidence that interacting with a higher supplier-base concentration can harm the financial performance of the focal firm through dependence asymmetry. The lack of diversification in the supply base is consistent with prior literature that has found vendor concentration risk to be the cause of supply chain disruptions, unplanned downtime, operational delays, brand, and reputational damage, reduced negotiation strength, and poorly planned switching to new third-party providers. However, our findings suggest that the impact of supplier-base concentration on SCF performance (i.e., payable period) remains insignificant.

Second, the findings emphasize the restrained application of power by the customer base and provide evidence that efficiencies from collaboration and coordination along the value chain can overpower concentration risks in dealing with major customers. However, apart from Tobin's Q and gross profit margin, the customer-base concentration did not significantly impact the financial performance of the focal firm. This might indicate that the operational collaboration offered by the customer base leads to a decline in COGS but is unsuccessful in introducing a meaningful reduction in other operating expenses such as rent, interest, customer service, investment costs, etc. In addition, we also did not find any pronounced impact of high customer-base concentration on the focal firm's receivable period.

Third, we also provide evidence on whether CEO characteristics such as gender, age, and tenure impact the focal firm's financial performance. Here, we find contradictory results in the context of CEO gender. An increase in the number of female CEOs reduces the supplier-base concentration but does affect the customer-base concentration. We postulate that the inaction of female CEOs against major customers might be a voluntary restraint. Sine female executives exhibit a heightened sense of awareness and tend to be prudent during strategic decision-making, they might have anticipated the cooperative nature of the association between the concerned focal firm and its supply chain partners.

Unlike the CEO age, which did not show any effect on the supplier-base concentration, the higher order term for the CEO tenure demonstrated a diminishing effect. Thus, this finding is consistent with some studies from the prior literature that have suggested that the relationship

between CEOs and firm performance becomes more efficient as CEOs remain in their position for a longer period. In addition, long-tenured CEOs acquire more experience and, thus, would be more willing and ready to become involved in situations requiring strategic risk-taking. In the context of customer-base concentration, the CEO age yet again did not demonstrate any notable impact, and neither did the CEO tenure. We posit two plausible reasons behind this development. It might be a strategic corporate policy not to disturb the collaborative balance between the focal firm and its supply chain partners. Also, the study of the impact of CEO characteristics on concentration risks can be carried out in the context of various other conditions.

6.2 Contributions

Prior studies have actively investigated the impact of manufacturer-buyer ties on corporate decisions. However, the attention has always been focused on how a customer concentration. There is very little evidence of how a supplier concentration moderates the financing decisions. This study contributes to the relevant literature of power dynamics in supply chain network by considering triadic analysis and investigating the impact of both the supplier-base and customer-base concentrations on focal firm's financial performance. Similar investigations have been conducted for the focal firm's payable and receivable periods, respectively. To the best of our knowledge, it is the also the first study in the field of managerial ability to link the CEO characteristics and the concentration risks posed by the nonfinancial stakeholders. The study bridges this gap and examines the effect of different CEO characteristics on the supplier-base/customer-base concentrations.

Another contribution of this study is the extensive supply chain and financial transaction data taken from the Bloomberg supply chain module. Bloomberg offers a vast amount of propriety supply chain relation data of over 35,000 companies, unfortunately, unavailable from other sources. Unlike other financial data forms, there are minimal mandated supply chain disclosure requirements among publicly listed companies globally. The SEC's Regulation S-K states that "if 10% or more of the revenue of an enterprise is derived from sales to any single customer, that fact and the amount of revenue from each such customer shall be disclosed." There are no additional customer requirements or supplier requirements. Other countries' exchanges lack even this level of relationship disclosure. Compounding this lack of mandated disclosure is the reason companies disclose supply chain data in various media (Bloomberg, 2011). Nevertheless, Bloomberg solves

this problem by employing human and computerized methods to aggregate publicly disclosed data included in but not limited to public filings, conference call transcripts, capital market presentations, sell-side conferences, and company press releases. Thus, the Bloomberg supply chain database has been of exceptional assistance in conducting a detailed study on base-level concentrations of the supply chain partners as well as their relevant financial transactions based on revenue and COGS percentages less than .01.

Lastly**,** almost all the supply chain literature studies rely on information solely from the buyer – predominantly survey and other qualitative data – to compute structural complexity. Generally, this form of data ignores the impact of structural links, of which the focal firm takes no notice (Lu & Shang, 2017). The empirical study will conquer this particular issue by constructing objective measures from buyer-supplier relations identified by independent third parties.

6.3 Limitations & Future Research

This study is subject to a few limitations, each offering opportunities for future research. First, we carefully acknowledge the endogeneity issue that might arise through omitted variable bias. However, future research can employ instrument variables and panel datasets to address the omitted variable bias. Second, we realize that CEO tenure and CEO age did not appear to impact the supplier-base/customer-base concentrations significantly. We do not test the regression models in the context of other board-specific or firm-specific variables due to the lack of theoretical support in the literature. Nonetheless, we think it is a promising area to advance the field of managerial ability. Third, this study emphasizes financial performance. Future research can implement a similar analysis but investigate a broader set of critical performance dimensions such as cost, delivery, and flexibility. Lastly, since this is a pilot study based on a single year of supply chain relation data, future research can be undertaken with a larger dataset over a more extended time period.

Appendices

Appendix A: Variable Description

Variable	Definition & Formulae	Literature Support
Tobin's Q	Share price (PRCC_F) multiplied by common shares outstanding (CSHO) plus preferred stock (PSTK) plus short-term liabilities (LCT) minus short-term asset (ACT) plus long-term debt (DLTT), divided by total assets (AT)	Chung & Pruitt (1994); McAlister et al. (2016) Source: Compustat
Gross Profit Margin	Net sales minus cost of goods sold, divided by net sales	Mahruzal & Khaddafi (2020); Nariswari & Nugraha (2020) Source: Compustat
Net Profit Margin	Ratio of net income to net sales	Mahruzal & Khaddafi (2020); Nariswari & Nugraha (2020) Source: Compustat
Accounts Receivable Period	365 divided by account receivable turnover ratio	Lo et al. (2009); Cho et al. (2018) Source: Compustat
Accounts Payable Period	365 divided by account payable turnover ratio	Lo et al. (2009); Cho et al. (2018) Source: Compustat
Supplier_Conc_5	$\frac{\sum_{i_k=1}^{n} i_k}{\sum_{s_k=1}^{n} s_k}$ Here, k = Focal firm s_k = Supplier in the supply base (i.e., first tier) of focal firm k i_k = Supplier firm which accounts for 5% or more of the COGS incurred by the focal firm k n = Total number of 1st tier suppliers of focal firm k	New, not empirically examined Source: Bloomberg L.P. SPLC
Supplier_Conc_10	$\frac{\sum_{i_k=1}^{n} i_k}{\sum_{s_k=1}^{n} s_k}$ Here, k = Focal firm s_k = Supplier in the supply base (i.e., first tier) of focal firm k i_k = Supplier firm which accounts for 10% or more of the COGS incurred by the focal firm k n = Total number of 1st tier suppliers of focal firm k	New, not empirically examined Source: Bloomberg L.P. SPLC

Customer_Conc_5	$\frac{\sum_{j_k=1}^{n} j_k}{\sum_{c_k=1}^{n} c_k}$ Here, k = Focal firm c_k = Customer in the consumer base (i.e., first tier) of the focal firm k j_k = Customer firm with revenue percentage equal to or more than 5% contributed to the focal firm k n = Total number of 1st tier customers of focal firm k	New, not empirically examined Source: Bloomberg L.P. SPLC
Customer_Conc_10	$\frac{\sum_{j_k=1}^{n} j_k}{\sum_{c_k=1}^{n} c_k}$ Here, k = Focal firm c_k = Customer in the consumer base (i.e., first tier) of the focal firm k j_k = Customer firm with revenue percentage equal to or more than 10% contributed to the focal firm k n = Total number of 1st tier customers of focal firm k	New, not empirically examined Source: Bloomberg L.P. SPLC
Horizontal Complexity Supplier	Total number of direct suppliers (i.e., 1st tier suppliers) of the focal firm	Bozarth et al. (2009); Bode & Wagner (2015) Source: Bloomberg L.P. SPLC
Vertical Complexity Supplier	Average number of 2nd tier suppliers per 1st tier supplier of the focal firm	Choi & Krause (2006); Lu & Shang (2017) Source: Bloomberg L.P. SPLC
Geographical Complexity Supplier	Total number of countries represented in the supply base of the focal firm	Lu & Shang (2017); Kafouros et al. (2018) Source: Bloomberg L.P. SPLC
Horizontal Complexity Customer	Total number of direct customers (i.e., 1st tier customers) of the focal firm	New, not empirically examined Source: Bloomberg L.P. SPLC
Geographical Complexity Customer	Total number of countries represented in the customer base of the focal firm	New, not empirically examined Source: Bloomberg L.P. SPLC
CEO Female	Dummy variable that takes the value of 1 if the CEO is female; 0 otherwise	Zeng & Wang (2015); Bennouri et al. (2018) Source: Execucomp
CEO Tenure	Measured as the number of years the CEO has been in the position	Simsek (2007); Shammari (2018) Source: Execucomp
CEO Age	Denotes the CEO age in years	Zeng & Wang (2015); Zhou et al. (2020) Source: Execucomp
Operating Cash Flow	Measured as operating cash flow scaled by total assets	Li et al. (2014); Mielcarz et al. (2018) Source: Compustat

Sales Growth	Percentage growth in reported sales between year t and year t-1	Lu & Shang (2017); Bennouri et al. (2018) Source: Compustat
Leverage	Ratio of long term debt to total assets	Salim & Yadav (2012); Zhou et al. (2020) Source: Compustat
Firm Size	Natural algorithm of firm's annual sales	Hendricks et al. (2009); Kafouros et al. (2018) Source: Compustat
R&D Intensity	Research and development expenditures scaled by total sales	Shin et al. (2017); Bennouri et al. (2018) Source: Compustat
Capital Intensity	Net property, plant and equipment (PPE) value scaled by total assets	Cho et al. (2018); Cho et al. (2019) Source: Compustat

Appendix B: Supply Chain Complexity Management

B.1 Identifying Supply Chain Complexity Drivers

In the last decades, complexity has grown continuously due to competition in the global business environment. To gain an advantage against its competitors, a firm should implement SCC management by first identifying the drivers responsible for the complexity and then prioritizing them (Kavilal et al., 2017). Numerous studies can be found in the supply chain literature that have contributed to identifying SCC drivers. Mohrschladt (2007) found several complexity drivers in the chemical industry's supply chain and investigated the impact of these drivers on the plant's performance. Bozarth et al. (2009) identified eleven SCC drivers and analyzed that complexity originating at any supply chain location hinders the manufacturing plant's performance. Manuj & Sahin (2011) tried to develop a broad theory of supply chain and supply chain decision-making complexity acknowledging SCC drivers like supply chain size and structure, customer expectations, adverse environmental conditions, globalization, and organizational restructuring. Serdarasan (2013) identified twenty SCC complexity drivers in various industries through qualitative meta-analysis. Bode & Wagner (2015) identified three complexity drivers at the upstream level of the supply chain. They found these drivers to increase the frequency of disruptions. Kavilal et al. (2017) identified fourteen SCC drivers and used fuzzy AHP and fuzzy PROMETHEE to prioritize the SCC drivers considering interdependence. Chand et al. (2018) applied procedures such as multi-criterion decision making (MCDM) and Analytic Hierarchy Process (AHP) to prioritize the twenty-three SCC drivers they found in the mining equipment manufacturing industry. The research project investigated evolving SCC drivers such as supplier sourcing risk, supplier competence, regional strategies, shortening product life-cycle, and changing customer service expectations, which were not discussed adequately in the existing literature. The growing interest in recognizing the complexity drivers resonates with the importance of SCC drivers classification to strategically manage and alleviate complexity in supply chains.

B.2 Classifying Supply Chain Complexity Drivers

After the requisite identification of SCC drivers, the complexity sources of all variations and their interdependencies should be defined and recorded to develop their solutions in the future. Supply chain researchers have mainly utilized one of two viewpoints while investigating SCC

(Aitken et al., 2016). The first considers SCC from a holistic, system-level perspective (Choi et al., 2001; Choi & Krause, 2006), while the other acknowledges SCC from the perspective of a business unit (Bozarth et al., 2009; Lu & Shang, 2017). Here, we also adopt the business unit viewpoint since the study does not require recognizing system-level complexity characterized by a broadly defined supply chain network but understanding how complexity originates within the business unit and at the interface with its supply chain partners (Aitken et al., 2016).

The twin concepts of numerousness and dynamism are found in the earlier empirical studies conducted on operations and SCC. According to Serdarasan (2013), static (detail) complexity is associated with the number and variety of components as well as the strength of their interactions. In contrast, dynamic complexity represents the uncertainty in the supply chain. Here, the static complexity is related to the structure of the supply chain networks, whereas the dynamic complexity investigates uncertainty at the operational level of the supply chain networks (Cheng et al., 2014). Manuj & Sahin (2011) further added another division called decision-making complexity for characteristics-based classification. According to Manuj & Sahin (2011), decision-making complexity is relevant to human cognitive and organizational decision-making processes. The meta-analysis conducted by Serdarasan (2013) revealed that firms tend to strategically reduce static complexity while managing dynamic and decision-making complexity and introducing operations and technologies to cope with them.

Another classification of complexity is according to the location it occurs at. There are two prominent approaches for origin-based classification of SCC viz: (1) upstream, internal, and downstream (2) internal, external (environmental), and interfacial. Bozarth et al. (2009) classified SCC at the business unit level into upstream complexity, internal manufacturing complexity, and downstream complexity. While the upstream complexity originates from dealing with the suppliers, the downstream complexity is caused by the customers. Internal manufacturing complexity generally arises from material and information flows within a single business unit. Serdarasan (2013) divided the SCC into internal complexity, supply/demand interface complexity and external complexity. Internal complexity originates from processes within the business unit and is relatively easier to manage since it remains within the control span. External complexity is induced by factors that the business unit has less control over, such as market trends, policies, and various other environmental situations. These drivers are apparently out of the system boundary

but still can be interpreted, monitored, and regulated with strategies to adapt and change. Complexity induced within the supply and/or demand interface is related to material and information flows shared between suppliers and customers. Coordination between the supply chain partners plays a crucial role in managing this form of complexity. Furthermore, there is also a stream of researchers that actively investigates the structural complexity originating at the firm level (Bode & Wagner, 2015; Lu & Shang, 2017; Sharma et al., 2019). They have constantly employed three notable dimensions of the structural complexity viz: horizontal complexity, vertical complexity, and spatial complexity.

The trend in the supply chain literature is to focus mainly on the adversarial influence of SCC. However, Aitken et al. (2016) stressed the importance of recognizing why some level of SCC might be required or even beneficial. Perona & Miragliotta (2004) and Serdarasan (2013) advocate a similar cause, albeit somewhat tacitly. Perona & Miragliotta (2004) concluded that SCC could be "reduced" or "managed," thereby shifting the trade-off curve between effectiveness (customer-related performance) and efficiency (cost-related performance). Similarly, Serdarasan (2013) differentiated between "necessary" and "unnecessary" complexity in a review of SCC drivers but did not provide any precise definition of either. Aitken et al. (2016) proposed that regardless of its nature or location, SCC can result because of trade requirements (strategic complexity) of the firm or because of the substandard business practices and policies (dysfunctional complexity). Dysfunction complexity is not profitable to the firm's business strategy. It prevents the organization from achieving a higher level of performance. In contrast, strategic complexity is required to achieve a competitive advantage and must be managed or absorbed by the firm's manufacturing and supply chain activities (Aitken et al., 2016). Based on a similar conceptual framework, Tachiwaza et al. (2015) classified SCC drivers as coercive and non-coercive, which have opposing repercussions in the context of green SCM approaches.

Lastly, SCC can also be classified based on the level of management hierarchy that needs to be accountable and address complexity created by the drivers (Piya et al., 2020). In an organizational structure, management hierarchy can be distinguished into top-level, middle-level, and lower-level management. Top-level management generally makes strategic decisions, whereas middle and lower-level management deal with operational and tactical challenges (Piya et al.,

2020). Such categorization helps in immediately drawing the attention of the specific level of a management hierarchy to address the related complexity (Piya et al., 2017).

B.3 Measuring Supply Chain Complexity Drivers

The goal of the complexity measurement is to obtain a numerical scale to compare the complexity values of a system on different problems (Isik, 2011). In the context of complexity measurement, previous studies can be classified into two categories. The first category utilizes an entropy-based approach to measure complexity. This approach measures SCC based on an information-theoretic model, which is rooted in Shannon's pioneering work (1948). In this model, the data needed to convey the current state of the system, relies on the system's complexity level. This implies that the more complex the system, the more information is required to quantify the complexity level. Efstathiou et al. (2002) developed a web-based information-theoretic model to measure the manufacturing system's complexity. Their model, embedded with the expert system, can estimate an organization's complexity, and provide suggestions to diminish complexity. Sivadasan et al. (2002) conducted a highly celebrated study relevant to entropic measure of complexity. They developed the concept of dynamic complexity and modeled it based on uncertainty (i.e., probability of an in-control state and an out-of-control state) and size (i.e., the number of products monitored and the number of out-of-control states possible). The dynamic complexity measure provides an accurate and deep understanding of constructs such as the degree of uncertainty, level of control, and the detail of monitoring required to manage the operational complexity of the supply chain network (Sivadasan et al., 2006). Cheng et al. (2014) introduced an entropy-based measure for analyzing the structural complexity concerning the structure and system uncertainty. The study involves applying entropy functions to the structural analysis of a supply chain network, considering the heterogeneity in the structural types of supply chain members, and establishing a structural complexity measurement system.

The second category employs an exploratory approach that utilizes empirical data to establish a relationship between SCC drivers and different aspects of supply chain performance. Perona & Miragliotta (2004) investigated how SCC drivers impact the manufacturing firm's performance. They postulated that complexity consists of four indexes: (1) an index for the duration of the supply relationship (2) an index for the procurement policies, giving lower scores for the level of complexity to those firms evading spot contracts and concentrating on rolling order

mechanisms (3) an index based on the variety in components and finished products to be managed (4) an index based on the number of production orders issued. They also concluded that the way firms cope with complexity influences the performance level. Lu & Shang (2017) created three visible (horizontal, vertical, and spatial) and two not–so–visible (eliminative and cooperative) structural complexity metrics and examined their impacts on buyer firms' financial performance measured by ROA and Tobin's Q. The empirical evidence suggests that an individual complexity dimension may have both positive and negative effects, and the overall effect may be non – linear. Kavilal et al. (2017) developed an integrated decision-making model based on fuzzy ISM, fizzy AHP, and fuzzy PROMETHEE to prioritize the identified SCC drivers for an Indian mining equipment manufacturer. The outcome reveals that the customer base and external drivers have a high driving power and may cause other SCC drivers. Overall, the central theme of this particular approach is conceptualizing SCC as a broad-level multi-dimensional construct, which can be operationalized and quantified through several determinants. Also, the following table summarizes the most relevant literature to the field of SCC management.

Table 17. Relevant Supply Chain Complexity Literature

Study	Sample	Source of Complexity	Response Variable	Complexity Related Metrics	Key Findings
Bode & Wagner (2015)	396 firms from Germany, Austria & Switzerland	Upstream supply chain (supply-side) disruptions	Frequency of supply chain disruptions	• Horizontal complexity • Vertical complexity • Spatial complexity	All the three complexity drivers – horizontal, vertical and spatial increase the frequency of disruptions. Additional risk for supply chain disruptions emerges from the coexistence and interaction of the three complexity dimensions.
Kumar et al. (2019)	303 global firms from 28 countries across 50 industries	Exploration and exploitation (ambidexterity) of firm-specific advantages in international markets	International ROA (ratio of international profits to the total assets; total value of revenue from international business)	• Network density • Betweenness centralization • Average clustering coefficient	While network density is negatively associated, betweenness centralization and average clustering coefficient have an inverted U-shape and a U-shaped relationship with international business performance, respectively.
Carnovale et al. (2019)	The same data used in Carnovale & Yeniyurt (2015)	Network embeddedness and relevant organizational structure	• Cash conversion cycle • EBITDA • ROA	• Network power • Network cohesion • Network cohesion squared	Network cohesion is positively associated with financial performance whereas network power is a critical factor in earnings performance. Firm's levels of network power and cohesion can

					be managed for heightened financial performance.
Sharma et al. (2019)	201 firms from 20 countries across 6 industries	Sourcing complexity and its implications for focal-firm innovation performance	Logarithm of transformed total patents count of the firm over time	• Horizontal complexity • Vertical complexity • Spatial complexity	Nonlinear relationship with diminishing growth between horizontal and vertical complexity with respect to innovation performance. Spatial complexity is negatively associated with innovation performance.
Basole et al., 2018	582 unique electronics industry companies listed in the EB300.	Network complexity and relevant organizational structure	• ROA • I/S • COGS/Sales	• Structural prominence (centrality of a firm's position) • Structural density (interconnectedness among firms in a network)	Both the structural prominence of firms and the density of the supply networks, along with the interaction between them, positively impact the firm's asset utilization, cost performance and operational efficiency.

Carnovale & Yeniyurt (2015)	1158 firms worldwide from the automobile industry , dealing with manufacturing partnerships	Network complexity and relevant organizational structure	• ROA • ROI • ROE • ROS	• Supply network centrality • Supply network centrality squared • Supply network remoteness	As firms increase their network connections and increase their network centrality, their financial performance increases. More remote firms will have less opportunity to generate increased revenue and experience poorer financial performance.
Bozarth et al., 2009	Survey data from manufacturing plants in U.S., Japan, South Korea, Germany, Austria, Finland & Sweden across machinery, electronics and transportation components industry	Supply chain complexity in terms of size (relative number or volume of products or activities); variability (sudden, large and variable changes in requirements over time); and speed (required responsiveness across the supply chain in terms of throughput times, delivery times and frequencies)	• Unit cost of manufacturing • Schedule attainment • Plant-level competitive performance • Plant-level customer satisfaction	• Upstream complexity (4 measures) • Downstream complexity (4 measures) • Internal manufacturing complexity (3 measures)	Higher levels of both upstream complexity and internal manufacturing complexity will have a negative impact on plant schedule attainment and unit manufacturing cost performance. Also, as downstream complexity increases, plant schedule attainment and unit manufacturing cost performance will decrease.

Li & Zobel, 2020	Japanese auto supply network (focal firms: Honda & Toyota)	Presence of ripple effect of disruptions, or risk propagation	• Robustness at initial impact • Robustness at full impact • Recovery time • Average functionality	• Network type • Network complexity • Node risk capacity	Influence of network type on supply chain network resilience (SCNR) is more significant in the short-term. SCNR can further be improved by adjusting node risk capacity. Trade-offs exist between network robustness against a disruption and recovery time.
Vachon & Klassen (2002)	Survey data on manufacturing practices from 19 different companies in the nonfashion textile industry and the small machine tool industry	Technology and information processing	Delivery performance in terms of • Lead time • Throughput time • Late delivery • Tardiness	• Process/product complicatedness (2 measures) • Process/product uncertainty (single measure) • Management systems complicatedness (2 measures) • Management systems uncertainty (2 measures)	Only process/product complicatedness and management systems uncertainty significantly impact delivery speed and reliability. This relationship is moderated by general competitive pressures, as measured by the country-level economic development.

Choi & Krause, 2006	N/A (Conceptual)	Supply base complexity	• Transaction cost • Supply risk • Supplier responsiveness • Supplier innovation	• Number of suppliers • Differentiations • Inter-Relationships	A reduction in complexity may lead to lower transaction costs and increased supplier responsiveness, but in certain scenarios it may also increase supply risk and reduce supplier innovation. Reducing supply base complexity can be a cost efficient strategy, but blindly reducing it may potentially decrease the buying company's overall competitiveness.

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