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Leveraging the Supply Chain: An Assessment of Supply Chain Partners' Influence on Organizational Performance

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Leveraging the Supply Chain: An Assessment of Supply Chain Partners' Influence on Organizational Performance

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Abstract

The supply chain is recognized as an integral part of the value creation process and a critical driver of performance. Indeed, a supply chain relationship grants buyers and suppliers the opportunity to share in the value generated by their partners, access partner capabilities and resources to enact their own strategic initiatives, and jointly generate value above what each firm could produce in isolation. The purpose of this dissertation is to investigate how firms can leverage the supply chain to attain superior organizational performance. Specifically, three essays, each focused on a distinct organizational process, explore how supply chain partners influence a firm's financial performance.

Essay 1 focuses on inventory management and the effect of supplier inventory leanness on a firm's financial performance. Essay 2 focuses on organizational governance and the potential value and risk of inviting an executive from a supplier or customer firm to serve on the board of directors. Essay 3 integrates supply chain and competitive dynamics research to explore the influence of supplier competitive actions on a firm's financial performance. Each essay covers a distinct area in which supply chain partners can act as a source of advantage and enable superior organizational performance.

Firms do not operate in isolation, and a failure to consider supply chain partners when developing and implementing firm operations and strategies is an opportunity lost. This dissertation, thus, contributes to extant supply chain research by expanding research on supply chain partners' influence on performance outcomes. The findings have major implications to managerial decision-making on sourcing, strategic management, and supply chain design. Collectively, this dissertation identifies additional avenues for firms to leverage the supply chain and, in turn, achieve superior organizational performance.

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List of Published Papers

I. Essay 1:

Barker, J. M., Hofer, C., Hoberg, K., & Eroglu, C. Supplier inventory leanness and financial performance. Preparing for 3rd round submission to *Journal of Operations Management*.

I. Introduction

The supply chain (SC) is recognized as a source of competitive advantage (Barney et al., 2012), and firms increasingly rely on their SC partners to enhance competitive outcomes and achieve superior performance (Hult et al., 2007; Petersen et al., 2008). For example, research has demonstrated that SC partners can contribute to enhanced firm outcomes such as manufacturing performance (Vonderembse & Tracey, 1999), demand responsiveness (Squire et al., 2009), innovation (Mackelprang et al., 2018), product quality (Shin et al., 2000), new product development (Azadegan & Dooley, 2010) and financial performance (Weigelt, 2013). A SC relationship grants buyers and suppliers the opportunity to share in the value generated by their partners (Krause et al., 2007), access partner capabilities and resources to enact their own strategic initiatives (Mahmood et al., 2011), and jointly generate value above what each firm could produce in isolation (Dyer & Singh, 1998).

Despite the recognition of the supply chain as a performance-driving factor, it is often overlooked when developing and implementing firm-level strategies (Ellram et al., 2013). Looking beyond a firm's boundaries at supply chain partner behavior has the additional challenges of salience and control (Narayanan & Raman, 2004), but to ignore supply chain partners' roles in a firm's own initiatives places limitations on firm's ability to achieve and sustain superior organizational performance (Squire et al., 2009). In fact, supply chain partners are neglected in research as well with many mature streams of research remaining nearly exclusive to studying firm- and industry-level drivers of firm-level outcomes. To broaden theory on the drivers of organizational performance, researchers must go beyond the internal operations and strategies of a single entity and incorporate those of its SC partners (Green et al., 2014; Mackelprang et al., 2018). Despite major advances in academic literature on the SC as a driver of firm outcomes, there remains significant opportunity to explore how SC partners influence

organizational performance and a need to develop theory on the creation and transmission of value across supply chain echelons.

The purpose of this dissertation is to incorporate SC partners into operational and competitive strategies which are traditionally developed internal to the firm. I present three essays that explore how SC partners can act as a source of superior performance. The essays are distinct from one another, each focused on a different organizational process, but the commonality is that I add a supply chain perspective to streams of research which are well-studied but largely limited to the link between firm-level factors and organizational performance. Specifically, I draw on a variety of theoretical lenses, data sources, and econometric methods to provide a nuanced understanding of how SC partners can enhance organizational performance by virtue of inventory management, organizational governance, and competitive strategy. Figure 1 presents an overview of the dissertation framework and briefly outlines the purpose of each essay.

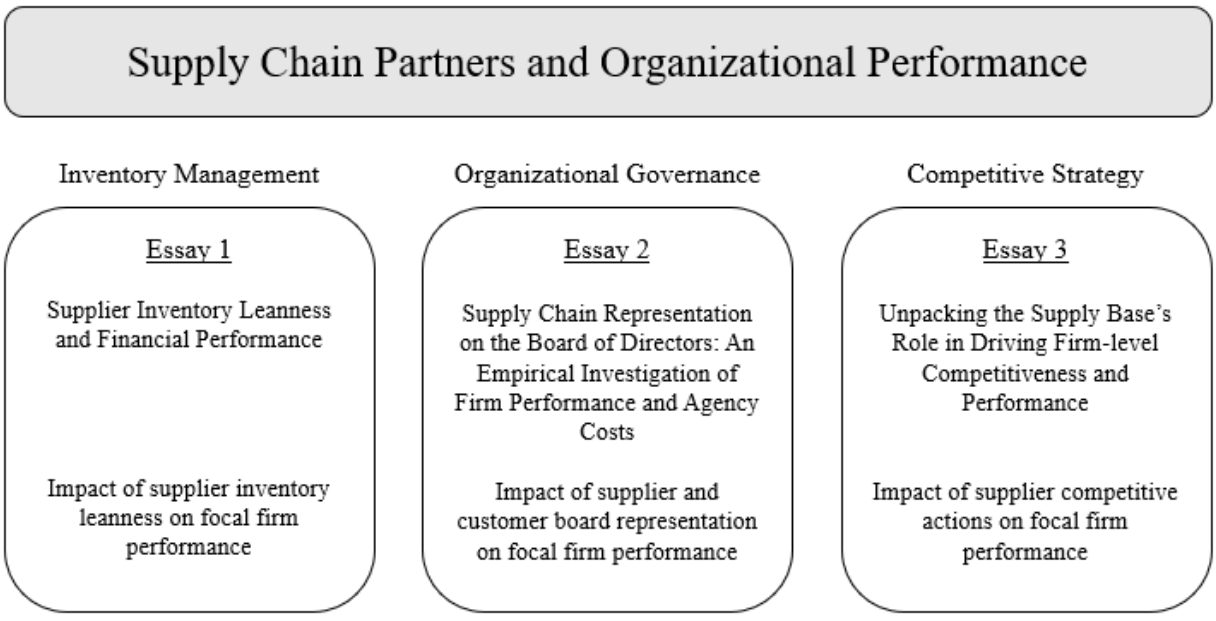

FIGURE 1: Dissertation framework

Essay 1 explores the influence of supplier inventory management on focal firm performance. The benefits of lean inventory have been well documented in operations research (e.g., Capkun et al. 2009; Eroglu & Hofer, 2011; Mishra et al., 2013), and analytical research suggests that inventories impact performance across the SC (e.g., Cachon & Fisher 2000; Shapiro & Wagner 2009; Dai et al. 2016). However, the focus of prior empirical inventory research has primarily been confined to relating a firm's inventory characteristics to its own performance outcomes. Drawing on the extended resource-based view and the inventory-theoretic literature, this essay hypothesizes about the effect of supplier inventory leanness on focal firm financial performance and how supplier and focal firm inventory leanness interact to affect financial performance. A large panel dataset is compiled of US manufacturing, wholesale, and retail firms from Compustat's North America Fundamentals Quarterly and Customer Segment databases spanning 2002-2017. The econometric analyses provide evidence that supplier inventory leanness both directly and through its interaction with focal firm inventory leanness affects financial performance. Thus, Essay 1 contributes to empirical inventory literature by broadening the scope of the inventory literature beyond the firm level and highlights the performance implications of an upstream partner's inventory management practices.

Essay 2 explores the performance implications of involving suppliers or buyers in organizational governance. Offering a customer or supplier a directorship position provides a visible signal of commitment to the partner firm which may cultivate the relationship with the connected firm (Hillman et al., 2001) and drives interfirm collaboration. A director position is rarely filled by a SC partner (Davis, 1996; Fee et al., 2006; Dass et al., 2014), but can act as an integrative mechanism that serves to align organizational strategies, create operational synergies, and improve performance of the SC dyad (Hillman et al., 2001; Minnick & Raman, 2017).

However, a director sourced from a customer or supplier firm has the ability to directly influence a focal firm's strategy and may leverage this position to appropriate value for his or her home firm at the expense of the focal firm (Scott & Lane, 2000). This study, thus, explores not only the potential collaborative benefits but also potential agency conflicts associated with SC board representation. Drawing on agency theory, as well as the board of directors and SC literatures, a set of hypotheses is developed relating SC partner representation on the board to focal firm performance outcomes. The hypothesis testing is based on the econometric analysis of a large panel dataset compiled from a variety of archival databases including Compustat's North America Fundamentals Annual, FactSet Revere, Institutional Shareholder Services, and Execucomp. The empirical results highlight the value potential of SC representation on the board of directors, but also call attention to the need for firms to structure board composition and incentive agreements to mitigate potential agency problems that arise with this type of board appointment.

Essay 3 explores the influence of supplier competitive activity on focal firm performance. Competitive actions are a manifestation of a firm's competitive strategy (Connelly et al., 2017) and are implemented to increase the firm's relative competitive position (Chen et al., 1992). Extant competitive dynamics research demonstrates that firm performance is contingent on the firm's ability to match or exceed the competitive actions of its rivals (Smith et al., 1991; Derfus et al., 2008; Giachetti et al., 2017). Drawing on the SC literature and competitive dynamics theory, this essay develops a set of empirical hypotheses to assess how suppliers contribute to a firm's competitiveness by implementing their own competitive actions which confer advantage to a firm or indirectly by enhancing the effectiveness of the firm's own competitive actions. A panel dataset is compiled from RavenPack News Analytics, FactSet Revere, Compustat North

America Fundamentals Annual, and the Bureau of Economic Analysis's input-output tables to test the hypotheses. The empirical results suggest that aligning competitive actions with the base of suppliers directly contributes to a firm's superior performance. Further, stronger supplier relationships with shared strategic visions are found to enable a firm to execute its own more effective competitive actions. This study adds to competitive dynamics theory by taking a broader perspective that incorporates both a firm's and its supplier's competitive actions, and, thus, extends competitive research beyond the realm of within-industry rivalry. The study has major implications for the concept of competition between supply chains and the potential value of coordinating competitive activity with suppliers.

Due to the evolution of business practices including globalization, increased outsourcing activities, and stronger relational approaches to managing vertical exchange relationships, organizational success is increasingly contingent on the support of the supply chain (Ketchen & Giunipero, 2004; Grimm, 2008; Min et al., 2008). Some scholars have even argued that the basis of competition has shifted from firm versus firm to SC versus SC (Christopher, 2011). To address this paradigm shift in the criticality of the SC, academic literature has had a more prevalent focus on the interplay of SC research and strategic management research (Hult et al., 2007; Hitt, 2011; Anand & Gray, 2017). This dissertation contributes to this stream of research and emphasizes that SC partners can drive organizational performance in many areas ignored in research and practice. The three essays each cover a distinct organizational process, investigate exchange partners' influences on the process, and provide empirical support for the SC acting as a source of superior advantage. In effect, each essay identifies novel considerations for theory and practice with implications to sourcing, strategic management, and SC design. Specifically, it

identifies additional avenues for firms to leverage the SC and, in turn, achieve superior organizational performance.

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II. Essay 1: Supplier Inventory Leanness and Financial Performance

Introduction

Several decades after Toyota pioneered just-in-time (JIT), inventory leanness—holding lower inventories relative to similar-sized peer firms (Eroglu & Hofer, 2011)—continues to be a strategic objective of organizations (Page, 2017). The emphasis on lean inventory has reshaped business operations and led to sustained decreases in firm-level inventory holdings throughout the end of the 20th century and into the 2000s (Lieberman & Asaba, 1997; Chen et al., 2007). Chen et al. (2005), for example, found that American manufacturers' work-in-process and raw materials inventory fell by approximately 6% and 3% each year, respectively, between 1981 and 2000. Similarly, the U.S. retail industry has seen consistent increases in inventory turnover and decreases in inventory-to-asset ratios between 1982 and 2012 (Johnston, 2014). Firms' focus on efficient and effective inventory management is well justified as it can have significant implications for operational and financial performance (e.g., Capkun et al., 2009; Mishra et al., 2013; Chuang et al., 2019).

In empirical operations management literature, there is a sizeable and growing body of research that investigates how inventories influence various firm-level performance outcomes (e.g., Eroglu & Hofer, 2011; Steinker & Hoberg, 2013; Elking et al., 2017; Chuang et al., 2019). While the locus of this stream of research has remained within the boundaries of the firm, inventory leanness may have performance implications that extend to the firm's supply chain partners. Indeed, analytical research has demonstrated that inventory decisions should be coordinated across the supply chain and that one firm's inventories will ultimately impact the performance of the supply chain (Goyal, 1976; Cachon & Fisher, 2000; Shapiro & Wagner, 2009; Dai et al., 2016; Dong et al., 2018). Yet, there is a gap in empirical research on the relationship between *supplier* inventory leanness and *focal firm* financial performance.

In this paper, we examine the following research questions: (1) How does supplier inventory leanness affect focal firm financial performance? (2) How does supplier inventory leanness affect the relationship between focal firm inventory leanness and the firm's financial performance? We draw on the extended resource-based view and the supply chain and inventory literature to develop a set of hypotheses that address the research questions at hand. We then empirically test these hypotheses using a large panel dataset of US manufacturing, wholesale, and retail firms compiled from Compustat's North America Fundamentals Quarterly and Customer Segment databases spanning 2002 to 2017.

This study contributes to operations and supply chain research by adding nuance to our understanding of inventory management as a supply chain process. Specifically, we theoretically and empirically examine how upstream supply chain partners' inventory leanness affects a firm's financial performance and, thus, contributes to further broadening the scope of empirical inventory literature beyond the firm-level. The statistical results offer evidence that supplier inventory leanness influences focal firm financial performance both directly and through interaction with the firm's own inventory leanness. The interaction of supplier and focal firm inventory leanness highlights another important contribution: namely, we contribute to firm-level inventory theory by identifying supplier inventory leanness as a boundary condition of the inverted U-shaped relationship between a firm's inventory leanness and financial performance. Thus, our research underscores complementarities in inventory management within the supply chain and demonstrates how supplier-side inventory characteristics can amplify, diminish, or even reverse the relationship between a firm's inventory leanness and performance. Consequently, our findings are relevant to practice and draw attention to supplier inventory

leanness as an important consideration in the selection and evaluation of suppliers as well as firm-level inventory decision making.

The remainder of the paper is structured as follows: First, we review the relevant literature streams and develop a set of theoretically grounded hypotheses. We next discuss sampling, measurement and methodological issues pertaining to the empirical analysis. We then present the estimation results of the empirical analysis before focusing on our work's implications for theory and managerial practice. We conclude by noting the study's limitations and highlighting future research opportunities.

Literature Review: The Inventory Leanness-Performance Link

The main premise of inventory control is that a cost tradeoff exists in the firm's decision to hold inventory. The choice to hold less inventory increases the probability of stockouts and poor customer service, thereby accumulating costs in the form of lost sales (Anderson et al., 2006). Conversely, holding more inventory is not only associated with direct costs of storage, insurance, and taxes, but also incurs indirect costs in the form of devaluation, spoilage, and obsolescence risk (Lee & Billington, 1992; Callioni et al., 2005). In addition, inventory investments come with opportunity costs and may constrain cash flows (Kesavan & Mani, 2012). Inventory carrying costs represent a significant operating expense, such that a reduction in firm-level inventory holdings can lead to considerable costs savings (Frohlich & Westbrook, 2002). Given these cost considerations, inventory decision-making strives to balance the tradeoff of inventory holding costs and customer service failures (Taylor et al., 2004).

Prior empirical research has shown that a firm's inventory leanness generally has a, positive effect on the firm's financial performance. For instance, lean inventory has been associated with increased stock market returns (Mishra et al., 2013), return on sales (Eroglu & Hofer, 2011), and EBIT (Capkun et al., 2009). Chen et al. (2007) did not find any short-term benefit of lean inventory, but over time, firms with high inventory holdings exhibited lower stock market returns. In addition, Hendricks and Singhal (2009) showed that firms that announced excess inventory buildup experienced negative stock market reactions. Conversely, Balakrishnan et al. (1996) and Cannon (2008) did not find evidence of a significant effect of inventory on improved performance, but such results may be due to measurement, sampling, and model specification issues (Eroglu & Hofer, 2011; Eroglu & Hofer, 2014; Kovach et al., 2015).

While there generally is support for a positive association between a firm's inventory leanness and its performance, a linear relationship cannot adequately capture the cost tradeoffs of inventory theory (Eroglu & Hofer, 2014). Excessive inventory leanness will constrain the flow of materials, increase stockout probability, and ultimately hurt financial outcomes. Inventories protect against delays in the inbound flow of raw materials, machine, or operator errors (Turnbull et al., 1992), process variance (Flynn et al., 1995), quality defects, and spikes in demand (Rumyantsev & Netessine, 2007). Delays and disruptions of the inbound flow of materials into a firm and through its operational processes can halt production, leaving machinery and workers idle (Baker, 2007; Peng & Lu, 2017). Further, disruption in the flow of materials through internal operations and outbound from the firm can result in stockouts, order fulfillment delays, and poor customer service. In turn, failure to meet customer fulfillment requirements can decrease long-term demand (Craig et al., 2016), require discounts and incur late fees (Hendricks & Singhal, 2003), endanger customer loyalty (Heim & Sinha, 2001), and ultimately increase customer

switching behavior (Kesavan & Mani, 2012). Sufficient inventory holdings, therefore, make the firm and supply chain more resilient in case of unforeseen disruptions (Christopher & Peck, 2004; Pettit et al., 2010).

Inventory research suggests that there is an optimal level of inventory that effectively balances these costs and risks of (not) holding inventory. In line with this theoretical prediction, researchers have found that, while inventory leanness is generally beneficial to at least some degree, there are decreasing or even negative returns to inventory leanness for particularly high leanness levels (Eroglu & Hofer, 2011; Eroglu & Hofer, 2011a; Hofer et al., 2012; Kesavan & Mani, 2012; Mishra et al., 2013). Further, Chen et al. (2005) and Eroglu and Hofer (2011) found the optimal level of inventory leanness to be slightly above the industry average. In sum, there is both theoretical and empirical evidence that the relationship between inventory leanness and performance generally follows an inverted U-shape.

Theory and Hypothesis Development

The extended resource-based view

The resource-based view (RBV) contends that firms can achieve sustainable competitive advantage through idiosyncratic resources and capabilities that generate value not replicable or substitutable by rival firms (Barney, 1991). The RBV is prevalent in strategy, operations, and supply chain research, and multiple variants of this theory have developed to build on and broaden the range of factors that drive an organization's success. For example, the practice-based view argues that researchers should focus on performance instead of competitive advantage and that superior performance can be achieved despite other rival firms having access to or control

over the same value-driving resources (Bromiley & Rau, 2014; 2016). Further, the relational view (Dyer & Singh, 1998) and the extended resource-based view (ERBV) (Lavie, 2006) suggest that valuable resources can lie outside of a firm's boundaries. We primarily draw on the ERBV to explore the effect of supplier inventory leanness on a firm's financial performance.

The main extension of ERBV over RBV is that firms do not need to own or fully control a resource in order to extract value from it (Lavie, 2006). Interorganizational relationships offer a means for firms to access resources outside of their direct control and derive benefits from those resources (Cousins & Menguc, 2006; Cao & Zhang, 2011). The ERBV considers three types of rents which all contribute to the value of firm: internal rents, appropriated relational rents, and inbound spillover rents (Lavie, 2006). An internal rent refers to the benefits and value of resources that are owned and controlled by the focal firm. A relational rent refers to the value generated by combining internal rents with those of a partner. Relational rents cannot be accrued by the interconnected firms in isolation but rather by combining and complementing their respective resources to achieve 'super-normal profits' (Dyer & Singh, 1998). While the relational view focuses on the common or joint benefits of relational rents, the ERBV specifically considers the private benefits that the focal firm is able to appropriate (Lavie, 2006; Cao & Zhang, 2011). Finally, an inbound spillover rent refers to the value derived from a partner's resources. As such, a firm's resource-based advantage is not only contingent on the firms internal resources, but also on external resources accessible through its relationships, the appropriation of rents from these external resources, and the complementarities that develop among internal and external resources (Lavie, 2006).

Supplier inventory leanness and firm financial performance

A firm's operational performance is intricately tied to that of its suppliers. Indeed, past research has argued that outcomes in terms of cost, quality, delivery, lead time, responsiveness and customer service are dependent on the supply base's ability to effectively and efficiently feed firm operations (Saeed et al., 2005; Krause et al., 2007; Liao et al., 2010). Supplier operations are an extension of a firm's own processes (Vonderembse & Tracey, 1999; Emery & Marques, 2011) that need to be managed in order to maximize competitiveness and value creation. Inventories, in particular, are a resource of the supply chain (Fawcett et al., 2010), and firms can leverage their position in a supply chain to access resources and capabilities held by their supply chain partners (Mahmood et al., 2011). As such, we argue that supplier inventories can act as a source of (dis)advantage that extends to a focal firm and affects focal firm financial performance.

At the firm-level, holding inventory is a balance between inventory holding costs and customer service level. The latter, of course, is directly tied to the firm's downstream supply chain partners. Inventory serves as a buffer against disruptions in the supply chain (Christopher & Peck, 2004), shortens lead times (Rumyantsev & Netessine, 2007), and ultimately fills customer orders more efficiently and effectively (Lieberman et al., 1999). As such, firms will extract value when sourcing from suppliers who can fulfill orders reliably and efficiently (Weber et al., 1991), and greater inventory holdings increase a supplier firm's ability to do so.

Responsive suppliers are critical contributors to a firm's operational effectiveness and value creation (Liao et al., 2010; Peng & Lu, 2017). Companies rely on their suppliers to respond and cater to their own downstream customers' needs and demands (Squire et al., 2009), and a supplier without sufficient inventory slack cannot provide high levels of customer service

(Radnor & Boaden, 2004). Delayed inbound order receipts can disrupt a customer firm's internal manufacturing processes, thus leading to halted production and lost sales (Gonçalves, 2006; Waller et al., 2008; Griffis & Whipple, 2012). Ultimately, this suggests that as supplier inventory leanness increases, a firm's operational performance will be adversely affected. Supporting this notion, a common practice is for firms to set minimal inventory levels for suppliers in an attempt to maintain high service levels and reduce order fulfillment time (Gupta & Weerawat, 2006).

When gauging the value of a resource, it is important to consider the cost associated with acquiring that resource (Lavie, 2006). While firm-level inventory research highlights that inventory holding costs can be substantial and offset the benefit of increased customer service from larger inventory holdings, these costs are not necessarily passed on to downstream customers. Powerful firms often require dependent suppliers to hold more inventory such that they enjoy the benefits of greater supply responsiveness while the suppliers absorb the inventory-related costs and risks (Fawcett et al., 2010; Emery & Marques, 2011). Although increased costs at a supplier can be expected to result in higher sourcing prices in the long-term, contracts often fix pricing levels for extended periods of time (Wever et al., 2012), thus depriving suppliers of the ability to pass on the inventory costs associated with meeting customer service requirements.

In sum, customers appropriate a significant share of the value generated by supplier operations (Kim & Wemmerlöv, 2015; Lieberman et al., 2017). Lean supplier inventory will adversely affect a focal firm's throughput and output levels and, thus, capacity utilization and customer service levels. Conversely, as supplier inventory levels increase, the focal firm is able to appropriate much of the operational value from enhanced customer service without having to bear the associated costs. Hence, we predict a negative relationship between suppliers' inventory leanness and a focal firm's financial performance.

Hypothesis 1: Supplier inventory leanness is negatively associated with focal firm financial performance.

The interaction of supplier and focal firm inventory leanness

The value of a resource is contingent on how it complements other internal and externally accessible assets and capabilities (Lavie, 2006). As such, the effectiveness of a firm-level strategy is a function of the specific processes and strategies employed by supply chain partners (Green Jr. et al., 2014; Mackelprang et al., 2014). A firm's inventory strategy is no different, and its effectiveness is subject to the conditions of the external environment and, specifically, the inventory positions of the firm's supply chain partners (Sucky, 2005; Fawcett et al., 2010). We, therefore, argue that supplier inventory leanness will moderate the relationship between a focal firm's own inventory leanness and its financial performance.

A firm with lean inventory becomes more dependent on the reliability of its supply base (Balakrishnan et al., 1996). As a firm decreases its inventory levels, its ability to maintain a high level of customer service will decline, and the costs of poor customer service begin to outweigh any inventory costs savings (Eroglu & Hofer, 2011; Kesavan & Mani, 2012; Mishra et al., 2013). While this detriment of implementing lean inventory can be diminished by sourcing from more responsive suppliers (Chopra & Sodhi, 2004), procuring from suppliers with limited inventory will add to the uncertainty of the firm's ability to meet customer service targets (Ahiska et al., 2013). For example, Waller et al. (2008) found that supplier stockouts increase the probability of its customer's own stockouts. Further, natural disasters demonstrate the vulnerability of lean inventory throughout the supply chain (Kubota, 2016). For instance, earthquakes led to major disruptions of Japanese automakers' supply chains in 2016. Toyota, in particular, struggled to recover due to its lean supply chain focused on minimal inventories and just-in-time deliveries.

As a result, both Toyota and its suppliers lacked sufficient buffers and suffered from production shutdowns that were much longer than those experienced by Toyota's rivals (Webb, 2016).

Inventory management is fundamentally a supply chain process that relies on sufficient inventories at all echelons to meet customer demand. As such, a firm's inventory leanness cannot be considered in isolation but must be viewed in conjunction with its supply chain partners and, most notably, its direct suppliers. A supplier's inventory leanness compounds a firm's struggle to meet customer demand as a result of its own inventory leanness. Put differently, there is an interaction effect between the inventory leanness of a firm and its suppliers such that the diminishing value (or negative effect) associated with high levels of inventory leanness will be exacerbated as supplier inventory leanness increases.

> **Hypothesis 2:** Supplier inventory leanness moderates the relationship between the inventory leanness and financial performance of a focal firm. Greater supplier inventory leanness enhances the rate at which a focal firm's inventory leanness is associated with diminished or negative returns such that high levels of focal firm inventory leanness are associated with lower focal firm financial performance.

If supplier and focal firm inventory leanness jointly influence focal firm performance, an important practical question is how a firm should adjust inventories relative to those of its suppliers. A firm has greater control over its internal resources and can, therefore, more easily and readily adjust its own inventory holdings to fit the contingencies in the external environment of which it has less control. Indeed, prior research has recognized that a firm's optimal inventory strategy is heavily influenced by the resources and capabilities of its supplier chain partners (Fawcett et al., 2010). As such, we argue that supplier inventory leanness affects the optimal inventory leanness of a focal firm.

Supplier resources can substitute for a firm's lack of such resources (Weigelt, 2013). Large inventory levels offer a buffer that protects not only the acting firm from disruptions, but also other members of the supply chain (Dong et al., 2018), thus decreasing a downstream partner's risk and need for large stockpiles of just-in-case inventory (Chopra and Sodhi, 2004). Hence, a supplier's inventory, to an extent, offers the same operational value to its customer as the customer's own inventory holdings (Emery & Marques, 2011). Larger inventory holdings afford a supplier the ability to more reliably and quickly respond to unexpected demand fluctuations (Christopher & Peck, 2004). In turn, a decrease in the variability and lead time for the customer firm's procurement drives down the customer's optimal inventory holdings (Lieberman et al., 1999; Rumyantsev & Netessine, 2007). This is consistent with the idea that inventory can shift to another member in the supply chain (Emery & Marques, 2011; Zinn, 2019) such that a supplier's decreased inventory leanness can support a customer's increased inventory leanness.

Greater supplier inventory decreases the marginal value of a customer's own inventory (Dong et al., 2018). As such, a supplier that is less lean affords the customer an opportunity to reduce its own inventory while minimizing total logistics costs. Conversely, a firm's optimal inventory level will be higher if its suppliers are very lean and, therefore, less able to mitigate the adverse effects of fluctuations in demand and supply.

> **Hypothesis 3:** Supplier inventory leanness moderates the relationship between inventory leanness and financial performance of a focal firm such that the optimal focal firm inventory leanness will decrease as supplier inventory leanness increases.

Our research model and the associated hypotheses are summarized in Figure 1 below.

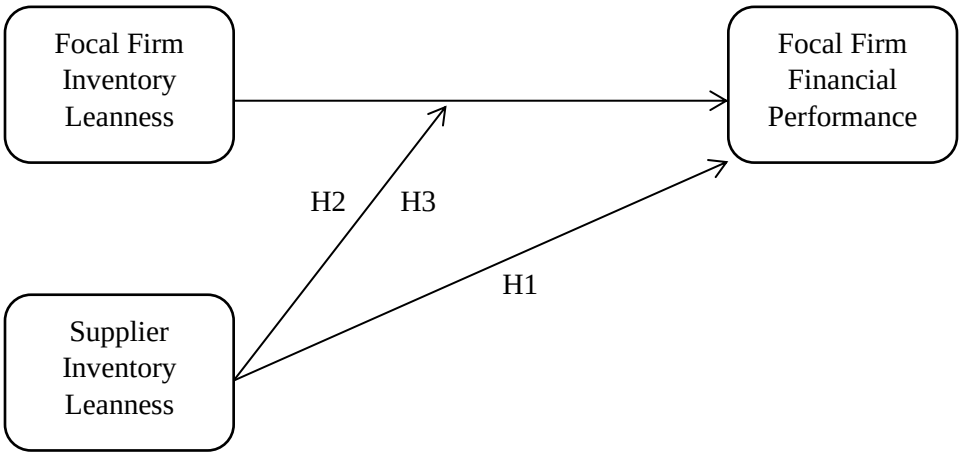

FIGURE 1: Research model.

Methodology

Data and sample

We test our hypotheses using a panel dataset comprised of dyadic supply chain relationships where the customer is the focal firm of interest. Customer-supplier dyads are identified using Compustat's Customer Segment database from 2002-2017. The Customer Segment dataset compiles firm disclosures of sales to major customers reported in annual 10-K reports. The Securities and Exchange Commission requires public firms to itemize customer revenues when such revenues account for at least 10% of the firm's total sales in a given fiscal year. One of the challenges with using Customer Segment data is that firms often report customers in aggregation, anonymously, or using ambiguous names (Chen & Ho, 2019). To address this issue, we drew the Customer Segment data from the WRDS Linking Suite which uses a name-matching algorithm and manual verification to identify customer firms (Cohen & Frazzini, 2008; Cen et al., 2017). Given our focus on the effects of inventory leanness, we limit our analysis to firms operating in industries where inventories and the flow of physical goods

play a major role in firm operations. As such, the dataset is restricted to dyads in which both the customer and supplier operate in manufacturing, wholesale, and retail industries.

The outcome of interest, focal firm financial performance, varies both within and across years, thus suggesting the use of higher-frequency (quarterly) data. Similarly, inventories are subject to seasonality (Steinker & Hoberg, 2013; Hoberg et al., 2017) and are typically evaluated on a monthly or more frequent basis (Grimson & Pyke, 2007; Thomé et al., 2012). As such, we follow recent research examining inventory as a driver of financial performance and use quarterly data (e.g., Kovach et al., 2015; Udenio et al., 2018; Kroes et al., 2018). Therefore, we assume any major transactional relationship reported in the Customer Segment data existed in all four quarters of the reported year so that customer-supplier relationships can be matched to quarterly periods.

Supplier and focal firm financial information were collected from Compustat's North America Fundamentals Quarterly database and imported into the dyadic dataset which consists of 24,624 dyad-quarter observations with complete inventory and financial information. Firms are often matched to multiple suppliers in the same period, thus creating repeated observations tied to our dependent variable of interest. To address this issue, we aggregated all dyadic observations pertaining to a given firm-quarter by calculating a weighted average of supplier-side measures (e.g., supplier inventory leanness) such that each supplier variable is representative of a firm's full supplier base as identified in the Customer Segment dataset. We used *dyad sales* as the aggregation weight (Dong et al., 2020) so that a supplier accounting for greater procurement spend receives a higher weight in calculating the final supplier base measure. For example, in the fourth quarter of 2008, ten suppliers identified Dell Technologies Inc. as a customer in the Customer Segment dataset. In aggregate, the ten suppliers' sales to Dell

accounted for 22.7% of Dell's COGS in that quarter. The largest supplier, Intel Corp., accounted for 60.42% of all suppliers' sales to Dell captured in the dataset and, therefore, received a 60.42% weight when aggregating supplier measures.

The final dataset consists of 4,157 firm-quarter observations pertaining to 350 unique (customer) firms over a time period spanning 2002-2017. On average, a firm is tied to 5.92 suppliers at a given time, and these suppliers account for an average of 10.1% of COGS. Firms represent a diverse set of industries covering 75 unique 6-digit NAICS codes. The majority of observations are classified as manufacturers accounting for 82.1% of observations followed by retailers (10.5%) and wholesalers (7.4%). At a more refined level, the top three industries are computer and electronic product manufacturing (43.3%), chemical manufacturing (17.4%), and machinery manufacturing (6.5%).

Measurement

The dependent variable in the current study is focal firm financial performance. We measure this using return on assets, (*F_ROA*), calculated as net income divided by total assets. The independent variables of interest are focal firm and supplier inventory leanness. Both are measured using Eroglu and Hofer's (2011) Empirical Leanness Indicator (ELI) which assesses a firm's inventory leanness relative to similar-sized firms operating in the same industry. Specifically, the ELI is the studentized residual (multiplied by -1) that is obtained after regressing the natural logarithm of average inventories on the natural logarithm of sales for all firms operating in the same six-digit NAICS industry-quarter. Interested readers may refer to Eroglu and Hofer (2011) for more detail. Focal firm inventory leanness is represented as *F_inventory leanness*, and weighted average supplier inventory leanness is represented as *S_inventory leanness*. Further, a squared term of customer inventory leanness (*F_inventory*

leanness²) is generated to account for the non-linear relationship of firm-level inventory leanness and performance. Finally, to address the moderation hypotheses, we interact supplier inventory leanness with both the linear and squared term of focal firm inventory leanness: *S_inventory leanness x F_inventory leanness* and *S_inventory leanness x F_inventory leanness²* (Aiken & West, 1991; Haans et al., 2016).

A number of control variables are included in the model to account for firm, industry, and dyad factors that can influence a customer firm's performance. First, we control for focal firm-level variables including firm size, sales growth, R&D intensity, marketing efficiency and production efficiency. Firm size (*F_firm size*) is measured as the natural logarithm of cost of goods sold, and sales growth (*F_sales growth*) is measured as the percentage change in firm sales from the prior quarter. A firm's innovativeness can affect the value of inventory leanness by increasing the risk of current stock obsolescence (Eroglu & Hofer, 2014). We, therefore, control for R&D intensity (*F_R&D intensity*), measured as the ratio of R&D expenses to sales. Finally, firm performance is largely driven by the efficiency in both marketing and production resources (Modi & Mishra, 2011; Lu & Shang, 2017). Hence, we control for both marketing efficiency (*F_marketing efficiency*) production efficiency (*F_production efficiency*), measured as the ratio of selling, general and administrative expenses to sales and the ratio of gross property, plant, and equipment to sales, respectively. Consistent with Modi and Mishra (2011), both marketing efficiency and production efficiency are standardized by subtracting the industry-quarter mean then dividing by the industry-quarter standard deviation.

Next, we control for industry munificence and dynamism. Industry munificence (*F_industry munificence*) represents the level of resources available to the industry to support growth (Dess & Beard, 1984). Industry dynamism (*F_industry dynamism*) represents the level of

unpredictability in the industry (Dess & Beard, 1984). We measure munificence and dynamism using the technique outlined by Boyd (1995). We regress industry sales on time over a rolling 5-year window. Industry munificence is measured as the regression coefficient divided by mean industry sales during the rolling window. Then, industry dynamism is measured as the standard error from the regression divided by mean industry sales during the rolling window. Both measures are calculated on an annual basis and applied to each quarter in the fiscal year in order to remove seasonal patterns and best capture overall industry growth trends and unpredictability.

We follow recent dyadic supply chain research and include control variables for supplier firm-level characteristics (Chu et al., 2019). We include supplier financial performance, size and sales growth as controls, and each supplier-side variable is aggregated using the same weighted average technique as supplier inventory leanness. Similar to the focal firm-level variables, supplier financial performance (*S_ROA*) is measured using return of assets, supplier size (*S_firm size*) using the natural logarithm of cost of goods sold, and supplier sales growth (*S_sales growth*) using the percent change in sales from the previous quarter. Finally, dependence on a supply chain partner is a factor shown to influence both inventory holdings (Emery & Marques, 2011) and financial performance outcomes (Kim & Henderson, 2015). We, therefore, control for dependence in focal firm-supplier relationships by including controls for industry concentration and dyad sales dependence. Industry concentration is captured both for the supplier (*S_industry concentration*) and focal firm (*F_industry concentration*) industries using the sum of squared market shares (Herfindahl-Hirschman Index). Supplier sales dependence (*S_sales dependence*) is captured as dyad sales divided total supplier sales, and focal firm sales dependence (*F_sales dependence*) is captured as dyad sales divided by focal firm COGS (Kim & Henderson, 2015). Sales dependence is a dyad-specific measure in which multiple suppliers are often tied to the

same firm. As such, both supplier and focal firm sales dependence measures are aggregated in the same manner as all supplier-side variables.

Empirical Analysis and Results

Main results

Descriptive statistics and pairwise correlations are included in Table 1. Pairwise correlations show no indication of excessively high correlation between any variables included in the analysis. Further, the largest variance inflation factor is 2.59 with a mean value of 1.40 suggesting no issues of multicollinearity.

The dataset contains repeated observations for each customer firm over time requiring the use of panel regression techniques. Given that the analysis covers a wide variety of customer firms and industries, there is significant unobserved heterogeneity among the sampled firms that influences our dependent variable of interest. Further, a Hausmann test ($p < 0.01$) suggests systemic differences between random and fixed effects estimators due to omitted firm-specific differences. We, therefore, conduct fixed effects regressions to account for time-invariant, otherwise unobservable predictors of firm performance (random effects estimates are consistent with our main analysis and presented in the Appendix). In addition, we add dummy variables for both the year and quarter covered in the dataset to account for panel-invariant time effects. Finally, a Breusch-Pagan test ($p < 0.01$) indicates the presence of heteroskedastic error terms. We, thus, use robust standard errors in all subsequent analyses. Our full statistical model is shown in Equation 1:

TABLE 1: Descriptive statistics and correlations

	Variable	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	F_ROA	0.01	0.03																
2	F_inventory leanness	-0.10	0.82	0.11*															
3	S_inventory leanness	0.09	1.00	-0.07*	0.01														
4	S_ROA	-0.01	0.07	0.12*	-0.01	0.10*													
5	S_sales dependence	0.20	0.15	0.06*	-0.01	0.03*	-0.14*												
6	F_sales dependence	0.05	0.13	-0.14*	0.05*	0.00	0.05*	0.08*											
7	F_industry concentration	0.21	0.16	0.02*	0.04*	-0.09*	0.10*	-0.09*	-0.08*										
8	S_industry concentration	0.22	0.15	0.07*	0.03*	-0.04*	0.06*	-0.08*	-0.10*	0.24*									
9	F_firm size	6.86	1.94	0.04*	0.06*	-0.00	0.09*	-0.06*	-0.09*	0.02*	0.03*								
10	S_firm size	3.89	2.20	0.01	0.02	-0.02	0.07*	-0.05*	0.24*	0.05*	-0.01	0.36*							
11	F_sales growth	0.04	0.16	0.13*	0.06*	0.00	0.01	0.01	0.02*	-0.00	-0.00	0.01	-0.01						
12	S_sales growth	0.06	0.26	0.03*	-0.00	0.04*	0.03*	0.04*	0.01	-0.04*	-0.03*	-0.02*	-0.02*	0.14*					
13	F_industry munificence	0.04	0.05	0.07*	-0.02*	0.00	0.01	0.02*	0.03*	-0.06*	-0.02*	0.06*	0.07*	0.02*	0.00				
14	F_industry dynamism	0.02	0.01	-0.01	-0.01	0.04*	0.02*	-0.01	-0.03*	0.03*	0.02*	0.04*	-0.01	0.02*	-0.01	0.22*			
15	F_R&D intensity	0.10	0.10	-0.32*	-0.04*	0.01	-0.22*	0.10*	0.20*	-0.31*	-0.31*	-0.16*	-0.08*	-0.02*	0.07*	0.01	-0.03*		
16	F_marketing efficiency	0.41	0.93	0.09*	0.10*	0.01	0.05*	-0.00	-0.10*	0.01	-0.04*	0.07*	0.04*	0.05*	-0.00	-0.01	-0.02*	-0.24*	
17	F_production efficiency	-0.18	0.59	0.05*	0.12*	-0.02*	0.01	0.01	-0.02*	0.10*	-0.04*	0.02*	0.03*	0.07*	-0.01	0.03*	0.01	-0.09*	0.20*

*$p < 0.05$

The dataset contains repeated observations for each customer firm over time requiring the use of panel regression techniques. Given that the analysis covers a wide variety of customer firms and industries, there is significant unobserved heterogeneity among the sampled firms that influences our dependent variable of interest. Further, a Hausmann test ($p < 0.01$) suggests systemic differences between random and fixed effects estimators due to omitted firm-specific differences. We, therefore, conduct fixed effects regressions to account for time-invariant, otherwise unobservable predictors of firm performance (random effects estimates are consistent with our main analysis and presented in the Appendix). In addition, we add dummy variables for both the year and quarter covered in the dataset to account for panel-invariant time effects. Finally, a Breusch-Pagan test ($p < 0.01$) indicates the presence of heteroskedastic error terms. We, thus, use robust standard errors in all subsequent analyses. Our full statistical model is shown in Equation 1:

$$
\begin{aligned}
F\_roa_{it} = \beta_0 \; & + \beta_1 F\_inventory\ leanness_{it} \\
& + \beta_2 F\_inventory\ leanness_{it}^2 \\
& + \beta_3 S\_inventory\ leanness \\
& + \beta_4 S\_inventory\ leanness_{it} \times F\_inventory\ leanness_{it} \\
& + \beta_5 S\_inventory\ leanness_{it} \times F\_inventory\ leanness_{it}^2 \\
& + \rho(\Gamma_{it}) + \alpha_i + \gamma_t + q_t + \varepsilon_{it}
\end{aligned}
\tag{1}
$$

where *i* denotes the firm and t denotes time. Firm fixed effects, year fixed effects, and quarter fixed effects are represented by α_i, γ_t, and q_t respectively. Finally, Γ_{it} represents the vector of control variables outlined in the prior section.

The results for the fixed effects regressions are presented in Table 2. The dependent variable is focal firm financial performance (*F_ROA*) across all models. Model 1 includes only the control variables. Model 2 introduces supplier inventory leanness to assess the direct effect of supplier inventory leanness on financial performance. Then, we add the two interaction terms in Model 3 to assess the moderation hypotheses. The addition of variables of interest in models 2 and 3 significantly increases the explanatory power of the model (Model 1-2: $F = 4.73$, $p < 0.05$; Model 2-3: $F = 3.50$, $p < 0.05$).

TABLE 2: Fixed effects regression results

DV: F_ROA	(1)		(2)		(3)	
F_inventory leanness	0.005***	(0.001)	0.005***	(0.001)	0.005***	(0.001)
F_inventory leanness²	-0.000	(0.001)	-0.000	(0.001)	0.000	(0.001)
S_ROA	0.033**	(0.015)	0.035**	(0.015)	0.035**	(0.015)
S_sales dependence	0.013***	(0.003)	0.014***	(0.003)	0.013***	(0.003)
F_sales dependence	0.007	(0.007)	0.007	(0.007)	0.009	(0.007)
F_industry concentration	-0.001	(0.011)	-0.001	(0.012)	-0.000	(0.012)
S_industry concentration	-0.008	(0.005)	-0.009*	(0.005)	-0.009*	(0.005)
F_firm size	-0.009***	(0.002)	-0.009***	(0.002)	-0.009***	(0.002)
S_firm size	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
F_sales growth	0.016***	(0.003)	0.016***	(0.003)	0.016***	(0.003)
S_sales growth	0.002	(0.001)	0.002	(0.001)	0.002	(0.001)
F_industry munificence	0.025	(0.016)	0.024	(0.016)	0.023	(0.016)
F_industry dynamism	-0.056	(0.053)	-0.058	(0.053)	-0.057	(0.052)
F_R&D intensity	-0.185***	(0.025)	-0.186***	(0.025)	-0.186***	(0.025)
F_marketing efficiency	0.009***	(0.002)	0.009***	(0.002)	0.009***	(0.002)
F_production efficiency	0.003**	(0.001)	0.003**	(0.001)	0.003**	(0.001)
S_inventory leanness			-0.001**	(0.001)	-0.000	(0.001)
S_inventory leanness x F_inventory leanness					-0.000	(0.001)
S_inventory leanness x F_inventory leanness²					-0.001**	(0.000)
Constant	0.078***	(0.013)	0.078***	(0.013)	0.078***	(0.013)
Year fixed effects	Yes		Yes		Yes	
Quarter fixed effects	Yes		Yes		Yes	
Observations	4,157		4,157		4,157	
Within R-squared	0.2035		0.2049		0.2076	

All tests are two-tailed: *** p<0.01; ** p<0.05; * p<0.1. Robust standard errors are shown in parentheses. Coefficients of time dummies are not shown due to space constraints.

Focusing on the control variables first, most coefficient estimates carry the expected signs and are largely consistent across Model 1-3. Similar to prior research, the linear term of inventory leanness is positive and significant ($\hat{\beta} = 0.005, p < 0.01$) indicating a positive effect of inventory leanness on financial performance. The squared term of firm inventory leanness is negative as expected but not to a statistically significant level ($\hat{\beta} = -0.0002, p > 0.1$). Although this result is somewhat counter to expectations, it is consistent with Eroglu and Hofer's (2011) finding that an inverted U-shaped inventory leanness-performance relationship exists in only 48% of all industries. The statistically positive coefficient for supplier firm performance and negative coefficient for supplier dependence suggest that firms perform better when connected to higher performing and more dependent suppliers. In line with expectations, both marketing efficiency and production efficiency have positive and statistically significant effects on financial performance. We also find that R&D intensity is negatively associated with firm financial performance in the short term.

Hypothesis 1 predicts a negative direct effect of supplier inventory leanness on customer financial performance. The coefficient of supplier leanness in Model 2 is negative and statistically significant ($\beta = -0.001, p < 0.05$), providing support for H1. In practical terms, this coefficient estimate suggests that a one standard deviation increase in the supplier's inventory leanness results in a corresponding 8.67% decrease from the mean ROA, all else equal.

Hypotheses 2 and 3 predict moderation effects of supplier inventory leanness on the relationship between a firm's inventory leanness and financial performance. To facilitate the interpretation of the estimation results, a 3D plot of supplier and focal firm inventory leanness and associated financial performance (ROA) is provided in Figure 2. Hypothesis 2 predicts a compounding effect of supplier and focal firm inventory leanness such that an increase in

supplier inventory leanness will increase the rate at which a firm's inventory leanness will provide diminishing returns and, eventually, negative returns. Haans et al. (2016) refers to this as a steepening effect where the coefficient of the squared term is enhanced, and the estimation parabola becomes narrower with a steeper slope. Assessing such an effect is dependent on the interaction terms which contain the squared independent variable, *F_inventory leanness²*. The negative and statistically significant coefficient of *S_inventory leanness x F_inventory leanness²* ($\beta = -0.001, p < 0.05$) provides support for this hypothesis.

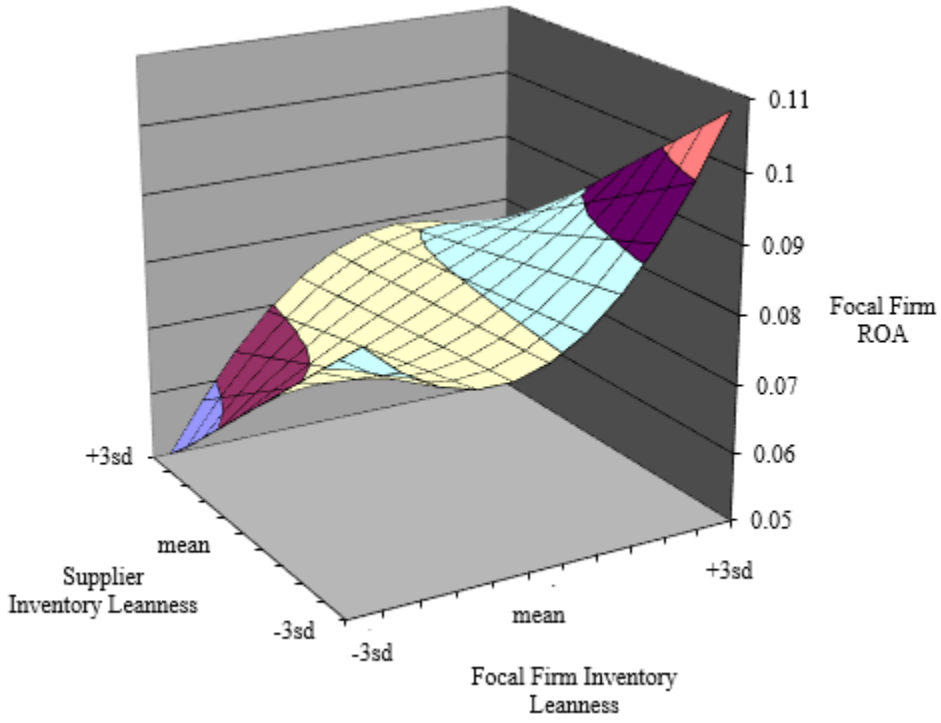

FIGURE 2: Supplier and customer inventory leanness interaction 3D surface plot

It is important to recall that the coefficients for *F_inventory leanness²* are not significant in any of the regression models, suggesting only a linear relationship of inventory leanness on focal firm financial performance, all else equal. However, as suppliers' inventory leanness

increases, the inverted U-shaped effect of firm inventory leanness on financial performance begins to take form.

Surprisingly, there is a perceived "shape flip" (Haans et al., 2016) visible in Figure 2. Specifically, we see a U-shaped effect of *F_inventory leanness* on *F_ROA* when suppliers are unlean and an inverted U-shaped effect when suppliers are lean. To better understand how supplier inventory leanness changes the nonlinear relationship between a firm's inventory leanness and its own financial performance, we use Stata's *margins* command to assess the conditional effects of the linear and squared terms of focal firm inventory leanness at fixed values of supplier inventory leanness (fixed at the mean and up to three standard deviations above and below the mean). The results are summarized in Table 3.

TABLE 3: Conditional linear and nonlinear effects of focal firm inventory leanness

	Focal firm inventory leanness				Focal firm inventory leanness²				
S_inventory leanness	b	SE	z	p-value	b	SE	z	p-value	Effect shape
-3sd	0.005	0.003	2.0	0.045	0.003	0.002	2.2	0.029	Positive exponential
-2sd	0.005	0.002	2.6	0.009	0.002	0.001	2.0	0.045	Positive exponential
-1sd	0.005	0.001	3.4	0.001	0.001	0.001	1.5	0.131	Positive linear
mean	0.005	0.001	3.8	0.000	0.000	0.001	0.2	0.857	Positive linear
+1sd	0.005	0.001	3.1	0.002	-0.001	0.001	-1.4	0.176	Positive linear
+2sd	0.005	0.002	2.2	0.026	-0.002	0.001	-2.0	0.047	Positive with diminishing returns
+3sd	0.004	0.003	1.6	0.101	-0.003	0.001	-2.2	0.028	Inverted U-shape

The linear effect of a firm's inventory leanness is positive and significant for each fixed value of *S_inventory leanness* except for +3sd. The squared term of firm inventory leanness, however, varies significantly as suppliers become leaner. When suppliers are very unlean (-3sd and -2sd), the effect is positive and significant. We test the simple slope of customer inventory leanness (considering all terms and interactions containing *F_inventory leanness*) to assess regions of significance and the overall shape of the estimation. The slope is negative at low

levels of firm inventory leanness but not statistically different from zero ($p > 0.1$), thus a U-shaped effect cannot be inferred (Haans et al., 2016). Rather, the marginal effect of firm inventory leanness is null at low levels and positive exponential at high levels. When supplier inventory leanness is closer to the mean (-1sd, mean, and +1sd), the effect of firm inventory leanness is not statistically significant, thus indicating a positive linear effect on financial performance. The marginal effect of firm inventory leanness squared becomes negative and statistically significant when suppliers become very lean (+2sd and +3sd). Simple slope tests suggest that the effect shape is positive with diminishing returns when *S_inventory leanness* is two standard deviations above the mean and follows an inverted U-shape when *S_inventory leanness* is three standard deviations above the mean. In sum, the results suggest that a firm's inventory leanness has a positive effect on its financial performance and that the marginal benefit of the firm's high inventory leanness is diminished as its suppliers become lean themselves.

Hypothesis 3 predicts a substitution effect of supplier inventory leanness such that the optimal inventory leanness of a firm will decrease as supplier inventory leanness increases. Assessing this hypothesis is dependent on all first-order and second-order terms containing the independent variable, focal firm inventory leanness, such that the hypothesis cannot be accurately assessed using t-statistics from the regression output. The results from Table 3 indicate that, in general, leaner is better. Throughout the majority of the distribution of supplier inventory leanness, an increase in the focal firm's inventory leanness is associated with superior financial performance, and the optimal inventory strategy is for firms be as lean as possible. Only when suppliers are very lean (+3sd) can a firm be considered too lean and its optimal inventory leanness decreases. Thus, H3 is partially supported: Optimal firm inventory leanness decreases only at very high levels of supplier inventory leanness.

As an additional assessment of H3, we implement a turning point shift test which estimates the slope of the turning point for a nonlinear function given an increase in a moderator (Haans et al., 2016). The turning point, which we will denote as *F_inventory leanness**, is the point of the parabola where the slope is 0 and the slope given an incremental increase has a different sign than an incremental decrease. In the case of an inverted U-shaped parabola, *F_inventory leanness** represents the optimal level of focal firm inventory leanness, whereas *F_inventory leanness** in a U-shaped parabola represents the least optimal point. Thus, the turning point shift test is only relevant to test Hypothesis 3 at levels of supplier inventory leanness in which the estimation produces an inverted U-shaped parabola. The shape flip occurs when *S_inventory leanness* = 0.19. This is derived using Equation 2:

$$S\_inventory\ leanness^* = \frac{-\beta_2}{\beta_5} \tag{2}$$

where *S_inventory leanness** represents the level of supplier inventory leanness at which the estimated effect of the focal firm's inventory leanness and financial performance is perfectly linear. As such, a decrease (increase) of supplier inventory leanness from this point will create an (inverted) U-shaped relationship between focal firm inventory leanness and financial performance.

The slope of *F_inventory leanness** given a change in *S_inventory leanness* is represented in Equation 3:

$$\frac{\partial F\_inventory\ leanness^*}{\partial S\_inventory\ leanness} = \frac{\beta_1\beta_5 + \beta_2\beta_4}{2(\beta_2 + \beta_5 S\_inventory\ leanness)^2} \tag{3}$$

If Equation 3 is significantly different from zero at meaningful values of the moderator, a turning point shift is present (Haans et al., 2016). We use Stata's *nlcom* command to estimate the equation at varying levels of supplier inventory leanness. The shape flip occurs when

S_inventory leanness is slightly above the mean (0.1 standard deviations above the mean). Hence, we fix *S_inventory leanness* at +1, +2, and +3 standard deviations. The results are presented in Table 4. A negative coefficient offers support for H3 indicating a decrease in the optimal inventory leanness given an increase in supplier inventory leanness. The coefficient estimates are not statistically significant at +1sd and +2sd. However, at +3sd, the coefficient is negative and marginally significant ($\beta = -0.26$, $p < 0.1$) offering partial support for H3 and reinforcing our finding that the optimal inventory leanness decreases only as suppliers become very lean.

TABLE 4: Turning point shift test

	S_inventory leanness	b	SE	z	p-value
Shape flip	0.19	-	-	-	-
+1sd	1.09	-2.68	3.41	-0.79	0.432
+2sd	2.09	-0.60	0.43	-1.40	0.162
+3sd	3.10	-0.26	0.15	-1.71	0.087

Endogeneity and robustness testing

The identification of supply chain relationships through Compustat Customer Segment is limited to observations where suppliers report customers in annual 10-K filings, and this reporting is only required if the customer accounts for 10% or more of the supplier's annual sales. As such, firms in the dataset generally account for a high portion of the supplier's sales, but the supplier may account for only a small portion of the focal firm's overall purchases. Therefore, the data is skewed toward firm-supplier relationships where the focal firm tends to be larger and likely possess a power advantage over its suppliers. Powerful firms can influence suppliers to conduct favorable actions (Chae et al., 2017) including placing a burden of holding greater inventory (Emery & Marques, 2011). Although we partially account for the dependence

relationships by including controls for firm size, industry concentration, and sales dependence, the non-random construction of the dataset may bias the relationships of interest and give rise to sample selection bias. Sample selection bias is a form of endogeneity in which an omitted variable is correlated with the error term both in the selection equation and the theoretical model (Certo et al., 2016). To account for sample selection bias, we implement Heckman's two-step method which controls for the selection of observations included in the sample (Heckman, 1979).

The first-stage regression models the selection criterion, where the dependent variable is a binary indicator denoting the inclusion of firms in our main analysis (1 = sample inclusion). In this analysis, we include all manufacturing, wholesale, and retail firm-quarter observations listed in the Compustat North America Fundamentals Quarterly database over the sample time frame. A random effects probit model is estimated where the sample inclusion variable is regressed on all focal firm-level variables from the theoretical model. To properly model selection, an additional variable that is absent from the theoretical model should be included in the selection equation (Wolfolds & Siegel, 2018). We expect that firms that are more vertically integrated will procure less from suppliers in the manufacturing, retail, and wholesale industries. Further, we expect that firms that have more diversified products will have a less concentrated supplier base. To this end, we use vertical integration, *F_vertical integration*, and business diversification, *F_business diversification*, as instruments for the first-stage selection regression. Vertical integration is captured using Frésard et al.'s (2020) text-based measure which identifies overlap in the description of a firm's portfolio of products with commodity descriptions for upstream and downstream industries as reported by the Bureau of Economic Analysis input-output tables. Business diversification is measured as the sum of the squared ratio of individual business

segment sales to annual sales (Hendricks et al., 2009). Sales data by business segment is collected from the Compustat Business Segment dataset. Both vertical integration and business diversification are highly significant predictors in the selection equation ($p < 0.01$) but do not explain variations in financial performance ($p > 0.1$) when added in our main regression model.

The second-stage regression replicates the main analysis while accounting for the non-selection hazard from the first-stage selection equation. The non-selection hazard is captured using the inverse Mills ratio and is computed by taking the ratio of the probability density function and the cumulative distribution function using the fitted values of the first-stage probit regression. The inverse Mills ratio is then added to the estimation of Equation 1 to control for potential sample selection bias (Certo et al., 2016). The results of the Heckman analysis are presented in Table 5. In Model 3, the coefficient for *S_inventory leanness* is negative and significant ($\hat{\beta} = -0.001, p < 0.05$) providing additional support for Hypothesis 1. In addition, the coefficient for *S_inventory leanness x F_inventory leanness²* in Model 4 is negative and statistically significant ($\hat{\beta} = -0.002, p < 0.01$) providing further support for Hypothesis 2.

TABLE 5: Heckman estimation results

	(1)		(2)		(3)		(4)	
DV:	Sample		F_ROA		F_ROA		F_ROA	
F_inventory leanness	-0.021	(0.038)	0.007***	(0.001)	0.007***	(0.002)	0.007***	(0.002)
F_inventory leanness²	0.001	(0.002)	-0.001	(0.001)	-0.001	(0.001)	-0.000	(0.001)
F_industry concentration	-0.976***	(0.313)	0.063***	(0.015)	0.061***	(0.018)	0.062***	(0.018)
F_firm size	0.543***	(0.034)	-0.044***	(0.005)	-0.046***	(0.005)	-0.047***	(0.005)
F_sales growth	-0.047	(0.110)	0.023***	(0.003)	0.022***	(0.004)	0.023***	(0.004)
F_industry munificence	4.855***	(0.453)	-0.244***	(0.040)	-0.258***	(0.046)	-0.260***	(0.045)
F_industry dynamism	5.090***	(1.357)	-0.239***	(0.049)	-0.256***	(0.053)	-0.254***	(0.053)
F_R&D intensity	1.620***	(0.332)	-0.284***	(0.026)	-0.283***	(0.026)	-0.284***	(0.026)
F_marketing efficiency	0.204***	(0.048)	-0.005**	(0.002)	-0.005**	(0.003)	-0.005**	(0.003)
F_production efficiency	-0.085*	(0.050)	0.009***	(0.002)	0.009***	(0.002)	0.009***	(0.002)
S_ROA			0.021**	(0.008)	0.020**	(0.010)	0.021**	(0.010)
S_sales dependence			0.012***	(0.004)	0.011**	(0.005)	0.010**	(0.005)
F_sales dependence			0.004	(0.007)	-0.000	(0.007)	0.002	(0.006)
S_industry concentration			-0.012**	(0.005)	-0.008	(0.007)	-0.008	(0.007)
S_firm size			0.000	(0.000)	0.001	(0.001)	0.001	(0.001)
S_sales growth			0.002**	(0.001)	0.002	(0.001)	0.002	(0.001)
F_ROA	1.764**	(0.738)						
F_vertical integration	-16.152***	(4.313)						
F_business diversification	-0.601***	(0.110)						
S_inventory leanness					-0.001**	(0.001)	-0.000	(0.001)
S_inventory leanness x F_inventory leanness							0.000	(0.001)
S_inventory leanness x F_inventory leanness²							-0.002***	(0.000)
Inverse Mills Ratio			-0.067***	(0.009)	-0.069***	(0.010)	-0.069***	(0.010)
Constant	-5.728***	(0.232)	0.506***	(0.053)	0.528***	(0.059)	0.532***	(0.059)
Year fixed effects	No		Yes		Yes		Yes	
Quarter fixed effects	No		Yes		Yes		Yes	
Observations	29,925		3,841		3,214		3,214	
Within R-squared			0.3233		0.3254		0.3301	

All tests are two-tailed: *** p<0.01; ** p<0.05; * p<0.1. Robust standard errors are shown in parentheses. Coefficients of time dummies are not shown due to space constraints. The sample size is reduced in stage 2 regressions due to missing data on stage 1 instrumental variables.

Finally, we conduct a turning point shift test for the inverted U-shaped portion of the estimation. The turning point occurs when *S_inventory leanness* = -0.132, just below the mean. Therefore, we test whether Equation 3 is significantly different than zero when fixing *S_inventory leanness* at the mean, +1sd, +2sd, and +3sd. The results are presented in Table 6. The coefficients are all negative suggesting that an increase in supplier inventory leanness leads

to a decrease in optimal firm inventory leanness. Similar to the main analysis, the estimates are not significantly different than zero at the mean and one standard deviation above the mean. However, the estimates become statistically significant at +2sd and +3sd ($p < 0.05$). These results offer strong support for Hypothesis 3 and suggest that optimal customer inventory leanness decreases as supplier inventory becomes very lean.

TABLE 6: Heckman model turning point shift test

	S_inventory leanness	b	SE	z	p-value
Shape flip	-0.13	-	-	-	-
Mean[1]	0.07	-49.93	226.43	-0.22	0.825
+1sd	1.06	-1.38	1.04	-1.33	0.183
+2sd	2.06	-0.41	0.19	-2.15	0.032
+3sd	3.05	-0.19	0.08	-2.58	0.010

[1]The coefficient at the mean is inflated due to its proximity to point of shape flip where the estimation is nearly a straight line and the turning point lies far above the sample range of F_*inventory leanness*.

Another concern of endogeneity relates to simultaneity. While there is little evidence in the supplier evaluation literature to suggest that inventory (or inventory leanness) is a major consideration when sourcing or evaluating suppliers (Ho et al., 2010), we do acknowledge the possibility of reverse causality such that more profitable firms might choose to partner with less lean suppliers. Since we aggregate supplier-side measures to a given firm-quarter, it is difficult to implement the instrumental variable regression methods that are commonly used in operations management research to address endogeneity concerns. Instrumenting aggregate supply base characteristics is problematic when the outcome of interest is financial performance since both measures are largely a function of managerial decisions (Lu & Shang, 2017). As such, poor instrumentation may induce more bias than it relieves (Ketokivi & McIntosh, 2017; Lu et al., 2018). We, therefore, chose to evaluate simultaneity by instead implementing Granger causality

tests using the *xtgcause* command in Stata (Lopez & Weber, 2017). This method utilizes Dumitrescu and Hurlin's (2012) panel data procedure to test whether past values of x predict y_t. The results suggest that supplier inventory leanness Granger-causes focal firm financial performance ($\tilde{Z}$= 4.24 , p < 0.01), but focal firm financial performance does not Granger-cause supplier inventory leanness ($\tilde{Z}$= 1.16 , p > 0.1). Therefore, reverse causality does not appear to be a concern.

As a series of additional robustness checks, we replicate our main regression analysis with an alternative DV, analysis technique, and sample. First, we test our model using return on sales, *F_ROS*, as the dependent variable of interest. Next, we test our model using random effects regression. Although the random effects technique may yield inconsistent estimates, it is more efficient and considers both within-panel and between-panel variance (Certo et al., 2017). Finally, we replicate our analysis with a new sample by restricting our analysis to dyads where both the supplier(s) and focal firm are manufacturers. The regression results are presented in the Appendix. The analyses yield coefficient estimates that are quantitatively similar to the results presented earlier and offer robust support for the qualitative conclusions of our study.

Discussion and Conclusion

Implications for theory and practice

The primary contribution of this study is the extension of empirical inventory literature beyond traditional firm-level research to include the link between supplier inventory leanness and focal firm financial outcomes. Our focus on the effects of supplier inventory strengthens our understanding of inventory management as a supply chain process (Fawcett et al., 2010). To our knowledge, this is the first study to provide empirical evidence that supplier inventory leanness

has a significant direct effect on a firm's financial performance and that it can greatly alter the relationship between a firm's own inventory leanness and its financial performance. The conclusions of our work, thus, contribute to inventory research and have significant implications for both theory and practice.

We contribute to empirical inventory literature by providing evidence for a boundary condition of the inverted U-shaped effect of inventory leanness on performance outcomes. Although it is well established in operations research that inventory leanness generally has a positive relationship with performance, some studies did not find evidence of an inverted U-shaped effect (e.g. Steinker & Hoberg, 2013). In a similar vein, Eroglu and Hofer (2011) found evidence of an inverted U-shaped effect in only 48% of the sampled industries. Our results suggest that greater supplier inventory can compound or substitute a customer's own inventory leanness. Specifically, the relationship between a firm's inventory leanness and its financial performance moves from a positive exponential effect when suppliers are very unlean to an inverted U-shaped effect when suppliers are very lean. Thus, the marginal benefit of a firm becoming very lean is diminished as the suppliers become lean themselves. Once suppliers become very lean, the inverted U-shaped effect advocated in firm-level inventory theory emerges in which the firm can experience negative effects from being too lean.

Finally, we contribute to supply chain research on the influence of supply chain partners on organizational performance. The success of an organization is substantially influenced by supply chain partners (Ketchen & Giunipero, 2004; Grimm, 2008; Min et al., 2008), and these partners can affect a wide range of outcomes (Vonderembse & Tracey, 1999; Squire et al., 2009; Mackelprang et al., 2018; Dong et al., 2020). Our study extends this stream to include supplier inventory leanness as one key partner characteristic that can benefit or harm customer financial

performance. Further, our focus on the interaction of supplier and customer characteristics builds on recent supply chain research arguing that the success of firm-level strategies and orientations are conditioned on the dynamics of the network of suppliers and customers (e.g. Mackelprang et al., 2018).

The current study not only aids in expanding theory and literature, but also has important implications for practice. First, the study suggests an additional consideration, namely inventory leanness, when sourcing, developing, and evaluating suppliers. Our analysis provides evidence of a direct and negative effect of supplier inventory leanness on focal firm financial performance, all else equal. The finding indicates that lean suppliers may not possess the requisite inventory holdings to efficiently fulfill customer orders and, in turn, adversely affect the customer's operations, order cycle time, and, ultimately, its financial performance. Conversely, firms benefit from having suppliers that are less lean. With pre-negotiated sourcing costs, suppliers cannot pass on the costs of holding more inventory to their customers. As such, firms can enjoy the benefit of having suppliers with large inventories and great customer service capabilities without incurring the associated holding costs.

The effect of supplier inventory leanness, however, differs substantially dependent on the firm's own inventory leanness. In fact, supplier inventory leanness significantly changes the relationship between the firm's inventory leanness and its own performance. Thus, a firm must simultaneously consider the balance of its own inventory-related costs and how their inventory management processes fit with those of its suppliers. In terms of fit, our results suggest that the greatest financial performance can be extracted when suppliers are very unlean while the focal firm is very lean. As suppliers' inventory becomes leaner, the benefits of the firm's own leanness are diminished. However, for the majority of cases the leaner the focal firm the better the

associated performance. It is only when suppliers become very lean and lack requisite inventory to effectively maintain a high level of customer service, that the optimal inventory leanness of the focal firm decreases. In aggregate, the results suggest that managers should generally strive to be lean, and they should only consider adjusting their inventory leanness subject to suppliers' inventory leanness if those suppliers are very lean.

Limitations

There are a number of limitations in the current work which are relevant to note. First, the analysis is restricted to short-term associations between the variables of interest. While our contemporaneous analysis using quarterly observations is consistent with recent empirical inventory research (e.g. Kovach et al., 2015; Udenio et al., 2018; Kroes et al., 2018), it is important to consider how the fit of supplier and focal firm inventories may ultimately affect buyer-supplier relationships and, in turn, longer-term performance outcomes. For example, prior research has noted that powerful supply chain members can shift inventory upstream in the supply chain (Emery & Marques, 2011), and our results suggest that doing so may indeed be beneficial to firm outcomes in the short term. However, such an adversarial approach to inventory management in the supply chain will likely strain the customer-supplier relationship (David & Eben-Chaime, 2003), increase opportunistic behavior (Fawcett et al., 2010), and lead to contentious price negotiations (Aderohunmu et al., 1995). Thus, we encourage future research to study the relational impacts of dyadic inventory policies as these may have longer-term implications for firm performance outcomes.

Another limitation rests in our operationalization of supplier inventory leanness. This measure was aggregated in an attempt to develop a more meaningful representation of the inventory leanness of a firm's portfolio of suppliers. However, with an aggregate measure from

multiple suppliers, we are unable to explore the potential effects of a firm's inventory leanness on its supplier's financial performance. This is another avenue suggested for future research. Indeed, the exploration of both supplier- and customer-side performance implications of inventory leanness in the supply chain will enable research on the appropriation of value generated from superior operational practices.

Conclusion

The current study takes a significant step towards broadening empirical inventory research beyond the firm-level. The econometric analyses provide evidence of a substantial influence of supplier inventory leanness on downstream customer outcomes, both directly and through interaction with the customer's own inventory leanness. This is an important result as it highlights the practical importance of considering inventory leanness when selecting and evaluating suppliers. Further, this research highlights the conditional nature of optimal inventory policy and the need to consider supplier inventory leanness when formulating firm-level inventory decisions. Looking at inventory antecedents and outcomes across supply chain echelons is a fertile ground for empirical operations research and warrants expansion in future research.

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Appendix: Robustness tests

	(1)		(2)		(3)		(4)		(5)		(6)	
DV:	F_ROS		F_ROS		F_ROA		F_ROA		F_ROA		F_ROA	
F_inventory leanness	0.018**	(0.008)	0.019**	(0.008)	0.005***	(0.001)	0.005***	(0.001)	0.006***	(0.002)	0.006***	(0.001)
F_inventory leanness²	-0.001	(0.004)	0.002	(0.003)	-0.000	(0.001)	0.000	(0.001)	-0.000	(0.001)	0.000	(0.001)
S_ROA	0.153**	(0.063)	0.157**	(0.064)	0.032**	(0.014)	0.032**	(0.014)	0.035**	(0.015)	0.035**	(0.015)
S_sales dependence	0.069***	(0.023)	0.065***	(0.022)	0.014***	(0.003)	0.014***	(0.003)	0.015***	(0.003)	0.014***	(0.003)
F_sales dependence	-0.026	(0.080)	-0.013	(0.068)	-0.002	(0.007)	-0.000	(0.007)	0.005	(0.010)	0.008	(0.009)
F_industry concentration	0.132*	(0.079)	0.138*	(0.079)	-0.009	(0.008)	-0.009	(0.008)	-0.003	(0.013)	-0.002	(0.013)
S_industry concentration	-0.050*	(0.026)	-0.055**	(0.026)	-0.010**	(0.005)	-0.011**	(0.005)	-0.007	(0.006)	-0.007	(0.006)
F_firm size	-0.046***	(0.014)	-0.046***	(0.014)	-0.001	(0.001)	-0.001	(0.001)	-0.009***	(0.002)	-0.009***	(0.002)
S_firm size	0.003	(0.003)	0.003	(0.003)	-0.000	(0.000)	-0.000	(0.000)	0.001	(0.001)	0.000	(0.001)
F_sales growth	0.075***	(0.025)	0.076***	(0.026)	0.015***	(0.003)	0.015***	(0.003)	0.013***	(0.004)	0.014***	(0.004)
S_sales growth	0.007	(0.010)	0.010	(0.010)	0.002*	(0.001)	0.003*	(0.001)	0.002	(0.001)	0.003*	(0.001)
F_industry munificence	0.129	(0.079)	0.122	(0.079)	0.024*	(0.014)	0.023	(0.014)	0.023	(0.022)	0.022	(0.022)
F_industry dynamism	-0.327	(0.302)	-0.317	(0.301)	-0.070	(0.051)	-0.069	(0.051)	-0.141*	(0.078)	-0.142*	(0.077)
F_R&D intensity	-1.432***	(0.164)	-1.436***	(0.162)	-0.155***	(0.019)	-0.155***	(0.019)	-0.188***	(0.024)	-0.188***	(0.024)
F_marketing efficiency	0.033***	(0.009)	0.034***	(0.010)	0.006***	(0.001)	0.006***	(0.001)	0.010***	(0.002)	0.010***	(0.002)
F_production efficiency	0.014*	(0.008)	0.014*	(0.008)	0.002*	(0.001)	0.002*	(0.001)	0.002	(0.002)	0.002	(0.002)
S_inventory leanness	-0.005*	(0.003)	-0.000	(0.004)	-0.001**	(0.001)	-0.001	(0.001)	-0.001*	(0.001)	0.000	(0.001)
S_inventory leanness x F_inventory leanness			-0.003	(0.005)			-0.000	(0.001)			0.000	(0.001)
S_inventory leanness x F_inventory leanness²			-0.009**	(0.004)			-0.001**	(0.000)			-0.001***	(0.000)
Constant	0.417***	(0.084)	0.416***	(0.084)	0.029***	(0.008)	0.029***	(0.008)	0.085***	(0.013)	0.084***	(0.013)
Year fixed effects	Yes		Yes		Yes		Yes		Yes		Yes	
Quarter fixed effects	Yes		Yes		Yes		Yes		Yes		Yes	
Observations	4,157		4,157		4,157		4,157		3,367		3,367	
R-squared	0.2285		0.2336		0.0952		0.097		0.2211		0.2245	

All tests are two-tailed: *** p<0.01; ** p<0.05; * p<0.1. Robust standard errors are shown in parentheses. Coefficients of time dummies are not shown due to space constraints. Panels 1-2 use ROS as an alternative DV, panels 3-4 use random effects panel regression, and panels 5-6 restrict the sample to manufacturing dyads only.

III. Essay 2: Supply Chain Representation on the Board of Directors: An Empirical Investigation of Firm Performance and Agency Costs

Introduction

The board of directors (BoD) is a powerful group at the highest-level of organizational leadership that has a major influence on firms' strategy formation and key hiring decisions and, thereby, firm success (Pearce & Zahra, 1992; Withers et al., 2012a). BoD composition research is one of the most prominent streams in the management literature (Hillman & Dalziel, 2003; Withers et al., 2012a; Tihanyi et al., 2014), and the key focus of such research is on the board's function to monitor management and mitigate managerial agency[1] (Daily et al., 2003; Lynall et al., 2003). The general assumption is that outside directors, those unaffiliated with the organization, more effectively monitor management than inside directors who are employed by the organization (Ryan & Wiggins, 2004). Another important function of directors is the provision of external resources (Hillman & Dalziel, 2003). Outside directors offer an opportunity to span firm boundaries (Ireland & Webb, 2007), co-opt with interdependent entities in the external environment (Pfeffer, 1972), and access valuable resources such as director expertise, information, and connections (Yoshikawa & Hu, 2017).

The focus of this research is on supply chain directors—outside directors whose primary employers are a focal firm's current customer (customer director) or current supplier (supplier director). Inviting a representative from a customer or supplier to serve on the BoD has been called a common practice in prior literature (Baysinger & Butler, 1985; Hillman & Dalziel, 2003), even though prior research has generally concluded that supply chain directors are found in less than 5% of US firms (Davis, 1996; Fee et al., 2006; Dass et al., 2014). Despite its rarity,

[1] Managerial agency refers to a manager, generally the CEO or other member of the top management team, acting in manner to achieve personal interests that do not align with those of the owners or shareholders of the firm that employs him or her. We will discuss agency theory and the role of the BoD in greater detail in the Theory and Hypothesis Development section.

offering an individual drawn from a supply chain partner a position on the BoD has potential to add unique value to the firm. Suppliers and customers are important stakeholders that can bring critical information and expertise to the BoD on upstream and downstream conditions relevant to organizational strategy and operations (Minnick & Raman, 2017). Further, offering a directorship position provides a visible signal of commitment to the customer or supplier which can entrench the relationship (Hillman et al., 2001) and drive interfirm collaboration. Anecdotal evidence supports this notion: Microsoft, for example, invited the CEO of Seagate Technology, a major supplier, to serve on its BoD between 2012-2014. During this time period, transaction values between the two firms increased nearly threefold, and the firms later went on to jointly launch hard drives designed specifically for Microsoft's video game console.

Supply chain directors are classified as 'gray directors' because they represent a stakeholder that has substantial dealings with the focal firm. As such, the director is not fully independent and may have conflicts of interest when performing tasks on the focal firm's BoD (Withers et al., 2012a). Supply chain partner firms have overlapping interests and share the goal of maximizing value creation across the supply chain, but they are in direct competition to appropriate that value (Wagner et al., 2010; Arslan, 2018). Thus, supply chain directors may find themselves in an agency relationship where the best interests of the principal—i.e., the focal firm's shareholders—conflict with the best interests of the director's employer. At the same time, supply chain directors have the ability to influence strategic decisions (Gulati & Westphal, 1999), executive appointments (Westphal & Frederickson, 2001), and access proprietary information (Minnick & Raman, 2017). The combination of potentially diverging interests, access, and influence enables opportunistic behaviors on the part of supply chain directors that make their appointment a potentially risky proposition. At worst, supply chain directors could

leverage their position to benefit their employer firm at the expense of the focal firm (Scott & Lane, 2000; Hillman et al., 2008).

Given the tension that exists between the potential benefits and risks of supply chain director appointments, it is vital to study the performance implications of a customer or supplier representative serving on the BoD and to explore the factors that can mitigate the risks of director agency[2] arising from this type of board appointment. Specifically, we address the following research questions: 1) How does supply chain representation on the BoD affect focal firm performance? 2) How can a focal firm structure the BoD to mitigate director agency problems that arise from the appointment of a supply chain director? Drawing on agency theory as well as the BoD and supply chain literatures, we develop a set of theoretically grounded hypotheses to address these research questions. We then test these hypotheses using a large panel dataset compiled from multiple archival sources including Compustat North America Fundamentals Annual, FactSet Revere, Institutional Shareholder Services, and Execucomp.

This research makes several contributions to extant literature and theory. First, we contribute to the supply chain and BoD literature streams by extending research on supply chain directors. While research has begun to study supply chain representation on the BoD (e.g., Minnick & Raman, 2017; Bommaraju et al., 2019), research in this area is rare apart from a few notable exceptions. Our research adds to this developing stream of research by distinguishing between supplier directors and customer directors, thus allowing us to gauge the divergent influence on firm performance. Indeed, our empirical results suggest that supplier directors are more likely to lead to increased firm performance, all else equal, while customer directors are

[2] In the case of director agency, the director is considered a self-serving agent in which their behavior does not necessarily align with the best interest of the owners or shareholders of the firm whose board they serve on.

only beneficial in terms of their effect on firm performance when they are properly incentivized and monitored. Further, our study is among the first to focus on the risks associated with supply chain directors and identify mechanisms to better control supply chain director agency.

Our focus on the agency relationship between supply chain directors and the focal firm also contributes to agency theory. As noted previously, the BoD is generally considered a mechanism to mitigate agency costs such that directors act as the monitors of upper management (Withers et al., 2012b). We build on extant literature by conceptualizing supply chain directors as self-serving agents themselves, thereby acting as a potential source of agency conflicts and detracting from a firm's performance. Our theoretical framework indicates that the appointment of supplier and customer directors creates a conflict of interest which warrants attention to mitigate supply chain director agency problems. We identify increased outcome-based director compensation as a means through which a firm can reduce supply chain director agency and achieve superior firm performance outcomes. Further, the empirical results suggest that an increased number of inside directors on the board can better monitor customer directors to enhance performance outcomes. We, thus, refine theory on director agency and identify mitigation mechanisms that are employable by the firm.

Finally, our research has major implications for firms and policy makers. Our findings suggest that inviting a supply chain partner to serve on the BoD is a strategic tool that can lead to superior performance. Supply chain directorships act as a visible signal of commitment to the partner firm (Hillman et al., 2001) which can secure greater access to critical supply chain resources such as information, procurement spend, or materials, and convey legitimacy (Haynes & Hillman, 2010). However, 'gray' supply chain directors are a double-edged sword. The potential risks of director agency can negate any such value and must be considered when

selecting directors and deciding on the structure of the board. Moreover, as corporate scandals have garnered tremendous political and regulatory attention, motivating significant changes to organizational governance policy (Hillman et al., 2008) and greater board accountability (Bommaraju et al., 2019), supply chain directors with potential conflicts of interest present a risk to shareholders and warrant the attention of policy makers.

Literature Review: Stakeholder and Supply Chain Directors

Directors are often drawn from stakeholder groups outside the boundaries of the firm (Hillman et al., 2008). Stakeholders represent any group or individual that is affected by an organization's actions or success (Freeman, 1984). These stakeholders can include suppliers, customers, government officials, employees, community members, financial institutions, law firms, and many others. Appointing a stakeholder to the BoD is considered a "formal mechanism" that signals the importance of and commitment to the stakeholder group (Mitchell et al., 1997). This tie to the stakeholder through board appointments can both benefit the stakeholder group and the focal firm. For example, board representation gives the stakeholder an active voice and should, thus, influence firm behavior to better represent the interests of that stakeholder (Hillman et al., 2001). In reverse, the stakeholders can bring expertise and valuable information to the board in forming organizational strategy to meet environmental demands (Baysinger & Butler, 1985).

Stakeholder appointment to the BoD is garnering increased attention in practice and aiding in the provision of important resources. Empirically, beneficial outcomes have been identified from the board representation of different stakeholder groups such as community

directors, financial institutions, and politicians. For example, community directors (drawn from academia, government, religious affiliates, nonprofits, or nonbusiness professionals) were linked to higher stakeholder social responsibility scores (Hillman et al., 2001). Firms with political experience on the board were found to be more likely to receive government contracts (Goldman et al., 2013) and achieve significantly higher financial performance when the firm operates in a highly regulated industry (Hillman, 2005). Further, firms with board ties to financial institutions are shown to be more successful garnering corporate loans (Stearns & Mizruchi, 1993).

Supply chain partners are also important stakeholders that can hold directorship positions, but this is notably less common. Prior empirical studies have found this to occur in as little as 1.2% of the sampled firms (Dass et al., 2014) and not exceeding 5% (Minnick & Raman, 2017). Fee et al. (2006) found that it is slightly more prevalent for customers to be represented on the BoD than suppliers, and the likelihood of appointment is increased given the customer is larger, accounts for a larger portion of sales, invests in more relationship-specific assets (Minnick & Raman, 2017), or holds an equity stake in the focal firm (Fee et al., 2006). Conversely, Bommaraju et al. (2019) found that approximately a third of their sampled S&P 900 B2B firms had directors affiliated to an entity that purchased goods or services from the focal firm, and these connected customers rarely exceeded 5% of the firm's revenues.

In general, supply chain representation on the BoD has been linked to beneficial outcomes. For example, firms with supply chain directors were associated with increased financial performance (Dass et al., 2014) and increased relationship-specific asset investment in the buyer-supplier dyad (Minnick & Raman, 2017). Further, Bommaraju et al. (2019) found directors with customer affiliations to be associated with enhanced firm performance, particularly when demand uncertainty is high and the focal firm is less diversified. Conversely,

Hillman et al. (2001) identified both customer and supplier directors but found no significant effect on the customer's or supplier's social responsibility outcomes.

Theory and Hypothesis Development

Supply chain directors and resource provision

One of the main functions of the BoD is the provision of resources (Haynes and Hillman, 2010), and firms can utilize board positions to co-opt with interdependent groups in the environment (Pfeffer, 1972; Howard et al., 2016; Zona et al., 2018). A director sourced from an interdependent organization can increase cohesion among the key decision-makers of the connected groups (Drees & Heugens, 2013), entrench the relationship (Hillman et al., 2001), and alleviate resource uncertainties (Pfeffer & Salancik, 1978; Pearce & Zahra, 1992). The perspective of employing the BoD as a co-opting mechanism has been supported in prior literature. For example, greater environmental uncertainty is associated with greater outsider representation on the board (Pearce & Zahra, 1992). Highly regulated industries are more likely to invite a director with political experience to serve on the board (Hillman, 2005). And, most relevant to this study, firms that rely on a given customer for more of its total sales are more likely have that customer represented on the board (Minnick & Raman, 2017).

Firms are dependent on supply chain partners as they play an integral role in the implementation of firm strategies (Grimm, 2008) and contribute to the firm's overall success (Ketchen & Hult, 2007). Inviting a supplier or customer representative to serve on the BoD will benefit the focal firm by securing the supply of critical inputs or finances (Bommaraju et al., 2019) and safeguarding relationship specific investments. Indeed, maintaining important

exchange relationships is critical to firm success because relationship dissolution can be associated with significant investments of time and money to find an alternative supplier or customer (Mir et al., 2016; Chen et al., 2013).

In addition to securing the relationship and existing exchange, a supply chain director can facilitate the provision to valuable information. Outside directors drawn from an interdependent group, such as supply chain partners, have greater knowledge of the focal firm and its environment, possess more relevant information, and provide better council (Joh & Jung, 2018). Further, a supply chain director serves as a boundary spanner opening a channel for regular communication and access to the relevant information held by the connected firm (Burt, 1980; Davis, 1996). Repeated interactions through the BoD can transfer tacit knowledge, mitigate information asymmetry, and lend to a greater understanding of connected firms' challenges and motives (Mizruchi, 1996; Drees & Heugens, 2013). Therefore, supply chain directors can provide an information advantage by providing relevant insight and knowledge of industry conditions at other levels of the supply chain (Dass et al., 2014).

The interaction of supply chain partners through a customer or supplier director position, can provide expertise and insight that informs organization strategies and operations. First, a customer has greater knowledge of evolving customer requirements and future demand levels. A customer director can transfer such information and, in turn, allow the focal firm to be more responsive to changing demands, improve the alignment of production and demand, decrease inventory obsolescence, and improve its competitive position (Flynn et al., 2010; Cao & Zhang, 2011). Suppliers, on the other hand, have knowledge of factor market conditions and operational bottlenecks. Further, suppliers have a deep understanding of the components and materials relevant to new product development (Tsai, 2009). Therefore, a supplier director can transfer this

knowledge to the focal firm stimulating innovation (Azadegan & Dooley, 2010) and allow for early detection of supply disruptions such as delays, shortages, and other factors that affect the inbound flow of materials (Minnick & Raman, 2017).

Finally, inviting a customer or supplier to serve on the BoD is a collaborative mechanism that can lead to beneficial performance outcomes. Director positions serve to integrate organizations and align organizational strategy and interests (Ireland & Webb, 2007). This visible sign of commitment allows the supplier or customer to actively participate in the formation of focal firm strategy (Johnson et al., 1996; Forbes & Milliken, 1999) and encourage actions reflecting a more aligned fit with the interests of the supplier or customer firm (Hillman et al., 2001). Supply chain director positions show a great level of commitment to the partner and enhance cooperation and social connectedness among the top decision-makers in the supply chain dyad (Gulati, 1995; Drees & Heugens, 2013; Minnick & Raman, 2017). Thus, supply chain directors are an extreme form of collaboration that facilitate the interaction of top managers and covers high-level strategic issues.

Supply chain collaboration has been described as the ultimate core capability (Min et al., 2005) and a precursor to maximize value creation and firm performance (Stank et al., 2001; Hardy et al., 2003; Flynn et al., 2010). Empirically, collaboration and integration activities have been applied to a myriad of outcomes and shown to benefit firms in terms of financial, operational, and relational performance. Supply chain collaboration has been linked to greater financial performance through decreased costs (Aviv, 2001; Aviv, 2007), profitability (Min et al., 2005), and revenue growth (Rai et al., 2006). Further, operational advantages of collaboration include increases to logistical performance, (Stank et al., 2001), operational agility (Narayanan et al., 2015), and operational performance (Flynn et al., 2010; Zacharia et al., 2011). Finally,

collaboration has been found to increase the relational performance of the supply chain (Zacharia et al., 2011), expand the exchange relationship (Min et al., 2005), facilitate the development of trust (Narayanan et al., 2015), and limit opportunistic behavior (Jap & Anderson, 2003; Narayanan et al., 2015; Cao & Zhang, 2011). Therefore, we posit that supply chain directors can accrue many benefits to a focal firm by facilitating collaboration.

To summarize, supply chain representation on the BoD allows a focal firm to access valuable resources from the connected partner. Specifically, this mechanism can allow a firm to strengthen the exchange relationship, access valuable information, and facilitate collaboration. We hypothesize that these benefits will be expressed in the form of superior financial performance outcomes. Stated formally:

> **Hypothesis 1:** A supplier director serving on a focal firm's board of directors is positively associated with focal firm performance.
>
> **Hypothesis 2:** A customer director serving on a focal firm's board of directors is positively associated with focal firm performance.

Agency theory and supply chain director agency

Agency theory is focused on the agency relationship in which *principals* delegate duties to *agents* to act their behalf (Eisenhardt, 1989). When goals conflict between the two parties, agents are likely to take actions that maximize their own utility rather than act in the best interest of the principals (Lassar & Kerr, 1996). This agency problem occurs because the principals cannot costlessly write and enforce contracts to ensure the alignment of agent behavior to match principal welfare (Jensen & Meckling, 1976). Applied to organizational governance, agency problems, and the associated costs to mitigate these problems, arise when there is a separation of

ownership and control of the firm (Fama & Jensen, 1983). This is a commonplace in public firms in which shareholders (principals) carry the risk and claim to residual gains tied to the performance of the firm but do not actively participate in organizational decision-making.

To date, the majority of agency theory research has focused on managerial agency and mechanisms that firms can take to mitigate agency problems between shareholders (principals) and top management (agents). Common agency costs include contracting, monitoring, and the use of incentives designed to curb managerial self-interest behavior (Jensen & Meckling, 1976; Fama & Jensen, 1983; Eisenhardt, 1989). For example, managerial self-interest behavior can be reduced by aligning principal-agent interests through compensation agreements such as stock and option awards (Himmelberg et al., 1999). Further, the BoD acts as a control system charged to monitor, evaluate, reward, and punish management to avoid upper management opportunism (Pearce & Zahra, 1992; Forbes and Milliken, 1999). Agency theory and corporate governance research was fueled by highly publicized examples of corporate fraud and resulted in substantial reforms to BoD composition over the past couple decades to curb managerial opportunism and protect shareholders. For example, the Securities and Exchange Commission along with the NYSE and NASDAQ now require boards to have a majority of independent directors, which in theory better monitor upper management.

Significantly less research, however, has focused on director agency. Despite this, a similar agency relationship exists where principals delegate duties and control to directors (Deutsch et al., 2010). These directors have a fiduciary duty to the principals and are expected to act in the best interest of the firm and its shareholders (Fama & Jensen, 1983; Campbell et al., 2012), but it is recognized that directors have different roles, identities, motivations, and incentives outside of the focal organization that influence their boardroom behavior (Lynall et

al., 2003; Hillman et al., 2008; Withers et al., 2012b; Yoshikawa & Hu, 2017). For example, in a case study by Garg and Eisenhardt (2017), a CEO noted that outside directors serving of the board had conflicts of interest related to their external ventures such that it influenced the directors' boardroom behavior to the detriment of the focal firm. We argue that supply chain directors present a clear conflict of interest with the focal firm, and that director agency problems are likely to arise (Hillman et al., 2008; Dass et al., 2014; Minnick & Raman, 2017; Bommaraju et al., 2019).

Beyond research generally assuming that inside directors have relationships with peer executives that temper their motivation to effectively monitor firm management (Johnson et al., 1996), the literature has generally ignored the motivation and incentives of the directors themselves (Hillman & Dalziel, 2003). A director's motivation and behavior are largely dependent on what is driving them to become engaged and how his or her actions are held accountable (Roberts et al., 2005; Hillman et al., 2008). Supply chain directors are likely to identify stronger with their home firm (supplier or customer firm) affecting their motivations and actions on the board (Scott & Lane, 2000). Directorships are a source of high prestige, yet the role of an outside director is on a part-time basis (Yoshikawa & Hu, 2017) and typically less visible or rewarding relative to their primary occupation. Thus, the majority of economic and status outcomes a supply chain director receives are derived from his or her home firm (Fama & Jensen, 1983), and as a result director loyalty is stronger to his or her home firm. Given that the focal firm and supply chain director's home firm are inherently linked in a transactional relationship, a supply chain director will consider the relative impact on his or her home firm when making decisions on the board.

The interlocked supplier and customer firms are distinct organizations. Although, they possess some degree of motivational overlap and collaboration, their goals are distinct and partially conflict (Lassar & Kerr, 1996; Zsidisin & Ellram, 2003; Narayanan & Raman, 2004). Specifically, in terms of value appropriation, vertical exchange partners are in direct competition to negotiate the greatest share of earnings (Wagner et al., 2010; Arslan, 2018). Therefore, conflicting motivations weighing on a supply chain director from the focal and home firm result in the creation of its own agency problem. Directors could leverage their position on the board to shape focal firm actions toward the supply chain partner's interests and private benefits (Hillman et al., 2008). For example, the supply chain director may misappropriate information to negotiate better contractual terms with the focal firm or even transmit this information to competitors (Dass et al., 2014). Further, supply chain directors may push strategies or leadership appointments which better represent their home firms interests at the expense of the focal firm.

The appointment of a supply chain director gives the customer or supplier a platform to engage in high-level decision-making and directly influence firm actions. This abundance of influence magnifies the potential for opportunism and adverse effects on the focal firm (Jensen, 1986; Zona et al., 2018). Highly embedded supply chain relationships have both "bright and dark sides" (Gulati & Westphal, 1999) because collaboration requires firms to lose some control to their partners (Stank et al., 2001) and, thus, open themselves up to partner opportunism (Villena et al., 2011). Despite the potential benefits of a supply chain director, agency theory highlights the potential hazards of such a BoD appointment that may diminish or even outweigh any value generated.

Just as firms can structure the agency relationship to mitigate managerial agency, firms can structure the BoD to mitigate director agency (Roberts et al., 2005). Specifically, we

hypothesize how firms can structure the BoD to enhance supply chain director monitoring and incentives and, in turn, achieve higher firm performance. First, one of the main methods of deterring agency problems is through the use of a monitoring system (Jensen & Meckling, 1976). Monitoring systems serve to ratify major decision-making initiatives and measure the performance of decision-making agents (Fama & Jensen, 1983). This is typically done via organizational hierarchy such that lower management monitors workers, middle management monitors lower management, and upper management monitors middle management. However, at the highest echelon of management such as the CEO, hierarchy fails because there are no other higher-level agents. Thus, the BoD acts as a separate body that monitors the top management team (Fama & Jensen, 1983; Forbes & Milliken, 1999). Although directors are not generally as powerful as the CEO in affecting organizational action, the utilization of a BoD allows for the decision-making process to be split such that the CEO cannot both implement and ratify the same decision.

If we consider director agency, hierarchy also fails as a monitoring system. Boards of directors operate behind closed doors (Graffin et al., 2011; Li et al., 2018), and directors are rarely subjected to performance evaluations (Sonnenfeld, 2002). Because of this, there are few mechanisms to monitor and control director actions beyond the specific dynamics on the board itself. Fama & Jensen (1983) refer to mutual monitoring systems as a process where agents at the same level interact, transmit decision information, and use this information as a way to monitor each other. Given that boards act and make decisions as a group, directors interact with each other on a regular basis and can act to monitor each other. There is limited research on director mutual monitoring systems, largely due to the lack of access to view and study boardroom interactions. However, one notable exception is Golden-Biddle and Rao's (1997) study of a large

non-profit. The researchers observed mutual monitoring of board members as one director raised concerns of excessive travel expenses from other board members. The concerns spurred a budget review meeting and resulted in changes to limit future board member travel expenses.

We argue that board composition can influence the effectiveness of director mutual monitoring systems. While director independence is generally considered a requisite to more effectively monitor management, this is not necessarily the case if we consider the monitoring of supply chain directors. Effective monitoring of the decision process requires specific knowledge relevant to the decision and the decision-maker (Fama & Jensen, 1983). In other words, individuals will be better monitors if they are knowledgeable about what they are monitoring and who they are monitoring. Outside directors tend to lack interaction with any other members of the firm outside of top management and other outside directors (Veltrop et al., 2018). They work on a part-time basis and rarely exceed ten full days per year devoted to their duties as a director (Davis, 1993). Therefore, outside directors divide attention with outside appointments, are less knowledgeable of the firm, are often unprepared or even abstain from board discussions (Carpenter & Westphal, 2001).

Conversely, inside directors possess specific knowledge on the organization's activities (Fama & Jensen, 1983). Inside directors devote significantly more time to the focal firm than outside directors (Davis, 1993). They are employees of the firm with regular interactions with members across different functional areas of firm activities. They, therefore, are more familiar with firm operations, threats, challenges, relationships, uncertainties, and negotiations needed to effectively fulfill the monitoring role (Arthurs et al., 2008). As such, inside directors can better monitor of supply chain directors, and their place in the boardroom can more effectively mitigate supply chain director agency. For example, inside director specific knowledge will lead to better

recognition of opportunistic behavior from a supply chain director at the expense of the focal firm. Further, inside director knowledge of contentious points of negotiation will help protect information leakage that the supply chain director could take back to his or her home firm to negotiate more advantageous contracts. We, thus, propose that boards with a greater number of inside directors will enhance the value of the customer and supplier directors.

Hypothesis 3a: The number of inside directors positively moderates the relationship between a supplier director serving on a focal firm's board of directors and focal firm performance.

Hypothesis 3b: The number of inside directors positively moderates the relationship between a customer director serving on a focal firm's board of directors and focal firm performance.

Agency problems arise when the goals of principals and agents do not align. One solution to this misalignment is to entice the agents with incentives tied to outcomes desired by the principals (Fama & Jensen, 1983). Indeed, the use of outcome-based compensation such as equity and option awards are commonly used in managerial contracts (Dalton et al., 2003). These incentives provide the agent a claim to a portion of gains tied to the performance of the organization and, in turn, promote self-interest behavior congruent to the interests of shareholders (Fama & Jensen, 1983; Zajac & Westphal, 1995; Himmelberg et al., 1999). Thus, organizations can employ outcome-based compensation to direct agent attention away from other stakeholders and motivate behavior that supports greater performance of the focal firm (Deutsch & Valente, 2013).

Director compensation can similarly be used to limit director agency problems by providing incentives aligned with organizational goals (Deutsch et al., 2010). Outside directors can receive fixed payments in the form of an annual retainer and a fee for each board meeting as well as performance-based compensation in the form of bonuses, stock awards and stock options (Ryan & Wiggins, 2004). Director equity and other outcome-based compensation can vary greatly firm to firm (Deutsch & Valente, 2013), but a survey of large US firms found that outcome-based incentives account for nearly half of director total compensation (Longnecker, 2004). Directors vary in their motivation and dedication to board duties (Veltrop et al., 2018), but outcome-based compensation plans can help to increase effort and curb opportunistic behavior (Hambrick & Jackson, 2000; Kang & Zaheer, 2018). For example, outside director compensation has been found to increase director monitoring vigilance and enhance firm performance (Maug, 1997; Magnan et al., 2009; Deutsch & Valente, 2013).

A supply chain director has competing motivations to serve their home firm and the focal firm whose board they sit on (Scott & Lane, 2000; Hillman et al., 2008). At the same time, the director is a self-serving agent who can be induced to act in certain ways by applying incentives that align with the goals of the focal firm (Ryan & Wiggins, 2004). Utilizing performance-based incentives in the director's compensation serves to detract attention from the supply chain directors' home firm and instead focus on adding value to the focal firm (Deutsch & Valente, 2013). Thus, we hypothesize that outcome-based director compensation will limit supply chain director agency and enhance focal firm financial performance. The research model is presented in Figure 1.

Hypothesis 4a: Outcome-based director compensation positively moderates the relationship between a supplier director serving on a focal firm's board of directors and focal firm performance.

Hypothesis 4b: Outcome-based director compensation positively moderates the relationship between a customer director serving on a focal firm's board of directors and focal firm performance.

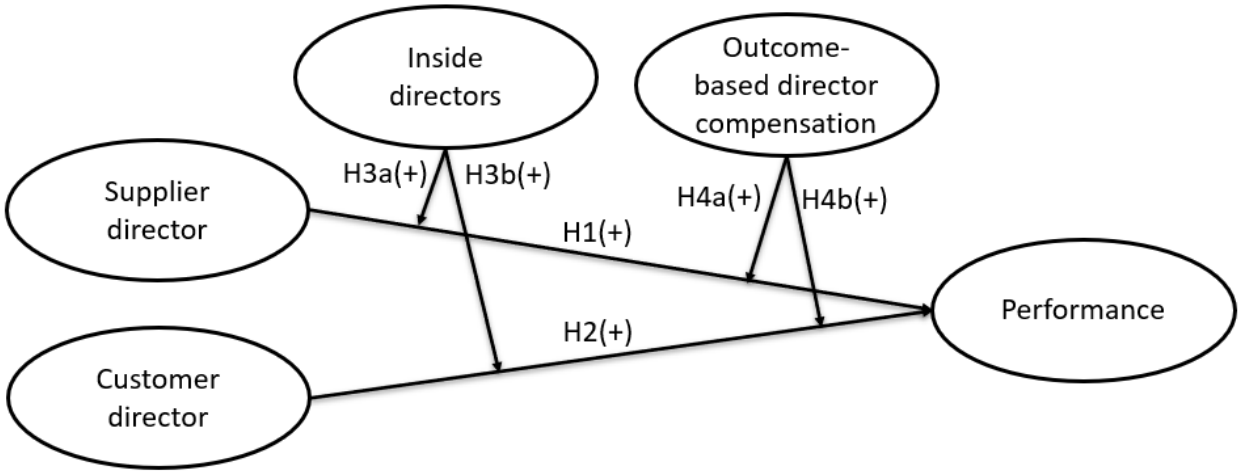

FIGURE 1: Research Model

Methodology

Data and sample

To test our empirical hypotheses, we compiled a panel dataset of publicly held U.S. firms collected from multiple archival sources. The unit of analysis is the focal firm-year, and our focus on supply chain directors limits the sample to firms in which we can capture both director-level information and supply chain relationships. We, first, started by identifying firms listed in the Institutional Shareholder Services (ISS) dataset. This director-level dataset is limited to S&P

1500 firms and is used to identify directors' primary employers and capture aggregate board-level data. Next, we match these firms to the FactSet Revere dataset which is used to identify supply chain relationships. FactSet identifies suppliers and customers released by companies from primary sources such as 10-k filings, investor reports, and other forms of corporate disclosure. Then, we merge in firm-level financial data from the Compustat Fundamentals Annual dataset and director compensation data from Execucomp.

The resulting dataset covers a time period of 2007-2019 and consists of 12,336 firm-year observations with full information to construct our theoretical model. The sample consists of 1,641 unique focal firms with an average panel length of 7.5 years. There are no restrictions on industry memberships, for lack of a theoretical reason, and the only limitation placed on the sample is the availability of data. As such, the sample is limited to S&P 1500 firms but covers a very diverse range of industries including all two-digit NAICS sectors with the exception of agriculture (NAICS code 11) and management of companies and enterprises (NAICS code 55). In total, there are 428 unique six-digit NAICS industries represented in the sample. 42.2% of the sample consists of manufacturing firms, followed next by finance and insurance (10.1%), retail (6.6%), real estate rental and leasing (6.2%), and wholesale (4.3%).

Dependent variable

The dependent variable of interest is firm performance. We measure this using Tobin's Q (*TobinsQ*), calculated as the ratio of the firm's market value divided by total assets. Market value is captured as the sum of a firm's common stock, preferred stock, inventories, and debt minus current assets (Modi & Mishra, 2011; Lu & Shang, 2017). Tobin's Q is a market-based measure that factors in both short-term performance and forward-looking expectations of future performance, growth, and valuation. As such, Tobin's Q is more appropriate than accounting-

based measures (i.e., ROA or ROA) because the BoD influences firm performance through the implementation of higher-level strategies which often have a longer-term horizon to create and capture value (Bommaraju et al., 2019). Further, accounting based measures are influenced by major differences in risk and regulations, creating bias when comparing a diverse range of industries (Dezső & Ross, 2012; Bommaraju et al., 2019).

Independent variables

To identify supplier and customer directors on a firm's BoD, we compare each of the focal firm's directors' primary employers (obtained from ISS) to the firm's direct customers and suppliers (obtained from FactSet) in the given period. Firm names are listed inconsistently both within and between datasets complicating the process and increasing the potential for measurement error. As such, we follow recent research combining both human and automated processes by utilizing a fuzzy string matching process with manual verification to code instances of overlap (Lu & Shang, 2017). The overlapping observations were coded as a supplier director (S*uppDirector*) if a director's primary employer is matched to a direct supplier or as a customer director (*CustDirector*) if a director's primary employer is matched to a direct customer. All observations were aggregated at the focal-firm level and the IVs are operationalized as binary variables (Minnick & Raman, 2017; Bommaraju et al., 2019). "1" indicates the presence of at least one identified customer (supplier) director in a given period while "0" indicates no customer (supplier) director among in the given period.

Our measure of supplier and customer directors is similar to prior research but differs due to our focus on the directors' primary employer constituting a direct customer or supplier. For example, Minnick and Raman (2017) used the Boardex dataset to identify overlap in directors' executive and board appointments at supply chain partners, but this captures both director

interlocks (the focal firm shares an independent director with a supply chain partner) and instances a where a director's primary employer is the focal firm and acts as a supply chain director on the partner's board. Conversely, Bommaraju et al. (2019) content analyzed firm 10k reports and captured the disclosure of director affiliations to customer firms. This is much more common and can consist of affiliations through familial or investment ties to the supply chain partner. For example, using this technique would classify Bill Gates as both a supplier and customer director on Microsoft's board in 2013 because Microsoft had both made purchases from and sold to Corbis Corporation, where Bill Gates was the sole shareholder. By restricting the capture to the instances where a director's primary employer is a direct supplier or customer firm, we are better able to isolate instances where the director is drawn from the partner firm rather than the firms having a shared director or a shared affiliation.

Our two moderator variables include inside directors and outcome-based director compensation. We capture inside directors (*InsideDirectors*) as a count of inside directors on the focal firm's BoD (Boivie et al., 2016). Further, we measure outcome-based director compensation (*OutcomeBased*) by taking the sum of directors' equity and option awards divided by total director compensation (Malenko & Shen, 2016). Director compensation is obtained through the Execucomp dataset and the measures are calculated in aggregate for all members of the BoD.

Control variables

We control for a number of factors at the firm-level, industry-level, and board-level that can influence firm performance. A firm's size and growth are common controls when predicting performance outcomes. Thus, we control for firm size (*FirmSize*) and sales growth (*SalesGrowth*) measured as the natural logarithm of total assets (Dong et al., 2020) and the

percentage change in annual sales from the prior year (Kim & Henderson, 2015), respectively. Similarly, a firm's performance is influenced by R&D intensity and asset efficiency. As such, we control for R&D intensity (*R&DIntensity*), measured as R&D expenses divided by sales (Dong et al., 2020). Finally, we include asset turnover (*AssetTurnover*), measured as sales divided by total assets, in the model to account for firm asset efficiency (Kim & Henderson, 2015).

Next, we control for industry factors that may influence performance outcomes. We control for industry munificence (*IndMunificence*) which refers to the level of resources available to the industry to support growth (Dess & Beard, 1984). Further, we account for industry dynamism (*IndDynamism*) which refers to the level of unpredictability in the industry (Dess & Beard, 1984). We measure munificence and dynamism using the technique outlined by Boyd (1995). First, industry sales is regressed on time over a rolling 5-year window to capture the rate of industry sales growth. Industry munificence is measured using the regression coefficient divided by mean industry sales during the rolling window. Industry dynamism is captured as the standard error from the regression divided by mean industry sales during the rolling window.

Given our focus on the BoD, we control for a variety of board characteristics including board size, CEO duality, board tenure, and gender ratio. Board size (*BoardSize*) refers to the number of members on the BoD (Lu & Shang, 2017). CEO duality (*CEODuality*) refers to the CEO of the firm serving as chair of the BoD. This is captured as a dummy variable such that a value of "1" represents duality of the CEO and board chair (Connelly et al., 2017). Board Tenure (*BoardTenure*) is measured as the average length of director tenure on the focal firm's board (Lu & Shang, 2017). Finally, gender ratio (*GenderRatio*) is captured as the percentage of BoD

comprised of men (Bommaraju et al., 2019). Table 1 presents a description of all variables in the main analysis.

TABLE 1: Variable descriptions

Variable	Measurement	Dataset	Source
TobinsQ	Tobin's Q: (market value of common shares + book value of preferred stock + long-term debt + inventories + current liabilities - current assets) / total assets	Compustat	Lu & Shang (2017)
SuppDirector	Binary indicator if director's primary employer is a direct supplier	FactSet & ISS	
CustDirector	Binary indicator if director's primary employer is a direct customer	FactSet & ISS	
InsideDirectors	Count of inside (employee) directors	ISS	Boivie et al. (2016)
OutcomeBased	(Equity awards + option awards) / total compensation	Execucomp	Malenko & Shen (2016)
FirmSize	Natural log of total assets	Compustat	Dong et al. (2020)
SalesGrowth	Percentage change in annual sales from prior year	Compustat	Kim & Henderson (2015)
R&Dintensity	R&D expenses / sales	Compustat	Dong et al. (2020)
AssetTurnover	Sales / total assets	Compustat	Kim & Henderson (2015)
IndMunificence	Standard error from regression of sales over time / industry sales	Compustat	Connelly et al. (2017)
IndDynamism	Regression coefficient of sales over time / industry sales	Compustat	Connelly et al. (2017)
BoardSize	Count of total directors	ISS	Lu & Shang (2017)
CEODuality	Binary indicator that CEO is also the board chair	ISS	Connelly et al. (2017)
BoardTenure	Average length of director tenure on the board	ISS	Lu & Shang (2017)
GenderRatio	Percentage of men on the board	ISS	Bommaraju et al. (2019)

Analysis

Descriptive statistics

Descriptive statistics and correlations are provided in Table 2. We asses multicollinearity by considering the variance inflation factors (VIF). The average and maximum VIF values are 1.66 and 2.33, respectively, suggesting no significant multicollinearity concerns.

TABLE 2: Descriptive statistics

	Variable	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	TobinsQ	1.492	1.134														
2	SuppDirector	0.023	0.151	0.034*													
3	CustDirector	0.022	0.147	0.030*	0.320*												
4	InsideDirectors	1.403	0.706	0.012	0.015	0.022*											
5	OutcomeBased	0.540	0.186	0.252*	0.011	0.002	-0.096*										
6	FirmSize	8.218	1.645	-0.183*	0.030*	0.035*	0.019*	-0.020*									
7	SalesGrowth	0.058	0.169	0.190*	0.009	0.006	0.024*	0.086*	-0.009								
8	R&Dintensity	0.037	0.074	0.216*	0.005	0.033*	-0.069*	0.266*	-0.191*	0.043*							
9	AssetTurnover	0.924	0.703	0.130*	-0.001	-0.023*	0.029*	-0.014	-0.299*	0.002	-0.196*						
10	IndMunificence	0.028	0.066	0.099*	-0.003	0.017	0.046*	0.076*	-0.017	0.130*	0.020*	0.028*					
11	IndDynamism	0.022	0.019	-0.150*	-0.010	-0.015	0.005	-0.065*	-0.070*	-0.049*	-0.113*	0.033*	-0.243*				
12	BoardSize	9.338	2.180	-0.121*	0.029*	0.026*	0.162*	-0.098*	0.612*	-0.095*	-0.177*	-0.102*	-0.052*	-0.007			
13	CEODuality	0.495	0.500	-0.000	0.006	0.002	-0.054*	-0.041*	0.136*	-0.027*	-0.084*	0.020*	-0.026*	0.050*	0.076*		
14	BoardTenure	9.088	3.789	0.046*	-0.007	-0.016	0.234*	-0.122*	-0.103*	0.013	-0.013	0.044*	0.009	-0.045*	-0.052*	0.044*	
15	GenderRatio	0.854	0.107	-0.037*	0.018*	0.017	0.089*	0.014	-0.311*	0.047*	0.111*	-0.029*	0.056*	0.076*	-0.276*	-0.067*	0.174*

All continuous variables are winsorized at the 1st and 99th percentiles (Kim & Zhu, 2018). * $p < 0.05$.

Consistent with prior research (e.g., Davis, 1996; Fee et al., 2006; Dass et al., 2014; Minnick & Raman, 2017), we find that directors drawn from direct supply chain partners are rather uncommon. Approximately 2.3% and 2.2% of the sampled firm-years have a supplier director and a customer director, respectively. Out of the 1,641 unique focal firms in our dataset, only 10.8% of the firms had a supply chain director for at least a single year with customer directors occurring more often (7.0% of firms) relative to supplier directors (6.6% of firms). However, supplier directors have a longer average tenure (2.7 years) relative to customer directors (2.4 years). We present a graph of the prevalence of supply chain directors over time in Figure 2. Interestingly, both supplier and customer directors exhibit a positive trend suggesting that firms are increasingly drawing directors from their supply chain partners.

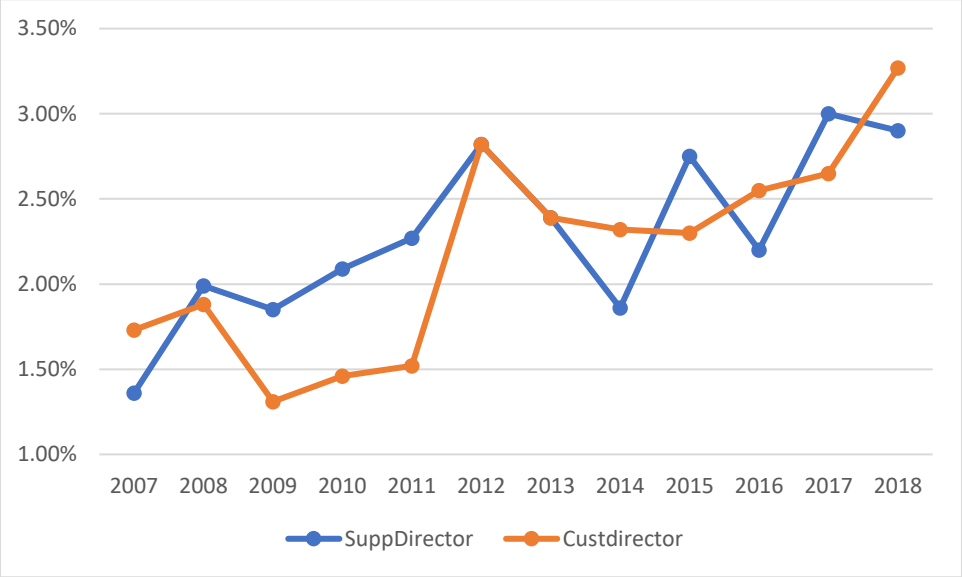

FIGURE 2: Prevalence of supply chain directors

Estimation method

We lag all board-level variables including the independent variables of interest for two reasons. First, given that board activities are not immediately visible to the market, we apply temporal precedence to allow sufficient time for the market to observe and react to activities

originating at the board-level. Second, our capture of supplier and customer directors does not differentiate the date of appointment. As such, many supply chain directors may be appointed later in the year with limited opportunity to influence firm strategies and performance in the year of their appointment.

Given the panel structure of the data, we fit our regression model using a maximum likelihood random effects estimator. Fixed effects models control for unobserved time-invariance heterogeneity, but they are limited to within-firm variance (Certo et al., 2017). Given the scarcity of supply chain directors, the majority of sampled firms have no supplier or customer directors and exhibit no within-panel variance. As such, we elected a random effects method which considers both within-firm and between-firm variance allowing us to retain the power of the sample size when estimating the influence of the variables of interest. In addition, we include year and industry indicators to account for panel-invariant time effects and time-invariant industry effects, respectively. Our statistical model is expressed in Equation 1:

$$
\begin{aligned}
TobinQ_{it} = {} & \beta_0 + \beta_1 SuppDirector_{it-1} + \beta_2 CustDirector_{it-1} + \beta_3 InsideDirectors_{it-1} + \beta_4 OutcomeBased_{it-1} \\
& + \beta_5 SuppDirector_{it-1} \times InsideDirectors_{it-1} + \beta_6 SuppDirector_{it-1} \times OutcomeBased_{it-1} \\
& + \beta_7 CustDirector_{it-1} \times InsideDirectors_{it-1} + \beta_8 CustDirector_{it-1} \times OutcomeBased_{it-1} \\
& + \beta_9 FirmSize_{it} + \beta_{10} SalesGrowth_{it} + \beta_{11} R\&DIntensity_{it} + \beta_{12} AssetTurnover_{it} + \beta_{13} IndMunificence_{it} \\
& + \beta_{14} IndDynamism_{it} + \beta_{15} BoardSize_{it-1} + \beta_{16} CEODuality_{it-1} + \beta_{17} BoardTenure_{it-1} \\
& + \beta_{18} GenderRatio_{it-1} + \gamma_t + \psi_i + \varepsilon_{it} \qquad (1)
\end{aligned}
$$

where *i* refers to the focal firm and *t* refers to the year. The vectors γ and ψ represent year fixed and industry fixed effects, respectively, while ε denotes the error term.

Main results

The main estimation results are presented in Table 3. Panel 1 contains the control model then the independent variables and interaction effects are introduced sequentially in Panels 2 and 3. Each regression model is highly significant, and the AIC statistics suggest the addition of the variables of interest in panels 2 and 3 increase the explanatory power of the regression models.

We start by focusing on the control variables. With the exception of board size which is only positive and significant in the control model, the coefficient estimates are consistent across panels. In line with expectations, *FirmSize* is negatively associated with *TobinQ* while *SalesGrowth* has a positive coefficient estimate. Further, firms with greater asset turnover and operating in industries with greater munificence and dynamism are associated with superior performance. The coefficient estimates for *CEODuality* and *GenderRatio* are positive and negative, respectively. This suggests that firms that construct the board with a CEO chair and more women are associated with greater performance. Finally, the direct effects of the moderator variables are introduced in Panel 2. Both, *InsideDirectors* and *OutcomeBased* are positively associated with *TobinQ*.

Hypothesis 1 predicts a positive direct effect of supplier director on focal firm performance. The positive and statistically significant coefficient of *SuppDirector* ($\beta = 0.122$, $p < 0.01$) supports this hypothesis, suggesting that a director drawn from a direct supplier is generally beneficial to the focal firm. Hypothesis 2 similarly predicts a positive direct effect of customer director on focal firm performance. The coefficient estimate of *CustDirector* is not statistically significant. As such, we find no evidence of a significant influence of a customer director on the focal firm's financial performance, all else equal.

TABLE 3: Main estimation results

	(1)		(2)		(3)	
DV:	TobinQ		TobinQ		TobinQ	
FirmSize	-0.131**	(0.014)	-0.132**	(0.014)	-0.133**	(0.014)
SalesGrowth	0.576**	(0.035)	0.571**	(0.035)	0.568**	(0.035)
R&DIntensity	0.002	(0.249)	-0.029	(0.248)	-0.023	(0.248)
AssetTurnover	0.434**	(0.028)	0.440**	(0.028)	0.440**	(0.028)
IndMunificence	0.345**	(0.105)	0.331**	(0.105)	0.337**	(0.105)
IndDynamism	0.829*	(0.398)	0.790*	(0.398)	0.795*	(0.398)
BoardSize	0.012*	(0.005)	0.008	(0.005)	0.008	(0.005)
CEODuality	0.049**	(0.015)	0.053**	(0.016)	0.053**	(0.016)
BoardTenure	0.001	(0.003)	0.001	(0.003)	0.001	(0.003)
GenderRatio	-0.239*	(0.094)	-0.268**	(0.094)	-0.273**	(0.094)
InsideDirectors			0.055**	(0.014)	0.053**	(0.014)
OutcomeBased			0.235**	(0.048)	0.198**	(0.048)
SuppDirector			0.122**	(0.046)	-0.247	(0.162)
CustDirector			-0.039	(0.045)	-0.584**	(0.165)
SuppDirector x InsideDirectors					-0.055	(0.056)
SuppDirector x OutcomeBased					0.788**	(0.224)
CustDirector x InsideDirectors					0.156*	(0.061)
CustDirector x OutcomeBased					0.579**	(0.223)
Constant	1.312	(0.879)	1.086	(0.872)	1.116	(0.873)
Year Fixed Effects	Yes		Yes		Yes	
Industry Fixed Effects	Yes		Yes		Yes	
N	12,336		12,336		12,336	
Log-likelihood	-12295.2		-12272.39		-12256.48	
LR $\chi 2$	2340.29		2385.93		2417.74	
AIC	24792.42		24754.78		24730.96	

** p<0.01; * p<0.05; # p<0.1. Standard errors are shown in parentheses.

Hypotheses 3a and 3b are focused on the monitoring role of the BoD. Specifically, we hypothesize that the greater number of inside directors on the BoD will positively moderate the effects of supplier directors (H3a) and customer directors (H3b) on focal firm performance. In panel 3, the interactions are introduced to assess these hypotheses. The interaction term between *SuppDirector* and *InsideDirectors* is not statistically significant, therefore H3a is not supported. The interaction term between *CustDirector* and *InsideDirectors*, however, is positive and significant ($\beta = 0.156, p < 0.05$) supporting H3b.

Hypotheses 4a and 4b are focused on the role of incentives in curbing supply chain director agency conflicts. We predict that a greater proportion of outcome-based director compensation will positively moderate the effects of supplier directors (H4a) and customer directors (H4b) on focal firm performance. In line with H4a, the coefficient estimation for the interaction *SuppDirector x OutcomeBased* is positive and statistically significant ($\beta = 0.788$, $p < 0.01$). H4b also receives support as the coefficient for *CustDirector x OutcomeBased* is positive and statistically significant ($\beta = 0.579$, $p < 0.01$).

Robustness testing

To check the robustness of our results, we replicate our analysis using an alternative sampling and estimation technique. Following Roh et al. (2016), who similarly examined a rare leadership appointment, we utilize a fixed effects estimation of only the 178 unique focal firms which had a supplier or customer director for at least a single period in the sampled time frame. While this greatly reduces the sample size (1,560 firm-year observations), it allows the estimation to be cater the prediction to the panels in which the primary independent variables vary. The addition of firm fixed effects, further, serves to limit endogeneity stemming from the omission of time-invariant firm heterogeneity (Lu et al., 2018).

One concern with restricting the sample to only firms that appointed a supply chain director, however, is that it may give rise to selection bias. Selection bias occurs when an omitted variable is correlated with both the theoretical model and sample selection (Certo et al., 2016). To address these concerns, we implement Heckman's two step method (Heckman, 1979) coupled with the fixed effects estimation. The estimation results for both stages are presented in Table 4.

The first-stage estimates a probit model predicting a binary indicator for sample inclusion. This stage consists of all observations with complete data (12,336 observations) and utilizes the same predictors from the main analysis with the exception of *SuppDirector* and *CustDirector* which account for the selection criteria. Following Bommaraju et al. (2019), we generate variables to account for the prevalence of industry peers in utilizing supplier and customer directors as instruments for the first-stage. The instruments include *IndSuppDirector* and *IndCustDirector* and are calculated as the percentage of industry peers in the same three-digit NAICS classification to have a supplier director and a customer director, respectively. The first-stage results are presented in Panel 1 and are highly significant predictors of selection. The first-stage estimation is then used to calculate the inverse Mills ratio, and this is included as a control in the second-stage regressions.

The second-stage regressions include the fixed effects estimation of our theoretical model. Panels 2-4 present these regressions such that Panel 2 includes the controls only, and the independent variables and interactions are introduced in Panels 3 and 4. The coefficient estimation for *SuppDirector* is positive and significant in Panel 3 ($\beta = 0.112, p < 0.05$) providing additional support for H1. *CustDirector*, however, is not statistically significant in Panel 3, offering no evidence in support of H2.

TABLE 4: Robustness check – fixed effects estimation

	(1)		(2)		(3)		(4)	
DV:	Sample		TobinQ		TobinQ		TobinQ	
FirmSize	0.081**	(0.012)	-0.353**	(0.073)	-0.348**	(0.077)	-0.344**	(0.077)
SalesGrowth	0.029	(0.094)	0.715**	(0.128)	0.730**	(0.128)	0.702**	(0.127)
R&DIntensity	1.194**	(0.207)	-1.797	(1.331)	-1.500	(1.381)	-1.158	(1.371)
AssetTurnover	0.071**	(0.020)	0.523**	(0.115)	0.535**	(0.118)	0.536**	(0.117)
IndMunificence	-0.020	(0.252)	1.059**	(0.374)	1.032**	(0.375)	1.054**	(0.373)
IndDynamism	-1.446	(0.892)	-1.218	(1.566)	-1.748	(1.646)	-1.904	(1.633)
BoardSize	0.038**	(0.009)	0.000	(0.020)	0.004	(0.023)	0.013	(0.023)
CEODuality	0.050	(0.031)	0.076	(0.053)	0.091	(0.056)	0.103#	(0.056)
BoardTenure	0.001	(0.004)	0.011	(0.009)	0.011	(0.009)	0.013	(0.009)
GenderRatio	0.691**	(0.163)	-0.787*	(0.390)	-0.636	(0.449)	-0.597	(0.446)
InsideDirectors	0.056**	(0.021)			0.069	(0.049)	0.036	(0.051)
OutcomeBased	0.386**	(0.088)			0.060	(0.220)	-0.201	(0.230)
SuppDirector					0.112*	(0.054)	-0.285	(0.196)
CustDirector					-0.057	(0.053)	-0.770**	(0.197)
SuppDirector x InsideDirectors							-0.030	(0.066)
SuppDirector x OutcomeBased							0.763**	(0.275)
CustDirector x InsideDirectors							0.225**	(0.076)
CustDirector x OutcomeBased							0.710**	(0.263)
IndSuppDirector	4.487**	(0.664)						
IndCustDirector	6.065**	(0.539)						
Inverse Mills Ratio			-0.596#	(0.346)	-0.331	(0.515)	-0.202	(0.512)
Constant	-3.474**	(0.214)	5.070**	(1.275)	4.263*	(1.824)	4.078*	(1.816)
Year Fixed Effects	Yes		Yes		Yes		Yes	
Firm Fixed Effects	No		Yes		Yes		Yes	
N	12,336		1,560		1,560		1,560	
Within R-squared			0.2247		0.2285		0.2435	

** p<0.01; * p<0.05; # p<0.1. Standard errors are shown in parentheses.

The interaction terms are included in Panel 4. The interaction of supplier directors and the number of inside directors is not statistically significant offering no support for H3a. The coefficient estimate for *CustDirector x InsideDirectors*, however, is positive and statistically significant ($\beta = 0.225, p < 0.01$) providing additional support for H3b. Consistent with the main results, the interaction of *SuppDirector x OutcomeBased* is positive and significant ($\beta = 0.763, p < 0.01$) and the interaction of *CustDirector x OutcomeBased* is positive and significant

($\beta = 0.710, p < 0.01$). These results draw additional support for H4a and H4b. In sum, the results of the robustness test are largely consistent with the interpretation of the main analysis. We receive additional support for H1, H3b, H4a and H4b, while H2 and H3a do not receive any empirical support.

Discussion

Notable findings

Our study draws on agency theory as well as the BoD and supply chain literatures to examine the influence of supply chain directors on a firm's performance. Directors drawn from supplier and customer firms are in a unique position to add value to the focal firm by enhancing the relationship with the supply chain partner and bringing their expertise and knowledge to inform BoD decision-making. Supporting this notion, our results suggest that inviting a supplier director to serve of the BoD is generally beneficial to the focal firm and associated with greater firm performance. Further, the value of supplier directors is enhanced when the focal firm structures director compensation schemes to consist primarily of outcome-based incentives. From an agency theory perspective, this serves to better align the director's motivations to that of the focal firm rather than the director's outside interests, notably those of their home firm.

Customer directors, however, were not directly associated with focal firm performance, all else equal. This is an interesting distinction from supplier directors justifiable through the inherent difference between how customers and suppliers perceive the relationship. Indeed, past research has noted that suppliers are generally motivated to meet the customer's needs more so than vice versa (Villena & Craighead, 2016). While supplier directors may perceive the

directorship as an opportunity to please the focal firm, customer directors appear to be more prone to view the BoD position as an opportunity to extract advantage directly for their home (customer) firm. As such, it is important for firms to structure the BoD with greater incentives and monitoring if inviting a customer director. Similar to supplier directors we find that greater outcome-based compensation increases the benefit of customer directors on focal firm performance.

Unlike supplier directors, we also find that the greater number of inside directors on the board positively moderates the relationship between customer directors and focal firm performance. Inside directors have stronger knowledge of firm operations the details of the supply chain relationship. This specific knowledge plays an important role in the board's ability to effectively monitor customer directors and limit potential opportunism. Again, the differences between supplier and customer perceptions of the relationship may explain why this is significant for customer directors but not supplier directors. For example, Nyaga et al. (2010) found the customers are more focused on supply chain relationships as a means to achieve performance outcome while suppliers tend to be more focused on safeguarding relationship specific investments. Suppliers will, thus, be more reluctant to act opportunistically for fear of relationship dissolution and substantial losses of relationship specific investments. As such, structuring the board with a greater number of inside directors appears critical to monitor customer directors but not supplier directors.

Theoretical implications

This research makes several contributions to extant literature and theory. First, we integrate the supply chain and BoD literature streams to expand prior studies on directors drawn from supply chain partners. Apart from a small number of notable exceptions (e.g., Hillman et

al., 2001; Dass et al., 2014; Minnick & Raman, 2017; Bommaraju et al., 2019), this area of research is very sparse and spread across the Management, Finance, and Marketing disciplines. Our research builds upon and extends the existing research in three primary ways: First, we conceptualize supply chain directors as directors whose primary employer is a direct customer or supplier allowing us to more effectively isolate directors drawn from supply chain partners rather than shared by or affiliated with supply chain partners. Second, we distinguish between directors drawn from upstream and downstream supply chain partners, thereby allowing us to gauge the divergent influence of supplier and customer directors on firm performance. Third, our study considers and identifies mechanisms to limit supply chain director agency problems. The potential conflict of interest associated with a supply chain director appointment has been noted in prior research (Dass et al., 2014), but this study is, to our knowledge, the first to empirically explore this type of agency conflict and its effect of the focal firm's performance.

The current research also adds to the literature on supply chain collaboration. Supply chain research has expounded on the benefits of collaboration and integration with supply chain partners (e.g., Zacharia et al., 2011; Flynn et al., 2010; Narayanan et al., 2015), and the literature highlights the potential to facilitate supply chain collaboration through boundary spanners (Ireland & Webb, 2007) such as employee implants (Grawe et al., 2015). We build on this notion and propose board positions as a strategic tool to facilitate collaboration. We evaluate the potential to create value by inviting boundary spanners from supply chain partners to serve on the BoD and the potential risks associated with this level of commitment. Our findings, thus, offer evidence of both the "bright side and dark side" of strong collaborative relationships with supply chain partners (Villena et al., 2011).

Supplier and customer directors are a unique form of supply chain collaboration in that they directly facilitate coordination at the highest level of the firm: influencing focal firm leadership structure and organizational strategy. The benefits of operational collaboration are well documented, but collaboration of buyer-supplier dyads in the formation of overarching organizational direction and strategy has received less attention (Revilla & Villena, 2012; Ralston et al., 2017) creating need for more research on the intersection of organizational leadership and supply chain management (Potter & Paulraj, 2020). Our study takes a step in this direction and opens the door for more supply chain research that intersects with organizational leadership and governance.

Finally, our study contributes to agency theory and BoD research by exploring the supply chain director agency problem. As noted previously, directors are generally considered the monitors to mitigate agency costs that arise given conflicting goals and risk preferences between the shareholders (principals) and management (agents) (Withers et al., 2012b). While prior research has asked "who monitors the monitors?" (Kumar & Sivaramakrishnan, 2008), the extent of director agency under investigation in empirical research has been directors failing to adequately perform the monitoring function of management. We build on extant literature by conceptualizing supply chain directors as self-serving agents with conflicts of interest that can redirect their motivations away from the firm whose board they serve on and cause them to act in a way that directly detracts from the firm's performance. Particularly in instances of gray directorships where the directors are tied to an interdependent group, firms should not assume the directors' activities on the BoD are not influenced by outside interests. Rather, directors are agents of the owners of the firm, and firms need to structure the BoD with greater incentives and monitoring to curb director agency.

Another contribution to agency theory and BoD research emerges from our theorizing of mutual monitoring systems on the BoD. Prior BoD research has largely been skewed toward director independence as a primary factor in influencing directors' monitoring performance, but research has begun to highlight other factors which affect the directors' motivations and abilities (Campbell et al., 2012). One of those important factors is specific knowledge about the firm and the individual being monitored (Fama & Jensen, 1982). Inside directors, though traditionally considered inferior monitors of management, may be more effective monitors when considering outside director agency because of their expertise in the firm and its operations. As such, we highlight that a director's monitoring effectiveness is contingent on more than the individual motivations, but also on the ability and the specific knowledge to effectively do so.

Practical implications

This study's findings also have important practical implications. A supply chain directorship can be utilized and drive superior performance but doing so is accompanied with risk that the director acts opportunistically and actually hurts the focal firm. At the upper range of inside directors (4) and outcome-based director compensation (93.8%), our estimation predicts firms that employ a supplier director or a customer director will be associated with a 0.24 or 0.51 standard deviation increase to Tobin's Q, respectively. Conversely, firms in which the CEO is the only insider on the BoD and no outcome-based director compensation is utilized, will, on average, see a 0.27 standard deviation decrease associated with the appointment of a supplier director and a 0.38 standard deviation decrease for a customer director. As such, supply chain directors are a double-edge sword and should be approached with the appropriate safeguards in place to properly incentivize and monitor an appointed supply chain director. By structuring the

board with more outcome-based compensation and inside directors, a firm is in position to effectively wield supplier and customer directors as a strategic tool to benefit the focal firm.

Further, our findings on supplier and customer directors have implications for differences of risk associated with upstream or downstream partner collaboration activities. Our results suggest that customer directors are generally riskier and that firms need to prioritize monitoring activities given such an appointment. A similar distinction between customers and suppliers can apply to other forms of supply chain collaboration. Because suppliers are more focused on relationship preservation (Nyaga et al., 2010) coupled with "the customer is always right" culture, suppliers are more focused on pleasing the focal firm (Villena & Craighead, 2016) and less prone to opportunistic behavior. Of course, this is not intended to deter collaboration with customers, but merely to highlight a greater need for firms to plan and protect internal interests in instances of affording customers substantial access and influence within the firm's operations and decision-making processes.

Finally, our research has major implications for policy makers. Corporate scandals have led to major changes to board composition, and regulatory changes have decreased the prevalence of inside directors (Campbell et al., 2012). Now, the CEO is often the only insider sitting on the BoD (Joseph et al., 2014). While such a board structure with more outside (independent) directors may be beneficial to control executive agency problems, it may harm the firm's ability to protect against gray director agency problems. Similar to Arthurs et al. (2008) which found evidence that inside directors help to safeguard firm interests against venture capitalists on the BoD, our results provide evidence that inside directors can more effectively monitor customer directors. As such, it is important to consider dual agency of both managers

and directors when developing policy to best protect the shareholders as the structure of the board can mitigate managerial agency while propelling director agency.

Limitations and future research opportunities

This study has several limitations that offer opportunities for future research. First, the study's level of analysis limits the operationalization of dyadic-level and director-level predictors. Since there are multiple suppliers, customers, and directors associated with a given focal firm-year, we chose to generate indicator variables for the measures of supplier and customer directors and aggregate of director-level data to represent a board characteristic. As such, we lose detail on the individual who acts as the supply chain director and the relationship with the connected supply chain partner. These individual and relationship factors likely play a role in the underlying value and risk potential of a supply chain director appointments. We, thus, encourage future research to consider such characteristics as moderators of the relationship between supply chain directors and firm performance.

Second, our focus was limited to the focal firm rather than the supply chain director's home firm. We apply prior literature and theory to predict how supply chain directors influence variations in performance for the focal firm whose board the supply chain director served. Another opportunity for future research is to examine how the director's home firm's performance is affected or dyadic performance to assess joint value creation. Finally, our study was limited to S&P 1500 firms due to data availability. As such, future research may consider if the findings differ across private firms or firms drawn from cultures outside the United States.

Conclusion

Firms are increasingly drawing directors from supply chain partners, and these supply chain directors can be an effective tool to drive superior performance. Our study details such an effect and identifies director outcome-based compensation and an increased number of inside directors as effective safeguards when employing supply chain directors. These important results highlight supply chain directors as a double-edged sword that can potentially benefit or harm the focal firm. The implications of this study build upon agency theory as well as the supply chain collaboration and board of directors literatures streams. We contend that there is ample opportunity to build expand research at the intersection of supply chain management and organizational leadership and governance.

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IV. Essay 3: Unpacking the Supply Base's Role in Driving Firm-level Competitiveness and Performance

Introduction

Firms must actively compete to improve performance and survive amongst rival firms striving for the same market resources (Chen & Miller, 2012). The primary mechanism for firms to compete is to leverage the capabilities and resources at their disposal to implement competitive actions (Gnyawali et al., 2006; Ndofor et al., 2011). Competitive actions are any actions initiated with the intent of gaining or maintaining the firm's competitive position and associated advantage (Chen et al., 1992). These can include, for example, mergers and acquisitions, promotional campaigns, and new product development. Firms constantly take such actions to generate temporary advantage that inevitably erodes as rival firms take their own competitive actions to disrupt the status quo (Jacobson, 1992; D'Aveni et al., 2010). Thus, firm performance is contingent on the firm's ability to match or exceed the competitive actions of rival firms (Derfus et al., 2008). Indeed, prior research has found that firms that implement more varied competitive actions and do so more frequently tend to outperform their less competitively active rivals (Smith et al., 1991; Ferrier et al., 1999; Chen et al., 2010; Giachetti et al., 2017).

But firms do not operate in isolation, and they increasingly draw on their supply chain partners to implement strategies and achieve targeted outcomes (Ketchen & Hult, 2007; Grimm, 2008). A firm's competitiveness is, therefore, a function of not only internal actions and rival actions, but also those of its partners (Gomes-Casseres, 2003). Indeed, the evolution of globalization and rise of outsourcing and specialization has placed limitations on the traditional view of competition as confined to firms operating in the same industry (Chen & Miller, 2015), and research is needed to develop a greater understanding of how cooperative supply chain relationships support competitive outcomes (Gimeno, 2004; Chen, 2008; Hoffmann et al., 2018).

The purpose of this research is to develop theory on the interplay of competitive horizontal relationships and vertical supply chain relationships, by examining the role of the supply base in directly competing with a firm and indirectly supporting a firm's competitive activity. Specifically, we pose the following research questions: 1) How do supply base competitive actions affect a firm's financial performance; and 2) how does the supply base influence the effectiveness of a firm's own competitive actions? Supply chain relationships afford the opportunity to access suppliers' resources and capabilities (Mahmood et al., 2011) to support and complement a firm's own strategic outcomes. We argue that this opportunity extends to competitive activity such that suppliers are a competitive weapon (Ketchen et al., 2008). Suppliers not only implement their own competitive actions[3] that can confer advantage to a firm but can also enhance the effectiveness of a firm's own competitive actions.

The current research makes several contributions to extant literature and theory. First, this study integrates the supply chain management literature with competitive dynamics research. "Competition and cooperation are both cornerstones of business strategy" (Chen & Miller, 2012, pg. 48), yet research tends to study them independently (Hoffman et al., 2018). Although research in coopetition has taken significant steps in enhancing the understanding of the interplay of horizontal alliances and competition, supply chain relationships offer a very different dynamic. Supply chain relationships are easier to manage, have less risk of knowledge leakage, and are associated with higher levels of trust and cooperation (Rindfleisch, 2000; Silverman & Baum, 2002; Belderbos et al., 2012). As such, we add to competitive dynamics theory by taking a broader perspective that incorporates both a firm's and its supply base's competitive actions

[3] Certain competitive actions implemented by suppliers may be considered detrimental to firms (i.e., price *increases* or capacity *reductions*). For the purpose of this research, we disregard such actions and only focus on actions aimed at increasing the attractiveness of a firm's products or services to its downstream customers.

and, thus, take an incremental yet significant step toward conceptualizing and testing competition as supply chain vs. supply chain.

This study also contributes to research on strategic alignment and integration across the supply chain. Supply chain alignment and integration is a major stream in the supply chain literature but tends to focus on operations, information systems, and process integration (e.g., Xue et al., 2013; Handfield et al., 2015). We extend this stream by examining the alignment of a firm's competitive action repertoire, the types of competitive actions initiated by a firm, to that of its supply base, finding increased alignment directly benefits a firm's financial performance. As competitive actions are a reflection of a firm's strategy (Connelly et al., 2017), our study provides evidence of superior value that can be derived from strategically aligning with direct suppliers.

Finally, our study increases our understanding of how supply chain partners contribute to a firm's competitiveness. Our empirical results suggest that a greater number of competitive actions implemented by a firm are associated with superior performance, but there is no direct relationship between the number of competitive actions implemented by suppliers and a firm's financial performance, all else equal. While supply base competitive actions do not appear to directly generate and pass down value to the firm, our findings provide evidence that competitive repertoire alignment and supply base concentration increase the value of a firm's competitive actions. These results suggest that supply chain partners enable firms to compete more effectively against rivals, advocating that stronger supplier relationships with a shared strategic vision afford a stronger foundation to successful execute competitive activity.

Our study has major implications for managers. Many firms and industries neglect the impact of suppliers on competitive outcomes because of difficulty detecting and controlling

partner behavior (Narayanan & Raman, 2004). However, failing to consider suppliers when developing and implementing a business strategy is an opportunity lost (Gomes-Casseres, 1994). Of course, suppliers are a separate business entity with their own goals and competitive orientations (Narayanan & Raman, 2004), but managers can still exercise some control to choose which supplier to partner with and even influence the suppliers to better align with their firm's own strategy. Customers are considered one of the most influential stakeholder groups and can incentivize or coerce their suppliers to adapt strategic initiatives (Bower & Christensen, 1995; Chen & Ho, 2019) that serve or support the customer firm's interests. The current research highlights the need for a macro focus that includes the upstream supply chain when devising and implementing competitive activity and offers guidance as to how the supply base can be a source of superior performance outcomes.

Theoretical Foundation and Hypothesis Development

The conceptual model is presented in Figure 1. We, first, briefly review theory and research in competitive dynamics to set up our baseline hypothesis (H1) predicting a positive causal relationship between a firm's competitive action intensity, or the number of competitive actions relative to rivals, and financial performance. Such an association is well-supported in prior literature, but we view this as a requisite base to provide the theoretical foundation before presenting and testing the hypotheses involving supply base characteristics. We, next discuss the interplay between cooperative and competitive relationships before identifying alternative methods in which cooperative partners can contribute to a firm's competitive outcomes. Then, we develop our primary hypotheses regarding the supply base. We predict direct positive effects of supply base competitive action intensity (H2) and competitive repertoire alignment with

suppliers (H3) on a firm's financial performance. Finally, we consider indirect effects of the supply base through interaction with our baseline hypothesis. Specifically, we hypothesize that competitive repertoire alignment (H4) and supply base concentration (H5) enhance the positive relationship between a firm's competitive action intensity and financial performance.

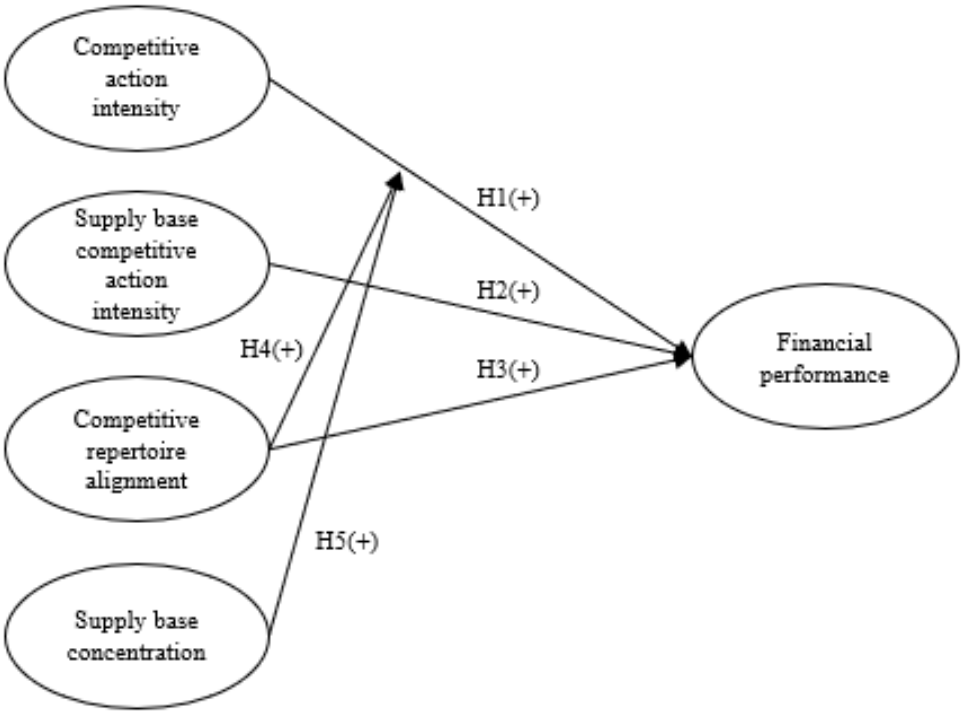

FIGURE 1: Research Model

Firm-level competitive dynamics

Competitive dynamics research is rooted in Austrian economics and focuses on competitive interactions among active, rivalrous firms (Jacobson, 1992; Chen & Miller, 2015). In pursuit of scarce market resources (i.e., growth, sales demand, profits, etc.), firms constantly implement competitive actions to expand or maintain their competitive positions (Chen, 1992; Ndofor et al., 2011). Rivals are interdependent such that successful firm competitive actions that procure a greater share of market resources detract from the rivals' performance by limiting their own resource potential (Derfus et al., 2008). Thus, competitive actions carry a signal to rivals

that call for the rivals' own actions as a response to either negate threats or capitalize on market opportunities (Smith et al., 1991). This contagious nature of competitive actions creates a dynamic cycle of escalating competition where firms continuously seek to match or exceed rival actions (Derfus et al., 2008; Hofer et al., 2012; Giachetti et al., 2017; Barker et al., 2021)

Competitive dynamics considers competitive advantage to be temporary as the competitive environment never reaches a fixed equilibrium (Jacobson, 1992; D'Aveni et al., 2010). Competitive actions allow the firm to adapt to the evolving needs and preferences of the market and can even drive the market to fit the firm's relative advantages (Giachetti et al., 2017). Therefore, competitive actions drive competitive advantage, but any advantage is inevitably imitated by competitors or disrupted by an improved rival response (Chen et al., 2010). Firms are, therefore, necessitated to implement competitive actions simply to not be passed by the competition and do so more frequently than rivals to string together temporary advantages that can drive superior performance. Indeed, empirical research has supported this notion finding that greater competitive action intensity, the volume of competitive actions relative to rivals, is an antecedent to competitive success. For example, Young et al. (1996), Derfus et al. (2008), and Giachetti et al. (2017) all linked more frequent firm competitive actions and less frequent rival competitive actions to superior firm-level performance outcomes. Consistent with this research, we offer a baseline hypothesis predicting a positive influence of competitive action intensity on financial performance.

> **Hypothesis 1:** A firm's competitive action intensity is positively associated with its financial performance.

The interplay of competition and cooperation

The interplay between competition and cooperation is traditionally viewed in strategy research as "paradoxical" (Chen, 2010), or "like water and oil" (Gomes-Casseres, 1996, pg. 70). While such a view tends to be focused on allies and rivals across the horizontal industry, research is often fragmented such that it tends to study competitive relationships and cooperative relationships independently (Chen & Miller, 2015). There are, however, several examples that highlight the influence of cooperation on competition and vice versa. For example, participation in horizontal alliances has been linked with increased firm-level competitive activity (Young, 1996; Gnyawali et al., 2006). An alternative perspective considers participation in alliances and various forms of cooperation as a competitive action itself that can improve a firm's relative competitive position (Chen & Miller, 2015). Supporting this notion, Silverman and Baum (2002) found that alliance formations impose greater competition on rivals and increase the rate of rival exit. From a supply chain perspective, research has noted the potential of a firm's supply chain information sharing initiatives to elicit a competitive response from horizontal rivals (Li, 2002). Further, Dai et al. (2015) provided empirical evidence that perceptions of rival competitive activity lead to a joint supply chain response.

There are multiple pathways in which a cooperative partner could contribute to a firm's competitive outcomes. For example, Gomes-Casseres (1996) introduced the term "collective competition" to refer to group vs. group competition. While it cannot be assumed that there is no internal conflict among group members, such conflict is suppressed in order to unite against common threats (Gomes-Casseres, 2018). This team-based approach to competition suggests that partners' combined efforts generate common benefits for the group to compete against rival

groups. Under the premise of collective competition, we posit that a partner's competitive activity directly benefits the group and contributes to group member performance outcomes.

Another pathway advocated in the literature is that cooperative relationships influence a firm's ability to compete more effectively; we will refer to this as relationship-enabled competition. A firm's ability to implement competitive actions, let alone successful actions, is a function of the underlying resources at the firm's disposal (Ndofor et al., 2011). Cooperative relationships open a channel to access partner resources, information, and capabilities (Young et al., 1996; Gimeno, 2004; Mahmood et al., 2011) which can be leveraged as tool to implement competitive activity (Gnyawali & Madhaven, 2001; Mathews, 2003). As such, a firm can effectively structure and bundle partner resources to create capabilities, but the impetus remains on the firm to deploy competitive actions that exploit such capabilities in order to achieve competitive outcomes (Sirmon et al., 2008). When considering relationship-enabled competition, we posit that partner influence on competitive outcomes is less direct such that partners enable the firm to execute more successful competitive actions.

We consider both collective competition and relationship-enabled competition in the development of our main hypotheses regarding the influence of the supply base on a firm's competitive performance. Importantly, we do not consider collective and relationship-enabled competition to be mutually exclusive, but rather alternative means which the supply base can contribute to superior firm outcomes. We formally develop and present these hypotheses in the succeeding subsections.

Collective competition and the supply base

Competition is increasingly moving toward supply chain versus supply chain (Hult et al., 2007; Ketchen et al., 2008), thereby shifting vertical exchange relationships from arm's length transactions to strategic partnerships (Min et al., 2008). Suppliers, in particular, play an integral part in the value creation process (Petersen et al., 2008; Azadegan & Dooley, 2010). The nature of buyer-supplier relationships generally follows that suppliers are very committed to customers and preserving the relationship (Nyaga et al., 2010), making it a priority to outperform alternative suppliers in meeting customer needs (Villena & Craighead, 2017). Scholars have even referred to the supply base as one of the most important factors to compete in the market (Ogden, 2006) or as a firm's "ultimate core competency" (Fine, 1998).

If the supply chain is the collective unit in which competition occurs, it can be inferred that competitive activity serves to advantage both the initiating firm and the supply chain as a whole. Therefore, supply base competitive actions can directly benefit a firm's performance if the firm is able to appropriate a share of the common benefits generated (Hoffmann et al., 2018). In line with prior research on buyer-supplier relationships, we maintain that supplier gains are not fully appropriated by the acting supplier firm (Mackelprang et al., 2018). Rather, a substantial portion of value created gets passed down and shared with its direct customers (Kim & Wemmerlöv, 2015; Lieberman et al., 2017).

The literature largely supports the notion that competitive actions initiated by the supply base boost a firm's outcomes. For example, supplier distribution upgrades can lower lead times and, in turn, allow those customers to be more responsive to demand further downstream (Christopher, 2000). Similarly, supply base investments in innovation have been linked to increases in a firm's financial performance (Dong et al., 2020). Supplier ties also factor into a

firm's image and reputation (Arend, 2006; Chen & Miller, 2015), and supplier competitive actions can directly reshape external perceptions of the firm. For example, supply base environmental management activity can bolster a firms' reputations, while firms are largely held accountable if a supplier fails to adhere to accepted social standards (Chen & Ho, 2019; Duan et al., 2021).

Under collective competition, competitive outcomes are a function of not only the actions of a firm and its industry rivals, but also the actions of its partners (Gomes-Casseres, 2003). Rivalry occurs all across the vertical supply chain (Porter, 1985; Markman et al., 2009) and suppliers implement competitive actions to generate collective advantage. Simultaneously, any advantage generated from supplier actions motivates rivals from competing supply chains to respond with their own competitive actions to negate or reverse the effect (Gimeno, 2004). Therefore, the of main tenets competitive dynamics apply to the link between supplier competitive actions and a firm's performance. Specifically, we predict that greater supply base competitive action intensity, or a greater number of competitive actions implemented by suppliers relative to the suppliers' rivals, increase a firm's financial performance.

Hypothesis 2: Supply base competitive action intensity is positively associated with a firm's financial performance.

The competitive success of each supply chain member is interlinked, and any firm's performance is dependent on how its partners deploy strategies throughout the different stages of the value creation processes (Villena et al., 2011; Green et al., 2014). Therefore, an atomistic approach to formulating competitive strategy among supply chain partners neglects the true basis of competition and can lead to incongruence or even competing actions which diminish any purported advantage (Gomes-Casseres, 1994). Porter (2001) notes that the effectiveness of

strategy is more than the implementation of best practices but is also a function of how it integrates with and reinforces the whole value chain. Therefore, a supply chain collective competes more effectively when partner strategies are aligned (Gomes-Casseres, 1996) such that the supply chain can generate synchronous value beyond that of each individual partner in isolation (Dyer and Singh, 1998) and outcompete rival supply chains (Min et al., 2008).

The supply chain literature demonstrates the value of aligning goals and processes with suppliers. Supply chain partners possess some level of motivational overlap due to their interdependence, but each of the connected firms' incentives and goals can misalign thereby detracting from operational and financial outcomes (Narayanan & Raman, 2004). The main intention of managing the supply chain is to seamlessly integrate exchange partner operations and strategies (Bowersox et al., 1999) with the primary goal of optimizing the entire system (Cardenas-Barron, 2007). Greater alignment with suppliers has been linked to a myriad of advantages including increased financial performance; operational agility, and customer service customization (e.g., Xue et al., 2013; Handfield et al., 2015; Gligor, 2018). While much of this literature stream has focused on the benefits of operational alignment, strategic alignment with suppliers is also necessary to compete more effectively (Revilla & Villena, 2012), and by doing so a firm is likely to realize superior performance outcomes (Cheng & Grimm, 2006; Ralston et al., 2015).

To examine the supply chain collective's strategic alignment, we consider competitive repertoire alignment—the extent to which a firm and its supply base implement the same type of competitive actions. A firm's strategy is expressed through the deployment of a repertoire of competitive actions, and these actions can encompass a wide mix of action types including: mergers, acquisitions, market expansions, alliances, product launches, marketing, joint ventures,

pricing changes, capacity adjustments, and legal actions (Connelly et al., 2017; Connelly et al., 2019). By aligning strategies (as executed by similar competitive action types), the supply chain performs at a much higher level such that the firm and its suppliers' competitive actions reinforce each other to achieve desired advantages (Gomes-Casseres, 1996; Lee, 2004). Misalignment, however, can lead to conflicting strategies where any purported advantage is diminished by the partners' own competitive actions. We, therefore, predict that competitive repertoire alignment between a firm and its supply base will generate common benefits that are partially appropriated by the firm. This hypothesis is expressed as a positive relationship between competitive repertoire alignment and financial performance.

> **Hypothesis 3:** Competitive repertoire alignment with the supply base is positively associated with a firm's financial performance.

Relationship-enabled competition and the supply base

Collective, supply chain versus supply chain, competition does not substitute for firm-level competition, but cooperative relationships can also provide a breadth of advantages that enable a firm to outcompete its direct rivals (Silverman & Baum, 2002). One of the primary benefits of cooperative relationships is the ability to access and combine partner resources and capabilities (Mindruta et al., 2016), creating "unique and valuable tools which can assist in creating value" (Grawe et al., 2015, pg. 89). However, these tools afforded from cooperative relationships do not directly generate competitive outcomes per se but require firm action to deploy and leverage the resources in the competitive environment (Sirmon et al., 2008). As such, under the premise of relationship-enabled competition we consider how supply base relationships can complement a firm's competitive actions to further enhance the firm's competitive positions and associated outcomes (Chen & Miller, 2015).

Firms can structure the supply base with partners that possess desired resources (Mathews, 2003) granting them the opportunity to leverage supplier complementarities to reinforce the firm's strategic imperatives (Mahmood, 2011). Supporting this practice, Arend (2006) found evidence that suppliers do not transmit unique advantages to firms, but these relationships instead enhance the firm's own internal capabilities. If the success of a firm's competitive actions is conditioned by its underlying resources (Ndofor et al., 2011), a supply base with competitive resources aligned with the firm's strategy should lead to superior competitive outcomes (Cheng & Grimm, 2006). For example, a firm can arguably be more effective implementing a low-cost strategy if its supply base follows a similar competitive strategy that transmits savings to the firm's procurement costs. Further, Wagner (2009) found that firms are more successful at developing new products when suppliers have similar strategic orientations and commitments to innovation. Conversely, supply base competitive resources would be less productive if utilized for competitive actions unrelated to the suppliers' competencies (Menon & Yao, 2017).

We argue that a supply base can more effectively support a firm's competitive activity when competitive repertoire alignment is high. Capability is a requisite of competitive action (Chen et al., 1992) such that a supply base with similar competitive actions possesses resources and capabilities relevant to the firm's competitive positions. These supplier resources are a source to increase internal capabilities (Purvis et al., 2014) and the firm's ability to implement more disruptive competitive actions. Thus, we posit that competitive repertoire alignment will positively moderate the relationship between a firm's competitive actions and financial performance. While similar to the hypothesis directly preceding, the supply base's role is to support a firm's competitive activity rather than directly compete with the firm. The basis of

relationship-enabled competition, therefore, is firm versus firm such that the focal firm utilizes internal and supply base resources to take its own actions to derive advantage. Stated formally:

> **Hypothesis 4:** Competitive repertoire alignment with the supply base positively moderates the relationship between a firm's competitive action intensity and its financial performance.

Supply base concentration is another relevant factor that determines the extent the supply base can support a firm's competitive activity. Supply base concentration represents the degree that a firm's procurement volume of similar products or services is concentrated among fewer suppliers (Moeen et al., 2013). Traditional supply base management techniques would often structure a very dispersed supply base in order to reduce dependencies on any single supplier and facilitate direct competition among the supply base members (Ogden et al., 2006; Schwieterman et al., 2018). However, more concentrated supply bases with fewer suppliers are becoming more popular as firms recognize the benefits of closely coordinating and integrating processes across the supply chain (Choi & Krause, 2006; Swing & Zsidisin, 2006). While researchers have found both benefits and drawbacks to supply base concentration, we posit that a more concentrated supply base will better support a firm's competitive activity for two reasons: 1) greater access to deploy supplier resources and 2) increased implementation performance.

One of the primary reasons for concentrating the supply base is to commit to important suppliers and build stronger relationships (Arora et al., 2020). Strong relationships with suppliers are increasingly important to take on competitors and effectively respond to dynamic changes in market demands (Flynn et al., 2010; Handfield et al., 2015). Such relationships better facilitate collaboration and the transfer of supplier knowledge and capabilities (Cousins & Menguc, 2006) affording a firm greater access to mobilize supplier resources for its own benefit (Dong et al.,

2020). Therefore, concentrating the supply base increases suppliers' willingness to serve the firm and dedicate its resources to support the firm's competitive initiatives, thereby leading to more effective competitive actions.

It is also important to consider the implementation of competitive actions. Competitive actions disrupt organization processes requiring adaptations both internally and among connected partners (Barnett & Hansen, 1996) including direct suppliers. Importantly, adaptations can accumulate substantial costs and time investments to the point that the costs may outweigh any benefits of the action (Barnett & Hansen, 1996). We argue that supply base concentration has a bearing on the successful implementation of competitive actions, thereby enhancing or diminishing the performance gains attainable from a firm's competitive activity.

A concentrated supply base is expected to increase the efficient and effective execution of processes to meet the firm's demands (Autry & Griffis, 2008). By rationalizing the supply base, a firm is able to focus more effort to optimize a limited number of supplier relationships, eliminate inefficiencies, and reduce transaction costs (Swink & Zsidisin, 2006). Supplier interactions become more frequent and allow for a stronger supplier understanding of the firm's products, operations, and strategies (Moeen et al., 2013). Taken together, more concentrated supply bases increase supplier know-how and responsiveness to serve and adapt to a firm's needs (Choi & Krause, 2006; Dong et al., 2020). Therefore, competitive actions which place new requirements on the supply base to adapt will be implemented more seamlessly and less costly if the supply base is more concentrated. Based on the preceding arguments we hypothesize:

> **Hypothesis 5:** Supply base concentration positively moderates the relationship between a firm's competitive action intensity and its financial performance.

Methodology

Data sources and sample construction

We draw a sample of publicly traded U.S. firms from multiple archival sources to empirically test our hypotheses. We started by capturing firm-supplier relationships using the FactSet Revere dataset. FactSet reports interfirm relationships from corporate disclosures such as 10-k filings, investor presentations, press releases, and various other forms of public corporate information. We connected firms to suppliers reported by any given firm and similarly linked the firm to suppliers that reported the firm as a customer.

Next, we matched[4] and imported firm- and industry-level financial data from Compustat Fundamentals Annual and firm-, supplier-, rival-, and supplier's rival-level competitive activity from the RavenPack News Analytics dataset. RavenPack reports firm-level activities captured and coded from the textual analyses of major news media sources. Their algorithm categorizes each event into specific action-level observations allowing users to isolate specific types of firm actions for large-scale archival analysis. RavenPack has become increasingly prevalent in academic research, particularly research on competitive actions and interactions (i.e., Connelly et al., 2017; Hill et al., 2018; Connelly et al., 2019; Guo et al., 2020). Finally, the Bureau of Economic Analysis' input-output tables were used to gather industry-to-industry sales volumes used to weight supplier measures and generate our measure of supply base concentration.

The focus of our research requires the assessment of firms' and their suppliers' interactions in the competitive environment. As such, the sample is limited to observations where

[4] Each dataset uses unique firm identifiers complicating the matching process. We started by matching firms across datasets using unique keys such as a CUSIP or ISIN numbers. Next, we used an automated fuzzy matching process based on firm names across datasets. Following the recommendation of recent research, each match on firm names was manually verified to minimize coding errors (Lu and Shang, 2017).

we are able to identify and measure the firm's active engagement in competitive activity vis-à-vis its rivals and the same for its supply base vis-à-vis the suppliers' rivals. In total, 95,094 dyad-year observations with complete information satisfy this criterion where at least a single competitive action is deployed and captured for the firm, its supplier, and their respective rivals. The average supplier relationship is captured in the sample for 3.1 years, and firms have an average of 7.1 suppliers identified for the construction of their supply base competitive action measures.

Given the unit of analysis is the firm-year, all supplier and dyadic measures in the theoretical model are aggregated to the focal (customer) firm-year. Following recent supply base research, a weighted average approach is taken such that more important suppliers receive a higher weight (Dong et al., 2020). While an ideal weight would be dyad-specific transactions, this information is only required to be disclosed in a supplier's 10-k report if the focal firm accounts for 10% or more of the supplier's annual revenues. FactSet offers a much broader identification of supply chain relationships beyond 10-k disclosures, thereby allowing us to capture a greater extent of the supply base. However, transaction level data for the connected supplier is only present in approximately 9.6% of the dyadic observations. To address this concern and retain the full base of supplier information, we instead use industry-level procurement data to weight the observations based on the importance of the suppliers' industry affiliations to that of the focal firm. Specifically, these measures are weighted by the percentage of the focal firm's industry's purchases accounted for by the connected supplier's industry.

After aggregation, the final sample consists of 12,340 firm-year observations representing an unbalanced panel of 2,340 unique firms. The dataset spans 2008-2018 with an average panel length of 5.3 years. Further, the sample is comprised of a broad range of heterogenous focal

firms accounting for 175 unique 4-digit NAICS industry classifications. We present the distribution of industry memberships for firms and their suppliers in Table 1.

TABLE 1: Sample composition by industry

2-digit NAICS	Industry classification description	Focal firm percentage	Supplier percentage
33	Manufacturing	34.21%	29.20%
32	Manufacturing	16.27%	19.84%
51	Information	8.55%	15.80%
21	Mining	7.84%	7.09%
44	Retail trade	5.24%	0.68%
42	Wholesale trade	4.32%	3.25%
31	Manufacturing	4.15%	3.51%
54	Professional, scientific, and technical services	3.48%	4.52%
45	Retail trade	3.19%	0.53%
72	Accommodation and food services	2.94%	1.06%
48	Transportation and warehousing	1.93%	3.13%
23	Construction	1.38%	1.12%
53	Real estate rental and leasing	1.26%	1.03%
62	Health care and social assistance	1.17%	0.47%
56	Administrative and support, waste management, and remediation services	0.92%	1.48%
52	Finance and insurance	0.88%	3.69%
71	Arts, entertainment, and recreation	0.75%	0.44%
22	Utilities	0.59%	2.48%
61	Educational services	0.34%	0.24%
81	Other services	0.29%	0.15%
11	Agriculture, forestry, fishing, and hunting	0.17%	0.15%
49	Transportation and warehousing	0.13%	0.15%

Dependent Variable

Our dependent variable, financial performance, is operationalized using Tobin's Q (*TobinQ*)—market value divided by total assets. A firm's market value is calculated as the sum of common share market value, book value of preferred stock, long-term debt, inventories, and current liabilities minus current assets (Modi & Mishra, 2011). Tobin's Q is a measure of the firm's market valuation, thereby accounting for both current performance as well as intangible

assets and longer-term expectations of growth and profitability (Lu & Shang, 2017). Competitive actions consist of both quick, easy to implement tactical actions and strategic actions, which require major resource and time requirements before the realized value can be appropriated by the acting firm (Chen et al., 1992: Guo et al., 2020). Tobin's Q, therefore, offers an advantage over accounting-based measures[5] when studying competitive dynamics because it factors in short- and long-term performance. Further, Tobin's Q is more comparable across different industry conditions, making it advantageous when considering a diverse sample of heterogenous firms and industries (Dezső & Ross, 2012).

Independent variables

The RavenPack dataset is reported at the level of a single event. Each event is tied to an entity and includes a time stamp for the associated news source which reported it. We start by removing observations with a relevance score less than 100 to omit instances where the firm is not a key part of the story (Hill et al., 2018). We also remove observations with an event novelty score (ENS) below 100. ENS represents how new the story is, thus, allowing us to filter out duplicate events reported on repeatedly or by multiple news outlets (Hill et al., 2018).

We follow Connelly et al. (2017; 2019) to code and categorize RavenPack events as competitive actions. Specifically, we capture ten types of competitive actions including: acquisitions, new products, marketing, alliances, capacity-related, mergers, pricing, joint ventures, legal, and market expansion. We consider all peer firms operating in the same four-digit NAICS classification when defining the field of rivals (Connelly et al., 2017). The level of competitive activity varies significantly by industry segment with firms implementing as few as

[5] For a robustness test, we consider ROA, an accounting-based metric, as an alternative measure of financial performance.

one competitive action in a given year or up to 1,179 actions. Firms, on a yearly basis, deploy an average of 30.55 competitive actions across 3.51 action category types.

Competitive action intensity (*ActionIntensity*) represents the number of competitive actions relative to rival firms. To measure this, we generate a count of a firm's annual competitive actions and standardized this number within each corresponding industry-year (Hill et al., 2018). The measure, therefore, accounts for differences in the level of competition across industries and captures the firm's actions relative to firms operating in the same competitive environment. Supply base competitive action intensity (*S_ActionIntensity*) is captured in the same manner for each individual supplier and standardized within the supplier's four-digit NAICS classification. Each supplier value is then aggregated to the supply base using the weighted average approach outlined previously.

Competitive repertoire alignment (*RepAlignment*) represents the extent to which a firm engages in the same types of competitive actions as its base of suppliers. We adapt Connelly et al.'s (2019) measure of competitive dissimilarity to measure this variable. Specifically, we take the Euclidian distance of the proportion of a firm's competitive actions to that of its supplier across each of the ten competitive action categories. This is, then, multiplied by -1 such that a value of "0" represents perfect alignment and more negative values represent an increased level of misalignment. The calculation can be expressed as:

$$RepAlignment = -1 * \sqrt{\sum_{k=1}^{10}(\mathrm{p}_{ikt} - \mathrm{p}_{skt})^2}$$

where *i* denotes the focal firm, *s* denotes the supplier, *k* denotes the competitive action category, *t* denotes the year, and the proportion of the firm's (supplier's) total competitive actions classified

as action type (*k*) is represented as P. Since this is a dyadic measure specific to each supplier in the supply base, it is aggregated in the same manner as the supplier-level variables.

Our final independent variable is supply base concentration (*SuppBaseConcentration*) which indicates the extent that a firm's similar purchases are more (less) concentrated to fewer (more) suppliers. We calculate supply base concentration using a variant of the Herfindahl-Hirschman Index to estimate the sum of squared revenue shares for the base of suppliers (Moeen, et al., 2013; Schwieterman et al., 2018; Dong et al, 2020) as follows:

$$SuppBaseConcentration = \sum_{s=1}^{s}\left(\frac{indproc_{imsjt} \div n_{isjt}}{\sum_{j=1}^{j} indproc_{imjt}}\right)^2$$

where *i* represents the focal firm, *m* represents the focal firm's industry, *s* represents the supplier, *j* represents the supplier's industry, and *t* represents the year. Therefore, $indproc_{imsjt}$ refers to the percentage of focal firm *i*'s industry *m*'s procurement percentage from supplier *s*'s industry *j* in year *t*. Since there are often multiple suppliers from the same industry tied to a focal firm, we divide this by n_{isjt}, or the number of suppliers from supplier *s*'s industry *j* tied to the focal firm *i* in year *t*, to split the revenue share among shared industry suppliers. Following Dong et al., (2020), the denominator refers to the estimated capture of supply base revenue percentage such that we sum the $indproc_{imjt}$ across all *j* captured supply base industries connected with the focal firm *i* in year *t*.

Control variables

We include several control variables to mitigate the influence of omitted variables confounding the relationships of interest. First, we include several firm-level variables that are known to predict firm financial performance. We include firm size (*FirmSize*) measured as the

natural logarithm of the number of employees (Hill et al., 2018). R&D intensity (*R&DIntensity*) is also controlled for and calculated as a firm's R&D expenses divided by total sales (Dong et al., 2020). Since firm-level efficiency is also a strong predictor of a firm's financial performance (Lu & Shang, 2017), we employ Modi and Mishra (2011)'s measures for marketing efficiency (*MktEfficiency*), production efficiency (*ProdEfficiency*), and inventory efficiency (*InvEfficiency*). These controls are operationalized as the ratio of a firm's selling, general and admin expenses; gross property, plant, and equipment; and average inventories to the firm's total sales, standardized within each industry-year.

We also control for a firm's competitive repertoire complexity (*RepComplexity*). This refers to the diversity and dynamism of a firm's repertoire of competitive activity and is commonly employed in competitive dynamics research predicting performance (Connelly et al., 2017). We utilize Connelly et al. (2017)'s composite measure to calculate *RepComplexity*, accounting for the diversity of repertoire actions, the change in repertoire actions, and the engagement in new action types. The diversity of repertoire actions is calculate using the Shannon index of the proportion of competitive actions across the 10 action categories. The change in repertoire actions is measured by taking the Euclidean distance of a firm's actions repertoires across all action categories in time *t* and time *t-1*. Finally, engagement in new action types is calculated as the number of action categories in which a firm deployed competitive actions in time *t* but not time *t-1*. Each of these three components are standardized within the industry-year and summed to form the measure of *RepComplexity*.[6]

[6] Interested readers can refer to Connelly et al. (2017) for more detail on how competitive repertoire complexity is calculated.

Industry-level controls are also included in the model to account for time-variant qualities of the competitive environment. We control for industry concentration (*IndConcentration*), calculated using the Herfindahl-Hirschman Index—sum of squared industry market shares (Guo et al., 2020). Next, we fit a time series regression of industry sales over a five-year rolling window. The regression coefficient is divided by total industry sales and included in the model to control for industry munificence (*IndMunificence*) (Connelly et al., 2017). The standard error is similarly divided by total industry sales and included in the model to account for industry dynamism (*IndDynamism*) (Connelly et al., 2017).

Finally, we control for a number of supply base characteristics. First, we control for supply base financial performance (*S_TobinQ*) operationalized using Tobin's Q and calculated in the same manner as the dependent variable. We also control for extent that a firm and its rivals share suppliers (*S_RivalTies*), measured as the number of ties a supplier holds in a given year to other firms in the focal firm's industry. Last, we control for the number of competitively active suppliers captured in the dataset (*ActiveSupp*). All of these measures are at the supplier-level and were, therefore, aggregated using a weighted average of supplier industry revenue percentage.

Analysis

Descriptive statistics

Descriptive statistics and pairwise correlations are presented in Table 2. To limit the influence of extreme values, we winsorized all predictors at the 1st and 99th percentile of their respective distributions (Kim & Zhu, 2018). Pairwise correlation coefficients are generally moderate to low. With the exception of the correlations of *ActionIntensity* with *RepComplexity* (ρ

= 0.643)[7] and *ActiveSupp* (ρ = 0.501), all other correlations coefficients are below 0.5. To assess multicollinearity among the variables, we compute the variance inflation factors (VIF). All VIF statistics are below the recommended threshold of five with an average of 1.29 and a maximum value of 2.09 for *ActionIntensity*. Therefore, multicollinearity does not appear to be a concern.

Estimation method

We estimate a mixed effects model which accounts for both within- and between-firm variance (Certo et al., 2017). We originally considered a fixed effects estimation to test our theoretical model in order to account for time-invariant and firm-specific heterogeneity comprising our diverse sample. However, fixed effects models are limited to the estimation of within-firm variance (Certo et al., 2017) making it a poor fit for competitive dynamics theory which is rooted in the performance of firms relative to their rivals. Supporting this conclusion, we assessed the intraclass correlation coefficient for the dependent variable finding that 72.5% of the variance occurs between firms.

Mixed effects models recognize hierarchical grouping interdependencies by estimating random effects at multiple levels of which an observation is nested. Specifically, we estimate a 3-level nested mixed effects model such that each observation (level one) is a repeated observation of a given focal firm (level two) which is nested within the firm's horizontal competitive environment—classified as the 4-digit NAICS industry segment. Such an approach is advantageous for competition research as it models group-level residual correlations to account for the inherent differences of individual firms as well as the varied competitive norms and intensities that define the specific industry segment (Connelly et al., 2017).

[7] We replicated the main analysis excluding *RepComplexity* and the estimates are consistent with the results presented in Table 3.

TABLE 2: Descriptive statistics and pairwise correlations

	Variable	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	TobinQ	1.464	1.174																
2	ActionIntensity	0.395	1.190	0.061*															
3	S_ActionIntensity	0.643	1.279	0.051*	-0.097*														
4	RepAlignment	-0.577	0.276	0.075*	0.163*	0.125*													
5	SuppBaseConcentration	0.050	0.087	0.067*	-0.070*	0.025*	-0.008												
6	FirmSize	1.659	1.986	-0.110*	0.421*	-0.219*	0.052*	-0.141*											
7	R&Dintensity	0.077	0.179	0.262*	-0.028*	0.114*	0.010	0.198*	-0.393*										
8	MktEfficiency	0.118	0.842	-0.065*	0.104*	-0.034*	0.004	-0.003	0.234*	-0.245*									
9	ProdEfficiency	-0.070	0.690	0.059*	-0.053*	0.044*	-0.005	0.026*	-0.142*	-0.043*	0.120*								
10	InvEfficiency	0.009	0.761	0.087*	0.040*	-0.029*	0.011	-0.009	0.050*	-0.049*	0.078*	0.074*							
11	RepComplexity	0.548	2.120	0.036*	0.632*	-0.081*	0.168*	-0.039*	0.319*	-0.012	0.076*	-0.047*	0.039*						
12	IndConcentration	0.289	0.229	-0.007	-0.053*	-0.037*	0.004	-0.097*	0.049*	-0.141*	0.005	0.015	0.042*	-0.053*					
13	IndMunificence	0.029	0.079	0.070*	-0.000	0.038*	-0.074*	-0.019*	0.018*	0.045*	0.026*	0.022*	-0.002	0.008	-0.003				
14	IndDynamism	0.026	0.022	-0.106*	-0.008	-0.007	-0.020*	0.048*	-0.133*	-0.086*	0.002	0.026*	-0.005	-0.005	0.106*	-0.116*			
15	S_TobinQ	1.485	0.941	0.202*	0.047*	0.124*	0.048*	-0.002	-0.048*	0.138*	-0.022*	0.008	-0.014	0.015	-0.025*	0.039*	-0.093*		
16	S_RivalTies	2.971	4.503	0.058*	0.002	0.135*	0.059*	0.120*	-0.116*	0.247*	-0.030*	0.015	-0.015	-0.015	-0.340*	0.002	-0.092*	0.020*	
17	ActiveSupp	7.506	11.983	-0.048*	0.501*	-0.060*	0.101*	-0.069*	0.490*	-0.070*	0.122*	-0.050*	0.063*	0.313*	-0.057*	-0.021*	-0.101*	0.010	0.028*

* $p < 0.05$.

All variables previously described are presented in the fixed part of the model with random effects intercepts estimated for the focal firm and the focal firm's industry. Dummy variables for the corresponding year are also included to account for time fixed effects. Finally, to account for heteroskedasticity, we utilize robust standard errors clustered within the industry segment—the highest level of the nested structure. The empirical model is expressed with the following equation (1):

$$TobinQ_{imt} = \alpha_0 + \beta_1 ActionIntensity_{imt} + \beta_2 S\_ActionIntensity_{imt} + \beta_3 RepAlignment_{imt} + \beta_4 S\_BaseConcentration_{imt} + \beta_5 ActionIntensity_{imt} \times RepAlignment_{imt} + \beta_6 ActionIntensity_{imt} \times S\_BaseConcentration_{imt} + \phi_{imt} + \alpha_i + \alpha_m + \gamma_t + \varepsilon_{imt} \quad (1)$$

where *i* refers to the focal firm, *m* refers to the focal firm's industry, and *t* refers to the year. The overall intercept is denoted as α_0, and the random effects intercepts for the firm and industry are represented as α_i and α_m, respectively. The fixed effects for the vector of control variables are represented as ϕ_{imt}. Finally, the time fixed effects are shown as γ_t, and the error term is expressed as ε_{imt}.

Empirical results

The main results are presented in Table 3. We first model the control variables only in Panel 1 and then incrementally introduce the variables of interest and interactions in Panels 2 and 3, respectively. The AIC and BIC statistics both decrease with the addition of variables across panels indicating that the model's predictive power improves as we introduce the relationships of interest. Focusing on the control variables first, there are several significant relationships with the dependent variable, *TobinQ*. Consistent with Modi and Mishra (2011), we find that firm size is negatively associated with Tobin's Q. Conversely, R&D intensity, the three efficiency measures (marketing efficiency, production efficiency, and inventory efficiency), and

competitive repertoire complexity are all associated a firm's superior financial performance. Finally, the positive and significant coefficient estimates for *IndMunificence* and *S_TobinQ* suggest that firms operating in more munificent industries and tied to higher performing suppliers are associated with greater financial performance. With the exception of *RepComplexity*, which loses statistical significance with the introduction of the variables of interest, all other control variables produce consistent estimates across the three regression panels.

We assess hypotheses 1-3 through the coefficient estimates in Panel 2. First, our baseline hypothesis (1) predicts a positive association between a firm's competitive action intensity and its financial performance. In line with prior competitive dynamics research, the positive and statistically significant coefficient estimate of *ActionIntensity* ($\beta = 0.050, p < 0.01$) draws support for Hypothesis 1. Hypothesis 2 predicts a positive effect of supply base competitive action intensity on financial performance. The coefficient for *S_ActionIntensity* is not statistically significant, and thus Hypothesis 2 is not supported. Hypothesis 3 predicts that competitive repertoire alignment between a firm and its supply base will have a positive effect on the firm's financial performance. The coefficient estimate for *RepAlignment* is positive and statistically significant ($\beta = 0.066, p < 0.01$), providing support for Hypothesis 3.

Hypotheses 4-5 are assessed with the coefficient estimates of the interaction terms introduced in Panel 3. Hypothesis 4 predicts that greater competitive repertoire alignment with the supply base will enhance the positive relationship between a firm's competitive action intensity and its financial performance. The coefficient estimate for *ActionIntensity x RepAlignment* ($\beta = 0.081, p < 0.01$) provides evidence in support of this hypothesis as predicted. Finally, Hypothesis 5 posits that greater supply base concentration will enhance the

effectiveness of a firm's competitive action intensity. *ActionIntensity x SuppBaseConcentration* has a positive and significant coefficient ($\beta = 0.113$, $p < 0.05$) suggesting that firms with a concentrated supply base have a stronger positive association between competitive action intensity and financial performance, thereby supporting Hypothesis 5. In sum, four of the five hypotheses receive empirical support including the baseline hypothesis, one of two collective competition hypotheses, and both relationship-enabled competition hypotheses.

TABLE 3: Mixed effects regression results

	(1)		(2)		(3)	
DV:	TobinQ		TobinQ		TobinQ	
SuppBaseConcentration	0.258	(0.225)	0.267	(0.225)	0.232	(0.206)
FirmSize	-0.054**	(0.017)	-0.067**	(0.017)	-0.066**	(0.017)
R&Dintensity	0.580**	(0.137)	0.570**	(0.138)	0.568**	(0.137)
MktEfficiency	0.048*	(0.024)	0.049*	(0.024)	0.047*	(0.024)
ProdEfficiency	0.122**	(0.026)	0.121**	(0.026)	0.121**	(0.026)
InvEfficiency	0.139**	(0.028)	0.139**	(0.028)	0.139**	(0.028)
RepComplexity	0.013**	(0.004)	0.004	(0.004)	0.004	(0.004)
IndConcentration	0.110	(0.139)	0.119	(0.137)	0.118	(0.137)
IndMunificence	0.663**	(0.153)	0.672**	(0.150)	0.665**	(0.153)
IndDynamism	0.175	(0.600)	0.164	(0.598)	0.156	(0.600)
S_TobinQ	0.054**	(0.019)	0.054**	(0.018)	0.054**	(0.018)
S_RivalTies	0.000	(0.005)	0.001	(0.005)	0.001	(0.005)
ActiveSupp	-0.003	(0.003)	-0.004	(0.003)	-0.003	(0.003)
ActionIntensity			0.050**	(0.014)	0.042	(0.031)
S_ActionIntensity			-0.011	(0.010)	-0.011	(0.010)
RepAlignment			0.066*	(0.030)	0.059*	(0.029)
ActionIntensity x RepAlignment					0.081**	(0.030)
ActionIntensity x SuppBaseConcentration					0.113*	(0.044)
Constant	0.831**	(0.065)	0.899**	(0.071)	0.893**	(0.071)
Year Fixed Effects	Yes		Yes		Yes	
N	12,340		12,340		12,340	
AIC	29378.3		29354.66		29332.29	
BIC	29578.66		29577.27		29569.75	

** p<0.01; * p<0.05; # p<0.1. Robust standard errors are shown in parentheses.

Robustness testing

We replicate our main analysis with an alternative dependent variable and an alternative estimation method to evaluate the robustness of our results. First, we consider return on assets (*ROA*)—net income divided by total assets—as the measure of financial performance to test the sensitivity of the results to variations in the measurement of the dependent variable. The results of the alternative DV robustness test are presented in Table 4, Panels 1-2. The relationships of interest are qualitatively identical when predicting ROA and provide additional support for the interpretation of the main results.

We, next, replicated our research model using an alternative method and level of standard error clustering (Dong et al., 2020). There are many sources of heteroskedasticity, and it can occur at different levels of the nested data structure (Andrews et al., 2006). As such, we elected to estimate a random effects (RE) regression and incorporate a robust standard error correction clustered at a lowest level group (the firm). We, further, included dummy variables for the year and four-digit NAICS classification to account for fixed time effects and fixed industry effects in the estimation. The results of the RE estimation are presented in Table 4 Panels 3-4. The results are largely similar to the main analysis, albeit the support for the direct effect of *RepAlignment* is statistically weaker ($\beta = 0.063, = 0.072$). Importantly, the results of the two sensitivity tests support of the interpretation of the main results and provide additional evidence of the predicted associations in hypotheses 1, 3, 4, and 5.

TABLE 4: Robustness results with alternative DV (ROA) and alternative method (RE)

	(1)		(2)		(3)		(4)	
DV:	ROA		ROA		TobinQ		TobinQ	
SuppBaseConcentration	0.027	(0.024)	0.025	(0.023)	0.246	(0.172)	0.209	(0.171)
FirmSize	0.023**	(0.003)	0.023**	(0.003)	-0.075**	(0.018)	-0.074**	(0.018)
R&Dintensity	-0.391**	(0.037)	-0.391**	(0.037)	0.519**	(0.189)	0.516**	(0.189)
MktEfficiency	0.030**	(0.004)	0.030**	(0.004)	0.051*	(0.021)	0.049*	(0.021)
ProdEfficiency	0.010**	(0.004)	0.010**	(0.004)	0.121**	(0.023)	0.121**	(0.023)
InvEfficiency	0.015**	(0.003)	0.015**	(0.003)	0.138**	(0.021)	0.138**	(0.021)
RepComplexity	-0.000	(0.001)	-0.000	(0.001)	0.004	(0.004)	0.005	(0.004)
IndConcentration	-0.002	(0.013)	-0.002	(0.013)	0.125	(0.120)	0.126	(0.120)
IndMunificence	0.128**	(0.027)	0.128**	(0.027)	0.654**	(0.125)	0.646**	(0.124)
IndDynamism	-0.068	(0.068)	-0.069	(0.068)	0.429	(0.576)	0.419	(0.575)
S_TobinQ	0.002	(0.002)	0.002	(0.002)	0.051**	(0.017)	0.051**	(0.017)
S_RivalTies	0.001	(0.001)	0.001	(0.001)	0.000	(0.005)	0.000	(0.005)
ActiveSupp	-0.001**	(0.000)	-0.001*	(0.000)	-0.004#	(0.002)	-0.003	(0.002)
ActionIntensity	0.003*	(0.002)	0.004	(0.003)	0.052**	(0.014)	0.044	(0.027)
S_ActionIntensity	-0.002	(0.001)	-0.002	(0.001)	-0.011	(0.011)	-0.012	(0.011)
RepAlignment	0.011*	(0.006)	0.011*	(0.005)	0.063#	(0.035)	0.055	(0.035)
ActionIntensity x RepAlignment			0.006*	(0.003)			0.082**	(0.031)
ActionIntensity x SuppBaseConcentration			0.007*	(0.003)			0.115**	(0.033)
Constant	-0.052**	(0.008)	-0.052**	(0.008)	0.312*	(0.144)	0.298*	(0.136)
Year Fixed Effects	Yes		Yes		Yes		Yes	
Industry Fixed Effects					Yes		Yes	
N	12,340		12,340		12,340		12,340	

** p<0.01; * p<0.05; # p<0.1. Robust standard errors are shown in parentheses.

Discussion

Discussion of results

This study integrates literature and theory on competition and supply chain management to develop a research model that jointly considers firms and their supply bases engaging in horizontal competitive activity. The empirical analyses extend existing research by presenting evidence in support of supply base partners contributing to and facilitating a firm's competitive prospects. Among the notable findings, it is important to first highlight the baseline hypothesis in

which we find consistent and robust evidence that a firm's competitive action intensity is associated with superior financial performance. The rise in strategic supply chain management and group-level competitive engagement does not negate firm-level competition nor the need for firms to actively deploy competitive actions (Silverman & Baum, 2002). Failure to remain competitively active will inevitably lead to firms getting passed by more active rivals adapting to the changes in the market (Jacobson, 1992; Derfus et al., 2008).

Under the premise of collective competition, we did not find empirical support for a positive association between supply base competitive action intensity and financial performance. While supplier competitive actions can arguably benefit a firm, suppliers seldomly sell exclusively to one customer. As such, clearly demarcated, closed groupings of supply chain collectives competing against each other is more myth than reality. Thus, as a supplier implements competitive actions—which are "externally directed, specific, and observable" (Ferrier et al., 1999, pgs. 377-378)—the benefits from supply base competitive activity are likely quickly nullified by the efficiency of the factor market as the firm and its rivals adjust procurement allocation to superior and more competitively active suppliers. Conversely, internally directed supply base actions such as the develop of relationship specific assets and processes with the firm are less visible and imitable for rival firms and may, therefore, act as a better source of competitive advantage (Dyer & Singh, 1998). Taken together, we cannot infer that suppliers engage in the competitive environment to directly compete for their customers nor substitute for the firm's need to implement their own competitive actions.

We introduce the concept of competitive repertoire alignment with the supply base, finding support for a positive effect on a firm's financial performance. Our justification of the direct effect of competitive repertoire alignment still presumes collective competition such that

the firm and its supply base compete together. However, the notion of competitive repertoire alignment driving competitive outcomes differs from supply base competitive action intensity at a core level in that it implies fit with upstream partners rather than exclusivity of access to said partners. As such, shared suppliers and factor market efficiency are less a concern. Rather competitive advantage is contingent on effectively aligning competitive activities within the larger value chain (Porter, 1985) which extends to and involves the upstream supply base (Villena et al., 2011). The deployment of similar competitive actions allows the firm and its supply chain to pool synergistic efforts to greater scale and more firmly entrench the firms in their targeted positions in the competitive environment (Lavie, 2006).

Last, our empirical results provide evidence that both competitive repertoire alignment with the supply base and supply base concentration enhance the performance gains associated with a firm's own competitive actions. Relationship-enabled competition is well supported by these results and premised on the well-recognized notion that competitive actions are a function of the underlying resources held by a firm (Ndofer et al., 2011) and accessible through the firm's cooperative relationships (Mathews, 2003; Lavie, 2006). Considering suppliers as sources of important competitive resources highlights additional considerations for structuring the supply base. Namely, partnering with suppliers that possess experience, capabilities, and resources aligned with the firm's targeted competitive actions can afford the opportunity to combine and leverage complementary supplier resources for deployment in the competitive environment. Further, concentrating the supply base and focusing on stronger development of relationships with fewer suppliers can allow for a more streamlined implementation of competitive activity.

Implications for theory

The primary contribution of this work is the extension of competitive dynamics research to encompass the efforts of partnering firms across multiple supply chain echelons. Research in competitive dynamics has called for a broader conceptualization of competition that accounts for relational embeddedness in cooperative and stakeholder relationships (Chen & Miller, 2015). Our work answers this call and demonstrates how cooperative relationships with upstream supply base partners have an underlying influence on a firm's interactions and appropriation of market outcomes in the horizontal competitive environment. Thus, our study takes an initial step to simultaneously examine and test the performance-driving interactions from a firm's embeddedness in both the horizontal competitive environment and upstream vertical cooperative environment.

The second contribution of this study is the identification and classification of collective competition and relationship-enabled competition as alternative means of partnering firms contributing to a firm's competitiveness. Specific to the supply base, we find mixed evidence in support of collective competition. The results offer no evidence that supply base competitive action intensity directly influences financial performance suggesting that suppliers do not compete *for* their customers, but the positive direct influence of competitive repertoire alignment on financial performance suggests that suppliers may compete *with* their customers. The path of relationship-enabled competition received more consistent support from our study, thereby, highlighting that capabilities, and specifically competitive capabilities, are largely a function of cooperative relationships with supply chain partners and the partners' resources (Squire et al., 2009; Mahmood et al., 2011). To borrow an analogy from Prahalad and Hamel (1990), we can describe this role of the supply base in relationship-enabled competition by considering a firm as

a tree. The firm branches out in the competitive environment deploying competitive actions that are like colorful leaves and flowers increasing the appeal of the tree to others. While less visible the branches and trunk of the tree represent the firm's resources that provide the structure capable of supporting and deploying the competitive actions. And below that further, hidden from view, the roots represent the supply base. The roots do not grow leaves nor flowers, but stronger roots provide the tree with the nutrients necessary to grow bigger and more colorful than the other trees.

The final contribution is to the supply chain literature by providing empirical support that competitive repertoire alignment drives superior performance outcomes. Many supply chain scholars have argued that the alignment of competitive strategies and visions with suppliers and customers is critical to a firm's performance (e.g., Cheng & Grimm, 2006; Revilla & Villena, 2012; Ralston et al., 2015). However, empirical testing has largely been confined to the effects of operational systems and processes, relationship strength and commitment, or the alignment on a singular strategic initiative (e.g., environmental management activities). Our measure of competitive repertoire alignment signifies the extent of congruence across a breadth of competitive initiatives, thereby offering a more comprehensive measure of strategic alignment. Thus, the finding adds strong empirical support that strategic alignment with the supply base is a best practice in supply chain management.

Implications for practice

At a practical level, this study highlights the need for managerial attention on the supply base when developing and deploying competitive strategies. The supply chain is an often-neglected component of a firm's strategic management, where organization leadership may only manage suppliers using a tactical, short-term lens focusing on costs and fulfillment metrics

(Ellram et al., 2013). However, a more comprehensive management of suppliers in terms of the overall fit and support to core strategies can lead to firms extracting performance-driving benefits far beyond the typical details on price, delivery, and quality benchmarks specified in supplier contracts (Hult et al., 2004; Ketchen & Hult, 2007; Azadegan, 2011).

In terms of the implications that guide practice, we summarize specific conclusions of the study that inform managerial conduct. First, supply base action intensity was insignificant in terms of its influence on firm financial performance suggesting that a supply base cannot be counted on to compete for a firm or substitute the firm's own competitive actions. Despite the increasing prevalence and attention on group-based competition, competitive interaction is at the heart of strategic management (Smith et al., 1991), and firms should not detract focus on their own direct engagement in competitive activity. Second, firms should target alignment among the firm's and its supply base's competitive strategies. Such a target may take significant time and effort to cultivate (Gomes-Casseres, 1994; Narayanan & Raman, 2004; Boyer & Hult, 2005), but achieving strategic consensus across upstream organizational boundaries can reinforce the firm's competitive position and the effectiveness of competitive actions executed by the firm. Finally, rationalizing the supply base may improve the implementation performance of competitive actions. Reducing the number of suppliers can simplify the management of suppliers and afford the firm additional leverage over those suppliers (Moeen et al., 2013), each of which will assist the coordination of inter-organizational efforts to adjust to and execute newly deployed competitive activity.

Limitations and Future Research Opportunities

There are, of course, limitations to all theoretical and empirical scholarly work. We note the limitations of this study and present opportunities for future research to address and build upon. First, the structure of the data places restrictions on measurement and modeling techniques. In the end, we elected to aggregate all supplier-level information with the benefit of operationalizing the most comprehensive measures of the variables of interest that incorporate all available supply base information. The tradeoff, however, is that we lose detail on dyad-specific and supplier-specific information. Therefore, the opportunity is foregone to model a firm's nested structure tied to a specific supplier or supplier industry (e.g., Chen & Ho, 2019) and measure dyad-specific relational factors that may explain systematic variations in a firm's ability to appropriate value from the partner's competitive activity (Gnyawali et al., 2006). As such, we encourage future research to consider the supply base's role in competitive dynamics at the dyadic level to examine more micro-level nuance in the extent that suppliers can and do contribute to a firm's competitive outcomes.

Another limitation of this work is that we only consider the indirect role of the supply base supporting a firm's competitive activity by influencing the effectiveness of the firm's competitive actions. An equally justifiable and interesting perspective would be that the supply base can enable the firm to implement more frequent competitive actions. Prior research has referred to the supply base as a source of dynamic capabilities (Handfield et al., 2015) and knowledge of future market opportunities (Arend, 2006) raising many important questions for future research such as: Do supply base competitive actions influence the type of competitive actions or the intensity of competitive actions enacted by a firm? Does the structure of the supply base influence the frequency or diversity of competitive actions implemented by the firm?

A final limitation rests on the employment of pooled counts of annual competitive actions. While such an approach is common in competitive dynamics research, certain supply base competitive actions would be expected to generate more direct and impactful value for a firm. As such, we encourage future research to conduct exploratory analyses on specific types of supplier competitive actions, the divergent influences on the focal firm's outcomes, and potential complementarities (beyond repertoire alignment) from fitting a firm's specific competitive action types vis-à-vis those of its supply base.

Conclusion

Competitive dynamics and supply chain management pose a natural fit for competition research (Grimm, 2008). We believe this work takes a significant step toward the development of a stream of research that marries these two core firm interactions with horizontal rivals and vertical exchange partners. We see tremendous scholarly and practical opportunity and hope that our study stimulates additional research in this promising area.

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V. Conclusion

The purpose of this dissertation is to add a SC perspective to an increased breadth of performance-driving organizational processes. I develop and test theoretically grounded empirical hypotheses that explore the influence of supply chain partners in the contexts of inventory management, organizational governance, and competitive strategy. While each essay is distinct and draws on different firm processes, literature streams, and theoretical frameworks, the dissertation as a whole advances our understanding of the vast opportunities to leverage the supply chain toward superior organizational performance. Taken together, the three essays highlight hidden benefits from SC partners that are likely neglected in favor of shorter-term costs and benchmarks (Ellram et al., 2013; Azadegan, 2011). Beyond the contracted details on the terms of exchange, SC partners provide support to a much larger system of organizational processes and play an integral role in the generation of unique value if structured and managed in such a way to reinforce a firm's operations and strategic initiatives.

The dissertation has important implications into how supply chain partners drive organizational performance. In Essay 1 and 3, I simultaneously consider inventory and competitive strategies implemented by a firm and its supply base. Importantly firm-level "best practices" are not necessarily beneficial for a focal firm if initiated by its suppliers. For example, in Essay 1 a focal firm's inventory leanness generally drives superior financial performance, but supplier inventory leanness is negatively associated with focal firm financial performance. In Essay 3, competitive action intensity, a firm-level best practice, of the supply base did not have a direct effect on a focal firm's financial performance. Rather, supply base competitive actions are only found to be beneficial to the focal firm if they are similar to the actions of the focal firm. Another important implication is that the effectiveness of a firm's strategies is largely conditioned by on the strategies of its suppliers (Mackelprang et al., 2018). For example, Essay 1

found that supplier inventory creates a boundary condition of the inverted U-shaped effect between a firm's own inventory leanness and financial performance. Further, Essay 3 finds that the supply base plays a major role in aiding the firm to implement more successful competitive actions. As such, the atomistic development and execution of firm strategies—even best practices—is severely limited in terms of value generation unless the firm accounts for its placement in the larger system of the value chain activities extending within and across organizational boundaries (Porter, 2001).

The dissertation also contributes to research on SC complementarities. SC complementarities are typically operationalized in research through the consideration of relationship strength, operational integration, operational alignment. This dissertation joins additional research in arguing for the value potential of strategic-level alignment and collaboration (e.g., Revilla & Villena, 2012; Ralston et al., 2015). The empirical results of Essays 2 and 3 provide evidence of the performance-driving potential of both involving SC partners in high-level organizational decision making and aligning competitive strategies with the SC partners, respectively. At the same time, the alignment of goals and operations can also be hazardous. Essay 1 identifies operational tradeoffs between a firm's inventory leanness and that of its suppliers' such that inventory leanness alignment can be quite detrimental to a firm. Further, Essay 2 notes the potential threats of opportunism from inviting a customer to serve on the board of directors. The collective results of the dissertation demonstrate an assortment of opportunities to SC complementarities research and highlight that the value of SC complementarities is contingent on how the firm and its supply chain partners jointly reinforce the targeted initiatives of the firm.

The dissertation also contributes to the development and refinement to multiple theoretical lenses. Essay 1 builds on ERBV through a greater emphasis on resource associated costs. Resource costs are often overlooked in resource-based theory, and research tends to take a "more is better" argument for a firm's resource endowments (Lavie, 2006). By accounting for the internal costs of resources and the transmissibility of resource costs to connected firms, the results capture a more realistic view of resource-based advantage to model optimal holdings, excessive resources, and partner resource substitution. Essay 2, similarly, contributes to agency theory by accounting for dual agency and mutual monitoring systems. Namely, directors are brought on to monitor and mitigate managerial agency but are self-serving agents themselves that are prone to opportunism (Deutsch et al., 2010). The results add insight to the application of director incentives, and mutual monitoring systems that can alleviate the threat of SC directors harming the firm by appropriating private benefits for their home firm.

Finally, Essay 3 contributes to competitive dynamics theory by broadening the conceptualization to competition to include the role of the supply base. Supply chain versus supply chain competition has been proclaimed in research (e.g., Min et la., 2008; Christopher, 2011; Handfield et al., 2015), but this view has seldom been subjected to empirical testing. The results of this dissertation add nuance to the conceptualization of competition beyond a firm and its industry rivals, suggesting that suppliers do not compete *for* their customers but rather that suppliers may compete *with* their customers. Further, the findings suggest that the supply base offers a foundation for a firm to more effectively initiate its own competitive activity. As such, the insights of the study take a step toward broadening the level of competition and rival interactions to include supply chain partners.

Overall, this research opens the door for more research at the intersection of supply chain management and the core firm processes of inventory management, organizational governance, and competitive strategy. More broadly, the investigation of supply chain factors in firm-level operations and strategies is an exciting area of research with tremendous opportunity for empirical and theoretical research.

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