How Coopetition Influences Environmental Performance: Role of Financial Slack, Leverage, and Leanness

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Paper accepted for publication at Production and Operations Management Journal.

Please cite this article at: Modi, S.B., D.E. Cantor. How Coopetition Influences Environmental Performance: Role of Financial Slack, Leverage, and Leanness. Production and Operations Management Journal. (2020). https://doi.org/10.1111/poms.13344

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Abstract

Focal firms are struggling to improve their environmental performance for several reasons, including a scarcity of internal and external environmental resources. This study suggests that coopetition can provide a boost to a focal firm's environmental performance. In particular, this study theorizes that coopetitor firms' environmental performance influences a focal firm's environmental performance. This study also investigates how a focal firm's financial slack, financial leverage, and leanness moderate this relationship. The empirical analysis indicates that coopetitor firms' environmental performance significantly influences a focal firm's environmental performance. This relationship is weaker for firms with higher financial slack and stronger for firms that have lower financial leverage and higher leanness. Collectively, these findings provide important managerial and research implications regarding the consequences of coopetition on a focal firm's environmental performance.

Keywords: Environmental Management; Coopetition; Buyer–Supplier Relationships

1. Introduction

Stakeholders continue to demand that firms improve their environmental performance (Jacobs, Singhal, & Subramanian, 2010; Klassen & McLaughlin, 1996; Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010). However, firms are struggling to meet this objective for several reasons. First, the lack of a universal standard for the reporting of environmental initiatives makes it difficult to demonstrate successful environmental outcomes (Kumar, Cantor, & Grimm, 2019). Likewise, there is a perception of potential conflict between a firm's revenue goals and financial returns that can be gained from environmental investments (Fisher-Vanden & Thorburn, 2011; Friedman, 1970). Further, the executive management team's vision and goals for environmental management might not align with the day-to-day operational decisions made by employees, resulting in principal–agent problems (Wichmann, Carter, Kaufmann, & Wilson, 2016). Perhaps even more relevant to this study, there remains a scarcity of environmental expertise within and outside of a firm's boundaries, which suggests that investment into environmental management can be a source of competitive advantage for a firm (Kaul & Luo, 2018).

In line with this logic, scholars have invested significant effort into assessing how internal and external resources influence a firm's environmental performance (Jacobs, Kraude, & Narayanan, 2016; Melnyk, Sroufe, & Calantone, 2003; Sroufe, 2003). Some scholars have suggested that *internal* resources such as an employee's engagement in environmental behaviors (Wichmann et al., 2016) and the implementation of lean practices (King & Lenox, 2001) can have a positive influence on environmental performance. However, other scholars remain cautious about suggesting that internal resources can improve firm environmental performance because organizational support structures need to be in place to leverage such resources (Cantor, Morrow, & Montabon, 2012).

Likewise, some scholars suggest that *external* resources in a firm's network can influence its environmental performance (Bellamy, Dhanorkar, & Subramanian, 2020; Hofer, Cantor, & Dai, 2012; Sarkis et al., 2010). For example, Hofer et al. (2012) provide evidence that rival firms (i.e., competitors) observe and attempt to mimic other firms' environmental actions. A related stream of research suggests that relationships with suppliers may help a firm to improve its environmental performance (Sarkis, Zhu,

& Lai, 2011). However, there are concerns about the effectiveness of suppliers in supporting a focal firm's environmental improvement goals (Mentzer, Min, & Zacharia, 2000). Some researchers note that a focal firm can become exposed to considerable risk when working with suppliers and that such effort often fails or harms a buyer firm's reputation (Kumar et al., 2019; Villena & Gioia, 2018). Nevertheless, there is evidence that cooperative buyer–supplier relationships can be fruitful in situations when the appropriate firm resources and governance structures are in place (Kumar et al., 2019).

It is important to consider alternative structures that can boost a focal firm's environmental performance. In this study, we examine coopetition, defined as a situation where two competitors cooperate in a sourcing relationship. Indeed, to the best of our knowledge, the existing literature has not yet examined coopetition's[2] effect on a focal firm's performance. While some research suggests that collaborating with competitors may yield certain benefits (Doz, Hamel, & Prahalad, 1989; Lado, Boyd, & Hanlon, 1997), other scholars call into question the efficacy of such cooperation (Park & Russo, 1996; Wilhelm, 2011) and highlight that such relationships are inherently imbalanced (Sytch & Tatarynowicz, 2014; Wilhelm, 2011), thus making coopetition risky, unstable, complex, and difficult to manage (Nair, Narasimhan, & Bendoly, 2011; Park & Russo, 1996; Wu & Choi, 2005). Nevertheless, given that there are reasons to believe that benefits to coopetition exist (Doz et al., 1989), it is important to examine the influence of coopetition on a focal firm's environmental performance.

The purpose of this study, then, is to develop a theoretical model that explores how coopetition can enable focal firms to leverage environmental resources in an inter-organizational context. We further enhance our examination of coopetition by focusing on two critical internal resources that are important determinants of a focal firm's environmental performance: financial resource position (Waddock & Graves, 1997) and lean operations (King & Lenox, 2001). Therefore, we propose that a focal firm's financial resource position and a focal firm's leanness serve as important contingencies that govern the extent to which coopetitors influence a focal firm's environmental performance. In doing so, we

[2] Briefly, coopetition exists when a firm holds two different types of roles, which embody competition and cooperation, in a business relationship with another firm (Nalebuff & Brandenburg, 1996).

conceptualize and test a model that answers these research questions: 1) to what extent does the coopetitors' environmental performance influence a focal firm's environmental performance; and 2) what is the role of a focal firm's financial resources (i.e., financial slack and financial leverage), and leanness in the relationship between coopetitor firms' and focal firm's environmental performance? Further, previous research in operations management has not compared single-role relationships (such as competitive or cooperative ties) to multiplex relationships (such as coopetition) (Slot, Wuyts, & Geyskens, 2020) on a focal firm's environmental performance. Thus, we take this opportunity to compare the influence of competitors, suppliers, and coopetitors' environmental performance on a focal firm's environmental performance.[3]

Our study makes multiple theoretical and empirical contributions to the literature. First, this is the first study to theoretically investigate why coopetition can improve a focal firm's environmental performance. As such, we build upon prior environmental management research that has studied competitors (e.g., Hofer et al., 2012) and suppliers (Sarkis et al., 2011) independently. In so doing, we provide clarity on why competition with rivals and cooperation with suppliers may not provide sufficient resources to enhance a focal firm's environmental performance. Thus, our investigation of the coopetition structure helps to fill this important void in the literature. Second, we also identify important internal resource contingencies that can influence the effectiveness of coopetition on a focal firm. Specifically, we investigate how financial slack, financial leverage, and leanness facilitates the spillover of environmental management practices from a coopetitor to a focal firm. Third, there is increased academic and practitioner interest on the broader topic of coopetition because of the prevalence of such relationship structures in today's economy. This is because coopetition represents a type of multiplex relationship or relationship pluralism (i.e., two firms that are connected by two distinct inter-firm ties that represent different roles). Several operations management scholars suggest that it is important to examine the role of complex relationship structures (Park & Russo, 1996; Pathak, Wu, & Johnston, 2014; Wilhelm, 2011)

[3] We would like to thank our reviewer for encouraging us to explore this issue in more detail.

because inter-firm ties provide the focal firm with needed expertise which can have a direct bearing on a firm's actions and performance (Khanna, Gulati, & Nohria, 1998; Lado et al., 1997; Slot et al., 2020). Further, multiplexed relationships such as coopetition are becoming increasingly prevalent in industry (Shipilov, Gulati, Kilduff, Li, & Tsai, 2014; Slot et al., 2020). Therefore, we contribute to this literature by examining the performance implications of coopetition. Fourth, while coopetition and environmental management both represent important aspects of operations management, research to date has often treated these topics independently. As such, we add to the literature by integrating these streams of research. Finally, to the best of our knowledge, previous research in sustainable operations management has not explored how coopetition compares with other types of inter-firm structures (i.e., competition or cooperation) on a focal firm's environmental performance (e.g., Slot, Wuyts, & Geyskens, 2020). In so doing, we demonstrate that focal firms are able to improve their environmental performance through participation in coopetion while controlling for the effects of cooperation and competition.

We empirically test our research questions by creating a unique panel data set that is constructed from multiple data sources, including Facset Revere, Kinder, Lydenberg, Domini Research and Analytics Inc. (KLD), and Compustat. The rest of this paper is organized as follows. The next section presents our conceptual development and formal hypotheses (Section 2). In Section 3, the methodology is described. This is followed by a presentation of our empirical results (Section 4). We discuss the managerial and theoretical implications of the findings of our study and conclude the paper in Section 5.

2. Conceptual Development

The coopetition literature serves as the primary theoretical lens for this study (Khanna et al., 1998; Lado et al., 1997; Li, Liu, & Liu, 2011; Pathak et al., 2014; Wilhelm, 2011). Our theoretical perspective is similar to a variety of coopetition arrangements that have been previously examined in the literature (Nalebuff & Brandenburger, 1996). For example, the top management team can encourage coopetition where multiple units within a firm are called upon to work jointly in cross-functional teams (Luo, Slotegraaf, & Pan, 2006). Other scholars have studied inter-firm coopetition, wherein competitors institute governance mechanisms in support of collaborative work at the same stage of the value chain

(Gnyawali, He, & Madhavan, 2006) or at adjacent supply chain stages (e.g., manufacturer and distributor) (Li et al., 2011; Nair et al., 2011). Coopetition is also said to facilitate a buying firm's desire for two suppliers to work together, thereby creating instances where the two suppliers compete for a buying firm's business while also engaging in supplier-to-supplier cooperation (Wu & Choi, 2005). As noted earlier, in this study, we examine coopetition in situations where two competitors cooperate via sourcing relationships (Nalebuff & Brandenburger, 1996).

The literature describes that coopetition relationships are primarily strategic in nature and can be characterized as multiplexed (Chen, Wang, & Xia, 2019; Gnyawali et al., 2006). Multiplex relationships exist when two or more firms have strategic roles and are connected by distinct inter-firm ties (Shipilov et al., 2014; Slot et al., 2020). Such multiplexed relationships typically offer joint-incentive structures that are not normally instituted in single-tie relationships, which has implications for spillover effects, firm actions and behaviors (Tuli, Bharadwaj, & Kohli, 2010). Firms are motivated to pursue coopetition relationships because of the potential realization of common and private benefits (Khanna et al., 1998). Generally speaking, private benefits are those in which a firm unilaterally earns based on the observation of another firm's behaviors. Common benefits can be earned when both firms enter into a strategic collaboration as determined by the objective of the relationship (Khanna et al., 1998).

The nature of the inter-firm relationship influences the type of benefit that the firm can earn (common versus private). In a competitive situation, the firm is only able to earn private benefits (i.e., common goals do not exist; as such, this often leads to a race between competitors). Moreover, there are limits to the attainability of private benefits (or spillovers) in competitive relationships. This is because firms often perceive competition as a zero-sum game; thus, rival firms create barriers that limit access to resources thereby restricting the competitors' ability to earn benefits from them (Lado et al., 1997). Hence, knowledge spillovers are limited in this situation.

In cooperative relationships (e.g., buyer–supplier relationships), the firms involved deliberately intend to share common benefits earned from participation in the relationship. These firms often aim to allocate resources towards a common goal (e.g., smooth product flow) (Khanna et al., 1998). As such,

coordination activities in cooperative relationships are structured to support the operational goals of the relationship. In essence, the business processes to support buyer-supplier collaboration and coordination reduces the motivation of firms to pursue private benefits, thus discouraging knowledge spillovers outside the primary scope of the relationship (Lado et al., 1997).

In coopetition (e.g., multiplex relationships), a firm has the potential to simultaneously earn both common and private benefits (Khanna et al., 1998). This is possible for the following reason. The presence of mutually beneficial incentive structures motivate participating firms to share and transfer knowledge not only within the scope of the cooperative activity but also beyond it, thereby encouraging a broader utility of knowledge spillover effects (Lado et al., 1997). A firm is motivated to do so because it recognizes that there are both private benefits in its role as a competitor (i.e., leverage knowledge spillover effects) and common benefits based on each firm's willingness to cooperate with one another. Thus, the joint incentive structure both reduces barriers to the sharing of knowledge resources and encourages a broader application of them. In such coopetition relationships, coordination mechanisms are established to facilitate collaboration on strategic as well as operational tasks (Shipilov et al., 2014; Tuli et al., 2010). In essence, firms that participate in a coopetition relationship are able to derive a greater extent of spillover effects over and above that is normally attainable in either buyer–supplier relationships or competition independently (Khanna et al., 1998; Lado et al., 1997). Indeed, as noted by Lado et al. (1997, p. 123) coopetition leads to "syncretic rent-seeking behavior [which] emphasizes the positive-sum, efficiency enhancing effects of competition and cooperation."

<Insert Table 1 here>

Table 1 presents a summary of the key points discussed above, which differentiates competitors, suppliers, and coopetitors. We will leverage this conceptualization to examine the role of inter-firm coopetition in the context of environmental management. We now turn to the detailed development of our hypotheses.

2.1 Hypothesis Development

Coopetitor and focal firm environmental performance

The first relationship in our theoretical model is on the impact of a coopetitors' environmental strengths on a focal firm's environmental strengths. Before we focus our discussion on coopetition, it is important to acknowledge that focal firms have a few options on how to improve their environmental performance. They can either utilize their own environmental expertise, leverage their supplier's environmental capabilities, observe their competitors' environmental best practices, and/or participate in coopetition. A focal firm is motivated to consider these options because of stakeholder pressure to improve their environmental performance. Indeed, focal firms recognize that customers are paying attention to their environmental performance (Dai, Cantor, & Montabon, 2015) and that rival firms have achieved some success in environmental management (Hofer et al., 2012). While in some situations focal firms can rely-upon their own expertise that is developed through internally oriented experiential learning opportunities, firms are often motivated to mimic a competitor's environmental actions because rivals have achieved success in this domain (Kumar, Cantor, Grimm, & Hofer, 2017). However, competitors typically create barriers around business practices that can lead to competitive advantage (Lado et al., 1997). To say this differently, in a strictly competitive sense, a focal firm typically does not have direct access to a rival's environmental practices. As such, while awareness of a rival firm's environmental performance may lead to *know-what* and thereby enabling mimicry, a focal firm is unlikely to observe the *know-how* regarding a rival firm's environmental efforts. Nevertheless, a focal firm's mimicry of its rival firm's environmental activities can lead to environmental knowledge spillovers in the form of know-what, which can result in environmental performance improvement (Dai et al., 2015; Hofer et al., 2012).

Traditionally, buyers form supplier relationships that are primarily oriented toward providing buying firms with quality products on time (Krause, 1999; Modi & Mabert, 2007); further, suppliers sometimes assist buyers in new product development (Clark, 1989; Koufteros, Cheng, & Lai, 2007). In order to achieve the common goal of improving product quality, focal firms implement processes and information systems to support many day-to-day operational activities such as production and distribution activities (Sahin & Robinson, 2002). Further, focal firms may also implement inter-organizational knowledge-sharing routines with suppliers to help them improve operational processes (Krause, 1999;

Modi & Mabert, 2007). In essence, these structures and processes enable a firm to observe *know-how* about its partner firm's activities. However, in sourcing relationships that are oriented towards product quality and cost objectives (i.e., when coopetition does not exist), focal firms and suppliers are likely focused on further improving their collaboration efforts that can yield high-quality products to a buyer firm. Thus, the motivation of firms to pursue private benefits that are intended to improve the buyer firm's environmental performance are unlikely (Lado et al., 1997). As such, buyer-supplier collaboration arrangements are deliberately structured to create common benefits that can be realized by both partner firms (i.e., product quality and cost objectives) and are not intended to yield private benefits (i.e., environmental performance improvement).

Previous research also indicates that buyer–supplier relationships were not originally created to assist buyer firms with improving their environmental performance (Krause, 1999; Modi & Mabert, 2007). Hence, focal firms continue to struggle to find and successfully collaborate with environmentally capable suppliers (Villena & Gioia, 2018). Indeed, some scholars suggest that suppliers can harm a focal firm's environmental performance (Kumar et al., 2019). As such, in pure sourcing relationships, while a focal firm is afforded an opportunity to observe its supplier's environmental practices, and a focal firm has the coordination structures in place to gain know-how, a focal firm may not always benefit from its supplier's environmental performance or be motivated to leverage their performance.

We theorize that a focal firm enters into a coopetition relationship because it wants to gain access to and leverage its rivals' environmental knowledge base.[4] Prior to the establishment of coopetition, a focal firm was only able to observe from the "outside" how a rival pursued its environmental initiatives. While the motivation to accrue private benefits (Khanna et al., 1998) would result in some environmental spillover effects, competitors typically create barriers to their knowledge resources (Lado et al., 1997). In contrast, firms engaged in coopetition are motivated and afforded the ability to learn from the skills of the

[4] Coopetition is likely to create spillovers of various types of knowledge including technological, supply chain (distribution and sourcing), environmental, general best practices, etc. Given the objective of this study, we focus our arguments on the spillover of environmental knowledge which represents one of the various potential knowledge spillovers from coopetitors to the buyer firm.

partner firm beyond the original purpose of the relationship (Khanna et al., 1998). Such relationships foster greater knowledge-seeking behaviors, which can lead to the lowering of competitive safeguards. This enables a focal firm to leverage coordination structures that were established previously to support a collaborative relationship. Therefore, a focal firm is able to experience knowledge spillover effects. Building on this logic, we theorize that such knowledge spillover is increasingly likely to occur because the element of competition provides both a structure and motivation for focal firms to improve their environmental performance (Dai et al., 2015; Hofer et al., 2012); further, the element of cooperation provides a focal firm with the opportunity to gain know-how regarding successful environmental practices employed by competitors (Reuter, Foerstl, Hartmann, & Blome, 2010; Schoenherr, Modi, Talluri, & Hult, 2014). Specifically, the syncretic rent-seeking behavior that maximizes the benefits of both competition and cooperation (Lado et al., 1997) results in a spillover of environmental performance. We, therefore, posit that a coopetitors' environmental performance will positively influence a focal firm's environmental performance. Thus, we present the following hypothesis:

Hypothesis 1: Coopetitors' environmental performance is positively associated with a focal firm's environmental performance.

Role of a focal firm's financial slack, financial leverage, and leanness

We now turn to a discussion of contingency variables that can moderate a coopetitor's environmental performance on a focal firm's environmental performance. Our choice of moderators is grounded in previous research on environmental management (Hofer et al., 2012) environmental operations (Rothenberg, Pil, & Maxwell, 2001), and strategic management (Mishra & Modi, 2013). This literature suggests that the availability of financial resources has a direct bearing on a firm's environmental performance (Greve, 2003; Hofer et al., 2012). For example, Greve (2003) suggests that financial resources provide a firm with the flexibility needed to invest in new initiatives, while other scholars indicate that financial resources lead to managerial inertia to change (Kraatz & Zajac, 2001; Thompson, 1967). Further, the literature suggests that financially constrained firms (e.g., as reflected in high financial

leverage) are more inclined to overlook the environmental implications of their actions (Mishra & Modi, 2013). In addition, there is evidence that a firm's leanness is a relevant factor in the environmental management debate because lean firms use their resources more efficiently (Rothenberg et al., 2001). As such, we theorize on the role of a focal firm's financial slack, financial leverage, and leanness in moderating the influence of a coopetitors' environmental performance as presented in hypothesis 1.

We begin by examining how a firm's financial slack negatively moderates the relationship of a coopetitors' environmental performance on a focal firm's environmental performance. We believe there are two reasons to explain this moderating relationship. First, previous research indicates that financial slack has the potential to insulate a firm from the external environment (Thompson, 1967), which can cause a firm's managers to become resistant to change (Kraatz & Zajac, 2001). Because financial slack creates structural inertia, managers may not become motivated to seek private benefits from coopetition to improve a firm's environmental performance since they are insulated from external stakeholder pressure (Kraatz & Zajac, 2001). Indeed, Cheng and Kesner (1997: p. 3) contend that financial slack "…may actually dull a firm's strategic response (e.g., slow its reaction to competitor's moves or to sudden market shifts)." Thus, we suggest that higher levels of financial slack may create "blind spots," thereby lowering a focal firm's incentive to leverage the environmental knowledge that resides within its coopetitors. As such, financial slack may negatively moderate the influence of coopetitors' environmental performance on a focal firm's environmental performance (i.e., this financial resource reduces the effectiveness of coopetition).

Second, agency concerns are salient here because higher levels of financial slack can amplify principal–agent problems, whereby managers may not act in a firm's best interests (Jensen & Meckling, 1976). Agency concerns arise because it is difficult for a firm's principals (e.g., shareholders) to monitor the environmental behavior of a firm's agents (e.g., managers). Further, it is difficult to monitor environmental performance because a universal standard does not exist for the tracking and reporting of environmental practices. Publicly traded firms in the United States are currently not required to report data regarding their environmental management activities to the Securities and Exchange Commission

(SEC) (Kumar, Cantor, & Grimm, 2018). Indeed, a firm may not always be financially rewarded by shareholders for making transaction-specific investments into environmental management practices, thus making managers skeptical of this strategy (Jacobs et al., 2010).

Given the uncertainty in reporting standards, the problems associated with monitoring environmental behaviors, the existence of structural inertia, and the lack of evidence regarding the value-creation potential of environmental management practices, managers may not be incentivized to take advantage of knowledge derived from their coopetitors (Grimm, Lee, & Smith, 2006; Miller & Chen, 1994). This is because financial slack not only reduces risk-taking but also creates organizational inefficiencies and monitoring costs (Jensen, 1986; Jensen & Meckling, 1976; Kim, Kim, & Lee, 2008).

While we contend that financial slack could insulate a firm from the positive environmental resources of its coopetitors, there are some reasons to believe that financial slack enhances a firm's effort to learn how it can improve its environmental performance from coopetitors. First, financial slack provides a firm with the flexibility to make riskier investments, where a positive return on investments may not be optimal. As such, a firm may use its financial slack resources to learn from coopetitors about how to meet the demands of stakeholders. Stated differently, a firm seeks to appease those stakeholders who hold a pro-environmental stance by making environmental investments, even though a firm does not expect a neutral or positive net present value (NPV) return on environmental projects. Therefore, a firm may be more likely to pursue private benefits, i.e., leverage learning opportunities in regard to its environmental efforts. Relatedly, in response to external pressure, many firms increasingly use their slack resources to create a pro-environmental culture by working with coopetitors to address environmental reputation concerns (Kumar et al., 2019). In so doing, these firms look for opportunities to improve their environmental performance by learning from coopetitors. Third, Hofer et al. (2012) discuss that firms allocate slack resources into environmental management initiatives for competitive reasons; as such, a firm learns about potential environmental investment opportunities by observing the experiences of others. Following Greve (2003), we also believe a firm uses slack resources to improve its environmental

performance because financial slack provides a firm with the flexibility it needs to invest into environmental strategies.

In summary, there are theoretical arguments that provide a sound basis to expect that a firm's financial slack could both negatively and positively moderate the relationship between a coopetitor and focal firm's environmental performance. Thus, we present the following competing hypotheses[5]:

Hypothesis 2A: A focal firm's financial slack positively moderates the association between coopetitors' environmental performance and a focal firm's environmental performance.

Hypothesis 2B: A focal firm's financial slack negatively moderates the association between coopetitors' environmental performance and a focal firm's environmental performance.

We now conceptualize why we expect a focal firm's financial leverage to negatively moderate the relationship between a coopetitor's environmental performance on a focal firm's environmental performance. We contend that higher levels of financial leverage reduce a firm's ability to benefit from coopetition for several reasons. First, financial leverage reduces a manager's ability to engage in inter-organizational environmental practices because environmental investments can be costly. A firm that is highly financially leveraged does not have the necessary financial resources for projects that cannot directly improve a firm's financial performance such as environmental management initiatives. When a firm lacks sufficient financial resources, a firm's managers become more motivated to make decisions that conserve financial resources (Bathala, Moon, & Rao, 1994). Stated differently, the managers will act carefully and only pursue projects that have a positive net present value. Thus, higher levels of financial leverage encourage managers, who might otherwise engage in wasteful practices, to focus on organizational efficiency (Jensen, 1986). Indeed, firms that are financially leveraged might have to offer corporate debt, make periodic payments of interest and principal, and centralize control over financial management decisions. Thus, managers do not have an incentive to engage in pro-environmental activities that represent nonoptimal financial returns (Bathala et al., 1994; Hiwt & Smart, 1994). Since

[5] We thank the review team for encouraging us to present competing hypotheses.

environmental projects may not have a positive NPV (Walley & Whitehead, 1994), managers might become discouraged from investing in environmental initiatives.

In summary, managers are more likely to choose value-enhancing (i.e., nonenvironmental) projects (Bathala et al., 1994) when a firm has higher financial leverage, inhibiting private benefits (i.e., spillover effects) from coopetitive engagements. Therefore, we expect financial leverage to negatively moderate the association between a coopetitors' environmental performance and a focal firm's environmental performance. Formally stated:

Hypothesis 3: A focal firm's financial leverage negatively moderates the association between coopetitors' environmental performance and a focal firm's environmental performance.

We now turn to presenting theoretical arguments regarding how a focal firm can benefit from its leanness in regard to leveraging a coopetitor's environmental performance. Lean manufacturing, by virtue of its objectives of waste reduction and continuous improvement (Voss, 2005), reflects a focal firm's dynamic capability to efficiently manage its operations (Anand, Ward, Tatikonda, & Schilling, 2009). We contend that a firm that demonstrates high levels of leanness is likely ready to implement complex operational routines, such as environmental management practices, for the following reasons.

First, *leanness* refers to the goal of reducing nonvalue-added activities that would otherwise result in high levels of cycle and safety-stock inventory (Shah & Ward, 2007). Existing research has often viewed a firm's negative environmental impact as a form of wasteful practice that needs to be reduced (King & Lenox, 2002). The literature also indicates significant synergies between lean and green (King & Lenox, 2001; Klassen, 2000). This relationship exists because a firm's investment in waste reduction initiatives provides it with significant advantages in the form of pollution prevention and environmental waste reduction (King & Lenox, 2001). Since there are synergies between leanness and environmental practices, we contend there is a greater likelihood that a coopetitor's environmental performance may spillover to focal firms with lean operations. Likewise, focal firms that have implemented lean are likely to require their employees to make changes to operations practices such as business processes and related inventory management practices (Porter & Van der Linde, 1995). Organizations that have successfully

implemented lean strategies typically have employees who are knowledgeable and motivated to further improve their organization's operations (Shah & Ward, 2003, 2007). As such, lean organizations have employees who are willing to implement new systems that, in part, mimic a coopetitor's environmental practices. Third, existing research supports the notion that lean organizations undertake continuous improvement initiatives and have the coordination infrastructure to institutionalize organizational learning (Anand et al., 2009; Molina, Llorens-Montes, & Ruiz-Moreno, 2007). The coordination infrastructure reflects an organization's ability to adapt and implement learning (Anand et al., 2009). This makes lean firms more likely to gain private benefits from coopetitors.

In summary, lean firms are likely to experience synergies in implementing environmental initiatives, have employees who are more likely to adapt to changes, and have the underlying infrastructure to facilitate coordination and learning, all of which would help to amplify the influence of coopetitors' environmental performance. Therefore, we present the following hypothesis:

Hypothesis 4: A focal firm's leanness positively moderates the association between coopetitors' environmental performance and a focal firm's environmental performance.

3. Sample, Data, and Variables

3.1 Sample

To test our theoretical model, we collected data from multiple secondary data sources, including Factset Revere (FactSet), Kinder, Lydenberg, and Domini Research and Analytics, Inc. (KLD), and Compustat. We relied on data from the FactSet database to identify a focal firm's coopetitors, suppliers, and competitors. FactSet is able to report on a focal firm's historical supply chain relationships based on SEC regulatory disclosure documents,[6] financial annual reports, and other primary data sources. FactSet provides an exhaustive reporting of dyadic relationships across many US firms spanning a diverse set of industries (Almeida, Cunha, Ferreira, & Restrepo, 2017; Auer, 2016).

[6] The SEC mandates firms to disclose a firm's customers if the revenue exposure is 10% or greater.

To construct our data set, we first identified all firms in the KLD database over the years from 2004 to 2009. Then, we matched firms in KLD with the competitors and suppliers that are located in the FactSet database. A focal firm's coopetitors are identified as those noted as both a competitor and a supplier to a focal firm in the FactSet database for a particular year. This matching exercise leads to three non-overlapping categories of focal firm relationships in our data set: 1) firms that are only competitors to a focal (buyer) firm; 2) firms that are only suppliers to a focal (buyer) firm; and 3) firms that are coopetitors to a focal (buyer) firm. For the matched firms, we obtain information on a firm's environmental ratings from the Kinder, Lydenberg, and Domini Research and Analytics, Inc. (KLD) database (Servaes & Tamayo, 2013). Given that the KLD rating system changed significantly starting in 2010 and that the data provided to us by Factset covered a limited time period (2004–2012), we restrict our sample to the time period of 2004–2009. Data derived from the Compustat database enabled us to calculate the other variables in our analysis. We used all matched firms with non-missing information to construct an unbalanced panel of data. Since focal firms had multiple relationships (e.g., multiple coopetitors) in a given year, we calculated average measures across all firms in the analysis.[7] This data collection process resulted in a sample of 1465 firm-year observations, representing 320 focal firms. Table 2, Panel A shows the number of focal firms (i.e., observations) across all years in our sample. Table 2, Panel B shows the total number of unique focal, competitor, supplier, and coopetitor firms in the sample across 2004–2009. Finally, Table 2, Panel C identifies the distribution of years of data by focal firm. We discuss our variable operationalization next.

<Insert Table 2 here>

3.2 Measurement of Variables

3.2.1 Dependent Variable

Our dependent variable, i.e., a *focal firm's environmental performance* (*FirmEnvPerf*), is derived from the KLD database. KLD evaluates a firm's environmental strengths on dimensions such as beneficial

[7] We also conduct a robustness check using the median measure instead of the mean.

products and services (e.g., products that promote efficient energy use), pollution prevention (e.g., strong emission reduction and toxic use reduction programs), recycling (e.g., substantial use of recycled material in manufacturing), clean energy (e.g., significant use of renewable energy or energy efficiency), and other strengths (e.g., superior commitment to environmental management systems). Similarly, KLD also provides information on a firm's environmental concerns. In addition, KLD assigns a score of zero or one to each of these dimensions.[8] In line with prior studies (Mishra & Modi, 2016; Waddock & Graves, 1997; Walls, Berrone, & Phan, 2012), the individual ratings are aggregated across all items that belong to the environmental strengths and environmental concerns categories. A focal firm's environmental performance is calculated as the difference between that *firm's environmental strengths* (*FirmEnvStr*) and its *environmental concerns* (*FirmEnvCon*) over the years from 2004 to 2009. Using the above methodology, higher scores denote a higher level of performance with a focal firm.

3.2.2 Independent, Moderating, and Control Variables

We next describe the independent and moderating variable measures. All variables are measured over the 2004–2009 time period. Our first key independent variable is *coopetitors' environmental performance* (*CoopEnvPerf*). Similar to our main dependent variable, we measured a coopetitor's environmental performance as the difference between the KLD ratings for a coopetitor's environmental strengths and a coopetitor's environmental concerns (*CoopEnvStr-CoopEnvConcerns*) variables. To construct our *coopetitor's environmental performance* variable, we first measured a *coopetitor's environmental strengths* (*CoopEnvStr*) using the same methodology as a focal firm's environmental performance variable. Note that a focal firm can have multiple coopetitors. Therefore, we first calculated the scores for each coopetitor. Further, since a focal firm has multiple coopetitors at any given point in time, we then averaged the scores of all identified coopetitors for a firm as our measure of a coopetitors'

[8] In taking a closer look at the KLD environmental ratings, we note that, while the ratings for strengths often include initiatives (e.g., the company has notably strong pollution prevention programs), the ratings for concerns seem to be performance-based (e.g., the company's legal emissions of toxic chemicals (as defined by and reported to the EPA) from individual plants into the air and water are among the highest of the companies followed by KLD). As such, given that we rely on a score of strengths minus concerns, we use the term "environmental performance" for our variable of interest throughout this paper.

environmental strengths.[9] Higher scores denote a higher average level of strengths of the coopetitor firms. Similar to environmental strengths, we measured a coopetitor's environmental concerns (*CoopEnvConcerns*) as issues such as hazardous waste, regulatory problems, activities impacting climate change, etc. We measured a coopetitor firm's environmental concerns using the same methodology as described for strengths. Finally, the difference between the two variables provides us with an estimate of the coopetitor's environmental performance. In summary, higher scores on our measure of *coopetitors environmental performance* variable denote a higher level of environmental performance of the coopetitors' firms.

The data source for the three moderating variables is Compustat. We measured a *focal firm's financial slack* using a firm's quick ratio. This measure reflects a firm's liquidity and indicates how well a firm can meet its financial obligations. We calculate financial slack as the ratio of current assets – inventories to current liabilities (Palmer & Wiseman, 1999). Further, in order to ensure that the financial slack variable is comparable across industries, we adjust this measure by expressing it as the percent difference relative to the industry median (subtracting the industry median and dividing by the industry median), with industry defined at the four-digit NAICS level. We measured the second moderating variable, *financial leverage*, as the ratio of a firm's long-term debt to total assets (Bae, Kang, & Wang, 2011; Wiles, Morgan, & Rego, 2012). Again, we industry adjust this measure relative to the industry median (subtracting the industry median and dividing by the industry median), with industry defined at the four-digit NAICS level. The third moderating variable, *focal firm's leanness* (*InventoryLean*), was operationalized using the method described by Eroglu and Hofer (2011). Specifically, we rely on an inventory-based proxy for measuring a focal firm's leanness. This is in line with existing research that has often relied on inventory-based proxies to measure a firm's leanness (e.g., Eroglu and Hofer, 2011; King and Lenox, 2001). Specifically, to calculate a firm's inventory leanness, we regress the natural logarithm

[9] We rely on a simple average to evaluate these measures. The FactSet supply chain relationship data only include information on the presence of a relationship and not its relative strength. This precludes us from calculating a weighted average.

of inventory for each firm *f* on the natural logarithm of a firm's sales for each industry *i* in year *t* (i.e., $\ln(Inventory_{fit}) = \alpha_{fit} + \beta \ln(Sale_{fit}) + \varepsilon_{fit}$). The reverse-coded residuals from this regression are used to calculate the measure of inventory leanness with industry defined at the four-digit NAICS level (c.f. Eroglu & Hofer, 2011).

We now turn to describing our control variables. Our first control variable is a focal *firm's size* (*Size*) because firm size can influence environmental performance (Hofer et al., 2012). We used the natural log of a firm's gross total assets as a measure of firm size (Modi & Mishra, 2011). We also control for *market share* (*MktShr*), which is defined as the ratio of a firm's sales to industry sales, with industry defined at the four-digit NAICS level.[10] We control for employee productivity (*EmpProd*) since it can potentially influence a firm's competitive actions. Employee productivity is measured as a normalized ratio of sales per employee of a firm, adjusted relative to its industry median, with industry defined by the four-digit NAICS (e.g., Koch & McGrath, 1996). Additionally, we also control for three industry-level characteristics. First, industry growth may positively influence firm performance. We control for this by including industry munificence as a variable. Following the literature in strategic management (Dess & Beard, 1984), we measure industry munificence as the estimated regression slope coefficient of the 10-year trend in sales divided by the average sales over that period. Second, higher uncertainty in industry growth may lead to lower firm performance. Therefore, we control for this by including industry dynamism in the estimation. Industry dynamism is measured as the standard error of the regression slope coefficient of 10-year sales trend, divided by the average sales over that period (Dess & Beard, 1984). These are estimated for each industry, with "industry" defined at the four-digit NAICS level, and calculated for each year for the period of analysis. Finally, we control for industry concentration by including the Herfindahl–Hirschman Index (HHI) in our estimations. Our final set of control variables include environmental performance of a focal firm's suppliers (*SupEnvPerf*) and competitors (*CompEnvPerf*). Note that suppliers, competitors, and coopetitors represent nonoverlapping sets of firms

[10] Firm size and market share are often correlated. In our analysis, we find that both variables remain significant; as such, we retain them both as control variables.

for a given year. Similar to the method for creating aggregate scores for coopetitors, we created the aggregate environmental strengths and concerns scores for a firm's competitors and suppliers and calculate the performance as the difference between the strengths and concerns. Table 3 presents the study's descriptive statistics.

<Insert Table 3 here>

4. Empirical Analysis and Results

4.1 Empirical Estimation Approach

We constructed a panel data set to test our hypotheses. Several characteristics of our data suggest it is important to account for simultaneity, unobserved effects, and serial correlation (e.g., Baltagi, 2008; Bradley et al., 2018; Senot, Chandrasekaran, Ward, Tucker, & Moffatt-Bruce, 2015; Shockley, Plummer, Roth, & Fredendall, 2015). Further, as noted above, given that focal firms may rely on their own past experience, it is also important that the estimation approach account for the focal firm's past environmental performance in estimations. Because of these concerns, using an ordinary least-squares fixed-effects regression is not appropriate (Wooldridge, 2015). An alternative approach is to use the dynamic panel Arellano-Bond (AB) generalized method of moments (GMM) estimator. This technique accounts for the persistence of the dependent variable by modeling it as a function of its lagged values while exploiting the panel nature of the data to generate internal instruments (Arellano & Bover, 1995; Blundell & Bond, 1998). The inclusion of a lagged dependent variable along with other control variables also allows us to assess whether the variables of interest influence the dependent variable over and above its past values, thereby accounting for the persistence of the dependent variable (Germann, Ebbes, & Grewal, 2015; Senot et al., 2015). This statistical approach is also appropriate since our panel has a short time length (T) compared with a large number of cross-sectional units (N). Our use of the GMM estimator allows us to generate consistent estimates for the model parameters (Arellano & Bover, 1995; Blundell & Bond, 1998; Hansen, 1982; Wooldridge, 2015). This estimation approach has also been used often in existing operations management research (Dreyfus, Nair, & Talluri, 2020; Senot et al., 2015; Shockley et al., 2015). In summary, the Arellano-Bond GMM estimator requires the specification of a linear dynamic panel model, including a lagged dependent variable

as one of the covariates as well as controls for firm-level fixed effects. This approach relies on generating the estimation parameters from a system of equations, which include one based on the first difference of the regressors (Arellano & Bover, 1995) and the second based on the level of the regressors (Arellano & Bover, 1995; Blundell & Bond, 1998). Specifically, the estimation takes the following general form:

$$\Delta y_{it} = \alpha \Delta y_{it-1} + \beta \Delta X_{it} + \gamma \Delta W_{it} + \Delta u_{it} \ (the\ difference\ equation),$$

$$y_{it} = \alpha y_{it-1} + \beta X_{it} + \gamma W_{it} + (\nu_i + \varepsilon_{it}) \ (the\ levels\ equation),$$

where α, β, and γ represent the vectors of parameter estimates for the lagged dependent variables, hypothesized variables, and control variables, respectively. In the difference equation, the first differencing removes a firm's fixed effects because the error terms (Δu_{it}) are specified as

$$\Delta u_{it} = \Delta \nu_i + \Delta \varepsilon_{it} = (\nu_i - \nu_i) + (\varepsilon_{it} - \varepsilon_{it-1}) = \Delta \varepsilon_{it},$$

where ν_i is a firm-specific fixed effect that is removed via first differencing. Although the first-differencing addresses the fixed effects, it is important to note that Δy_{it-1} remains correlated with the error term ε_{it}. This is because ε_{it-1} has a component to y_{it-1} and therefore of Δy_{it-1}. To account for this endogeneity concern, Arellano and Honoré (2001) demonstrated that lags 2 or more of the dependent variable (i.e., y_{it-2}) serve as valid instruments for Δy_{it-1}, assuming that $E[\varepsilon_{it-1}, \varepsilon_{it-2}]=0$. As such, when employing the Arellano-Bond GMM estimator, this assumption needs to be checked with the AR(2) test to ensure that the second-order difference terms ($\varepsilon_{it} - \varepsilon_{it-1}$) and ($\varepsilon_{it-1} - \varepsilon_{it-2}$) are not correlated and that the assumption $E[\varepsilon_{it-1}, \varepsilon_{it-2}]=0$ holds true. Further, in the presence of strong persistence (i.e., as $\alpha \rightarrow 1$), a difference estimator in of itself can provide biased estimates for finite samples. Arellano and Bover (1995) and Blundell and Bond (1998) show that adding an equation for levels with the lagged difference of the dependent variable as instruments and solving them as a stacked system overcomes this, resulting in unbiased and efficient parameters. The logic of instrumenting the lagged dependent variable in this system extends to all independent variables. In the system GMM specification, past levels of variables are used as instruments in the difference equation, and past differences are used as instruments in the levels equation. Instruments for the lagged dependent variable ($Y_{(it-1)}$) and the endogenous variables (X_{it}) are generated using their lagged values. To test that the instruments are valid and the assumption of uncorrelated errors holds, the AR(2) test for second-order correlation of residuals is

evaluated. In summary, this estimator allows researchers to control for the dynamic effects in the dependent variable while also accounting for the time-series cross-sectional nature of the data (i.e., controlling for firm fixed effects) and controlling for endogeneity (c.f., Arellano & Bover, 1995; Blundell & Bond, 1998). For our estimation, given that all variables are focal firm characteristics and can potentially be endogenous, we do not assume any of the independent variables (including controls with the exception of time dummy variables) to be exogenous or predetermined and thereby specify them as endogenous. In relying on the system GMM estimator (Roodman, 2006), the estimated model for our variables is as follows, with Eqs. 1a (and b) representing the system of equations for the main effects model and Eqs. 2a (and b) for the interaction model:

$$\Delta FrmEnvPerf_{it} = \alpha \Delta FrmEnvPerf_{i(t-1)} + \beta_1 \Delta Size_{it} + \beta_2 \Delta MktShr_{it} + \beta_3 \Delta EmpProd_{it} + \beta_4 \Delta Munificience_{it} + \beta_5 \Delta Dynamism_{it} + \beta_6 \Delta HHI_{it} + \beta_7 \Delta CompEnvPerf_{it} + \beta_8 \Delta SupEnvPerf_{it} + \beta_9 \Delta FinSlack_{it} + \beta_{10} \Delta InvLean_{it} + \beta_{11} \Delta FinLev_{it} + \beta_{12} \Delta CoopEnvPerf_{it} + \gamma_t + \Delta u_{it} \quad (1a)$$

$$FrmEnvPerf_{it} = \alpha FrmEnvPerf_{i(t-1)} + \beta_1 Size_{it} + \beta_2 MktShr_{it} + \beta_3 EmpProd_{it} + \beta_4 Munificience_{it} + \beta_5 Dynamism_{it} + \beta_6 HHI_{it} + \beta_7 CompEnvPerf_{it} + \beta_8 SupEnvPerf_{it} + \beta_9 FinSlack_{it} + \beta_{10} InvLean_{it} + \beta_{11} FinLev_{it} + \beta_{12} CoopEnvPerf_{it} + \gamma_t + (v_i + \varepsilon_{it}) \quad (1b)$$

$$\Delta FrmEnvPerf_{it} = \alpha \Delta FrmEnvPerf_{i(t-1)} + \beta_1 \Delta Size_{it} + \beta_2 \Delta MktShr_{it} + \beta_3 \Delta EmpProd_{it} + \beta_4 \Delta Munificience_{it} + \beta_5 \Delta Dynamism_{it} + \beta_6 \Delta HHI_{it} + \beta_7 \Delta CompEnvPerf_{it} + \beta_8 \Delta SupEnvPerf_{it} + \beta_9 \Delta FinSlack_{it} + \beta_{10} \Delta InvLean_{it} + \beta_{11} \Delta FinLev_{it} + \beta_{12} \Delta CoopEnvPerf_{it} + \beta_{13} (\Delta FinSlack_{it} \times \Delta CoopEnvStr_{it}) + \beta_{14} (\Delta FinLev_{it} \times \Delta CoopEnvStr_{it}) + \beta_{15} (\Delta InvLean_{it} \times \Delta CoopEnvStr_{it}) + \gamma_t + \Delta u_{it} \quad (2a)$$

$$FrmEnvPerf_{it} = \alpha FrmEnvPerf_{i(t-1)} + \beta_1 Size_{it} + \beta_2 MktShr_{it} + \beta_3 EmpProd_{it} + \beta_4 Munificience_{it} + \beta_5 Dynamism_{it} + \beta_6 HHI_{it} + \beta_7 CompEnvPerf_{it} + \beta_8 SupEnvPerf_{it} + \beta_9 FinSlack_{it} + \beta_{10} InvLean_{it} + \beta_{11} FinLev_{it} + \beta_{12} CoopEnvPerf_{it} + \beta_{13} (FinSlack_{it} \times CoopEnvStr_{it}) + \beta_{14} (FinLev_{it} \times CoopEnvStr_{it}) + \beta_{15} (InvLean_{it} \times CoopEnvStr_{it}) + \gamma_t + (\nu_i + \varepsilon_{it}) \quad (2b)$$

where the parameter α accounts for the dynamic effect of environmental performance, and the β's represent the estimated effects for the variables described earlier, γ*t* is the time intercepts, and Δu_{it} represent the error term. First, for our estimations, we check the Arellano-Bond test for autocorrelation of residuals, i.e., AR(2) in first differences, and find that the second-order autocorrelation for residuals is not significant for all models (Table 4). Further, to assess the instrument validity, we rely on the Hansen test of overidentifying restrictions and find this to be nonsignificant for all models (Table 4). Together, these tests and the use of the system GMM estimator helps us to mitigate endogeneity concerns in our model estimation. Further, to avoid potential multicollinearity concerns, we mean-centered the variables before creating the interaction terms. Additionally, with the OLS specification, we also checked the variance-inflation factors (VIFs) and condition indices of the variables (including interaction terms and excluding dummy variables) used in the estimation. The VIFs ranged from 1.04 to 1.77 (which are below the rule-of-thumb value of 10), and the max condition index number was observed to be 18.6116 (which is less than the rule-of-thumb value of 30), indicating that it is unlikely that multicollinearity will lead to biased estimation (Cohen, Cohen, West, & Aiken, 2013).

< Insert Table 4 here>

4.2 Hypothesis Testing Results

We now turn to describing our results, which are also presented in Table 4. H1 states that a coopetitor's environmental performance is positively associated with a focal firm's environmental performance.

Results from the main-effects model (Model 2) indicate that there is a positive and statistically significant coefficient ($\beta = .0417$; $p < 0.01$) for the coopetitors' environmental performance variable (CoopEnvperf), which provides evidence supporting H1.

H2A posits a significant and positive interaction effect of a focal firm's financial slack, with the presentation of a competing hypothesis. The results for Model 3 show that the interaction effect of financial slack has a negative and significant coefficient ($\beta = -0.0244$; $p < 0.01$), providing support for H2B. As such, focal firms with higher financial slack are less likely to leverage coopetitors' environmental performance. Further, it is also important to note that the main effect of financial slack in Model 2 is positive and significant ($\beta = 0.0081$; $p < 0.01$). Taken together, this indicates that, while a focal firm's financial slack overall is likely to be positively associated with environmental performance, it does hamper firms from experiencing the conceptualized spillover effect from coopetitors' environmental performance. Looking at the effect of financial leverage, we found a negative and statistically significant interaction effect ($\beta = -0.0010$; $p < 0.01$). This finding provides support for H3 and indicates that the more a focal firm is financially leveraged, the less likely a focal firm is influenced by a coopetitors' environmental performance. The main effect of financial leverage (Model 2) is also negative and significant ($\beta = -0.0001$; $p < 0.1$), indicating that highly leveraged firms are less likely to demonstrate higher environmental performance. Finally, H4 posits that a focal firm's leanness will enhance the effect of a coopetitor's environmental performance on a focal firm's environmental performance. Given the positive significant coefficient ($\beta = .0361$; $p < 0.01$) of the interaction term H4 is supported. Further, the main effect of leanness (Model 2) is also positive and significant ($\beta = 0.0062$; $p < 0.01$), indicating that firm leanness is also directly associated with improved environmental performance.

In terms of the control variables, in reviewing the results presented in Table 4 (Model 3), we found that larger firms ($\beta = 0.0091$; $p < 0.01$), higher market share ($\beta = 0.0134$; $p < 0.01$), higher employee productivity ($\beta = 0.0009$, $p < 0.01$), and industry dynamism ($\beta = 4.9250$; $p < 0.01$) tend to have higher environmental performance. In contrast, firms that exhibit higher industry munificence ($\beta = -0.2768$; $p < 0.01$) and concentration ($\beta = -0.2115$; $p < 0.01$) are associated with lower environmental

performance. We also find in Table 4 (Model 3) that the coefficient for the competitor's environmental performance is significant ($\beta = .0361$; $p < 0.01$), which suggests that a competitor's environmental performance positively influences a focal firm's environmental performance. Interestingly, however, we also note that there is a negative and statistically significant coefficient for supplier's environmental performance ($\beta = -.0104$; $p < 0.01$) in Model 3 as well. We conduct additional analysis in Section 4.3.4 to explore this finding.

4.3 Post-hoc Analysis

We conduct a series of post-hoc analysis[11] to provide further insight and to demonstrate the robustness of our findings. We discuss this next.

4.3.1 Comparing the Main Effects of Competition, Cooperation, and Coopetition

In the introduction section, we described that previous research has not yet explored how coopetition compares with other types of inter-firm structures (i.e., competition or cooperation) in sustainable operations management research. We now turn to comparing the influence of competitors' and suppliers' environmental performance with the coopetitors' environmental performance. The results of Model 2 (Table 4) indicate that competitors' environmental performance ($\beta = .0442$; $p < 0.01$) positively influences a focal firm's environmental performance, and the suppliers' environmental performance ($\beta = -.0124$; $p < 0.01$) negatively influences a focal firm's environmental performance. In order to compare the coefficients, we calculate the standardized effects[12] for coopetitor ($\beta_{std} = .0733$; $p < 0.01$), competitor ($\beta_{std} = .0463$; $p < 0.01$), and suppliers ($\beta_{std} = -.0154$; $p < 0.01$). Comparing the magnitude of these standardized effects, we find that coopetitors' environmental performance has the highest influence, followed by competitors and suppliers' environmental performance. Further, we find the difference between the standardized effect of the coopetitors and competitors' environmental performance (difference = .0269; $p < 0.01$) is statistically significant. Similarly, the difference between the standardized effect of the

[11] Tables with detailed results for post-hoc analysis are included in Web Appendix (WA)

[12] Standardized effects are calculated as the estimated effect multiplied by the ratio of the standard deviation of the independent and dependent variables. We rely on the nlcom command in Stata to calculate and test the significance of the standardized effects as well as the difference of the standardized effects.

coopetitors and suppliers' environmental performance (difference = .0887; p <0.01) is also statistically significant. These results indicate that firms do benefit from coopetition in the context of environmental performance more than in purely competitive or supplier relationships. We conduct additional analysis to evaluate the implications of the negative effect of suppliers' environmental performance and present it in Section 4.3.4.

4.3.2 Decomposing Environmental Performance into Environmental Strengths and Concerns

Our baseline statistical models reflect results based on the firm's environmental performance measure (environmental strengths minus environmental concerns). For additional insight, we estimated our next model by first measuring and estimating a coopetitor and focal firm's environmental strengths and then their environmental concerns. In so doing, we used the same GMM empirical estimation as noted earlier. The results for the environmental strengths model are presented in the web appendix (WA) Table WA1, while the results presented in Table WA2 are based on our environmental concerns measure. These results are largely consistent with the main analysis. Our results also indicate that not only do coopetitor's environmental strengths have a positive and significant effect on focal firm's environmental strengths (Model 7: $\beta = 0.0177$; $p < 0.01$), but also that higher environmental concerns with coopetitors are also associated with higher focal firm's environmental concerns (Model 10: $\beta = 0.0145$; $p < 0.01$). However, the overall spillover of strengths tends to be higher, leading to a net positive effect. The effects are more nuanced with regard to the interaction terms. With regard to the interaction with financial slack, results in Table WA1 indicate a negative and significant effect (Model 8: $\beta = -0.0127$; $p < 0.01$). The results in Table WA2 also indicate a negative and significant interaction effect for concerns (Model 11: $\beta = -0.0107$; $p < 0.01$). As such, higher financial slack leads to lower leveraging of the coopetitors' environmental strengths as well as lower influence of coopetitors' environmental concerns by a focal firm. With regard to the interaction with financial leverage, the results in Table WA1 indicate a positive and significant effect (Model 8: $\beta = 0.0001$; $p < 0.01$). The results in Table WA2, however, indicate a negative and significant interaction effect for concerns (Model 11: $\beta = -0.0009$; $p < 0.01$). As such, higher financial slack leads to greater leveraging of the coopetitors' environmental strengths and leads to lower

influence of coopetitors' environmental concerns by a focal firm. However, given that the estimate of the positive interaction with environmental strengths is lower in absolute magnitude than the suppression effect of environmental strengths, the overall effect is likely negative. Finally, we also note that, in examining the interaction with leanness, the results in Table WA1 and WA2 indicate a significant relationship, i.e., higher leanness at focal firms leads to more leveraging of environmental strengths (Model 8: $\beta = 0.0076$; $p < 0.01$), and results in Table WA2 show that leanness will also reduce the spillover of concerns (Model 11: $\beta = -0.0035$; $p < 0.01$).

4.3.3 Sensitivity of Results to Aggregation of Supplier, Competitor, and Coopetitor firms

In our main analysis, we calculate the mean of environmental performance scores across all suppliers, competitors, and coopetitors' sets. As described in the methods section, these are nonoverlapping sets of a focal firms' partners. We also note that the average scores for a partner's environmental performance variables are higher for coopetitor firms as compared with those for supplier or competitor firms. We estimated additional models to evaluate whether the results are sensitive to how we aggregated all partner firms in a set (i.e., competitors, suppliers, and coopetitors).

Table WA3a (Models 12–14) presents results wherein the median score of the supplier, competitor, and coopetitor firm sets is used to measure the environmental performance of these firms. Based on the operationalization of environmental performance using the median values, the results of the estimation are similar to the main analysis.

Table WA3b (Models 15–20) presents results, wherein we limit firms in the partner firm set to be only those that are represented at most in N dyads (with N taking on the value of 5, 3, and 1) for a focal firm in a given year. In the sample, there are instances wherein all partner firms are represented in greater than N dyads. For these focal firms, we iteratively rank firms in the dyad by how many times they appear as partners and select only one partner firm, which appears in the least number of dyads. This process ensures that our analysis is not driven by firms, which have undue influence by virtue of multiple appearances as a partner firm. Employing this approach, the results of the estimation remain consistent with the main analysis.

It is plausible that some firms are more attentive to the performance of larger partner firms; the inclusion of smaller firms in our main aggregation process could bias the results. Table WA3c (Models 21–26) presents results, wherein the aggregation is conducted by considering only the top N (with N taking on the value of 5, 3, and 1) largest partner firms by firm size (total assets). The results of this estimation are consistent with the main analysis. Taken together, the analysis with the use of median partner firms and for different aggregation processes provides similar results to our main analysis.

4.3.4 Suppliers' Only Model and Additional Interactions Model

In our main analysis, we also find an unexpected result wherein the suppliers' environmental performance is negatively related to a focal firm's environmental performance. As noted earlier, we did not find evidence of multicollinearity in our correlation matrix and diagnostics. We also find a statistically significant and positive pairwise correlation between suppliers' environmental performance and focal firm environmental performance (Table 3).

We examine the supplier and focal firm relationship further by taking the following steps. First, to compare our model with the literature on buyer–supplier relationships, we estimate a model that includes all control variables and *only* the suppliers' environmental performance variable. The results presented in Table 5 (Model 4) provide evidence that a supplier's environmental performance is positively related to a buyer's environmental performance (Model 4: $\beta = 0.0098$; $p < 0.01$), which is consistent with the literature. We note that previous research that links buyer–supplier environmental practices has not evaluated the simultaneous impact of supplier, competitor, and coopetitor practices on a buyer firm's performance. Therefore, our research extends the prior buyer–supplier environmental management literature by examining coopetition while also for controlling these additional relationship types. It is well documented that in terms of supplier relationship management a one-size-fits-all approach is inadequate and firms often manage supplier portfolios with different management strategies (e.g. Kraljic's Matrix) (Kraljic, 1983). In line with this, it is conceivable that suppliers belonging to various portfolios have different influence on the focal firm's environmental performance. Our results provide an

impetus for future research to explore whether specific supplier types based on supplier portfolios have differential effects on the buying firm's environmental performance.

We also estimated a model that includes all interaction terms for the moderators of interest in our study. The results in Table 5 (Model 5) reveal interesting insights. First, we note that our main results with regard to coopetitor effects remain similar to those in the main analysis. Second, we note that with regard to suppliers' environmental performance effects, the interaction with inventory leanness is positive (Model 5: $\beta = 0.0151$; $p < 0.1$). This indicates that suppliers' environmental performance effects do help under conditions when a focal firm has high inventory leanness. Results with the interaction term of financial slack and leverage are not significant. Third, with regard to competitors' environmental performance effects, the interaction effect with financial slack is negative (Model 5: $\beta = -0.1031$; $p < 0.01$), while the interaction effect with inventory leanness is positive (Model 5: $\beta = 0.0283$; $p < 0.1$). This indicates that competitors' environmental performance influences a focal firm's differently. When focal firms have high financial slack, it makes them less likely to improve their environmental performance (i.e., focal firms feel more insulated in the presence of high slack). However, focal firms that have high leanness are more likely to experience a positive influence from competitor's environmental performance. Results with the interaction term of leverage are not significant. These analyses, taken together, help mitigate concerns regarding the negative effect of suppliers' environmental performance in earlier models by demonstrating that we observe similar effects presented in previous research when our model aligns with that literature. We also identify conditions under which suppliers' environmental performance may help, i.e., it is contingent on a focal firm's inventory leanness. This analysis also demonstrates that the influence competitors' environmental performance on a focal firm's environmental performance is contingent on a focal firm's financial slack as well as a focal firm's inventory leanness.

4.3.5 Counterfactual Analysis

We also conduct a counterfactual analysis by relying on the potential outcomes framework[13] (Pearl, 2009) to estimate the average treatment effects (Dehejia & Wahba, 1999; Rubin, 2005). This technique helps to provide evidence of a causal relationship and has been used in the operations management literature (Batt, KC, Staats, & Patterson, 2019; Subramanian & Subramanyam, 2012). Specifically, in our sample, a coopetitor's environmental performance (i.e., environmental strengths – concerns) can take on positive, zero, or negative values. This allows us to split the sample observations into two groups, i.e., firm years with positive coopetitor environmental performance (i.e., the treated group, i.e., Treat=1), and firm years with zero or negative coopetitor environmental performance (i.e., the control group, i.e., Treat=0). In so doing, we conduct a counterfactual analysis to estimate the average treatment effects, using the nearest-neighbor matching approach (Wooldridge, 2010). This method minimizes the Mahalanobis distance between the matched observation based on the covariates specified (Wooldridge, 2010). We specify variables in our model as covariates (including the lagged environmental performance) for the nearest-neighbor matching and estimate the models with the number of neighbors set to one and two. Results (Table WA5) indicate that the average treatment effect (ATE) is 8.5% (coefficient = 0.0850; $p < .01$) when untreated firms are considered those with zero or negative coopetitor environmental performance, and is 4.57% (coefficient = 0.0457; $p < .01$, for #neighbors = 2) when untreated firms are those with zero coopetitor environmental performance (Abadie & Imbens, 2011), using two matched nearest neighbors. This indicates that if a firm exposed to coopetitors with negative environmental performance had instead been exposed to coopetitors with positive environmental performance, the expected improvement in its environmental performance would be 8.5% on average (or 4.57% if the contrast is with coopetitors of zero environmental performance). The overall results provide support to the notion that the potential outcome (counterfactual) for firms that did not experience positive coopetitors' environmental

[13] A typical counterfactual under the potential outcomes framework perspective derives the estimated effect for a hypothetical in which a unit difference in the causal variable leads to a change in the outcome variable under the logic that the cause (i.e., coopetitors' environmental performance) creates a response (focal firms' environmental performance), which would not have occurred otherwise.

performance is expected to be positive and significant should they have been in a situation with positive coopetitors' environmental performance.

4.3.6 Assessing Productivity Spillover

In our final robustness check, we provide additional evidence that spillovers do occur between a coopetitor and a focal firm with regard to employee productivity. Our productivity results are presented in Table WA6, where focal firm employee productivity is the dependent variable and a coopetitors' employee productivity is the key independent variable (along with other controls). The results provide evidence that a coopetitor's employee productivity has a significant and positive influence (Model 27: $\beta = 0.1292$; $p < 0.01$) on a focal firm's employee productivity. This robustness check provides further credence that spillover effects do exist more broadly. We now turn to the discussion of the theoretical and managerial implications of our study.

5. Discussion

5.1 Theoretical Implications

Firms remain under stakeholder pressure to improve their environmental performance. Focal firms have attempted to address this issue by using either internal resources or leveraging external resources. However, several firms have struggled to improve their environmental performance because these resources are not sufficient. Our study suggests that focal firms should consider coopetition as an alternative structure that can provide a boost to their environmental performance. While it is risky and can lead to uncertain outcomes, we theorize that coopetition can enable a focal firm to leverage resources from competitors who are simultaneously involved in a sourcing relationship with them. Therefore, this study presents new theoretical and empirical insight into the operations management literature on why coopetition can influence a focal firm's environmental performance. Further, this study also broadens our understanding of how firm resources (e.g., a focal firm's financial slack, a firm's financial leverage, and leanness) can have a moderating impact on a focal firm's environmental performance.

Our study also contributes to the literature by bringing together environmental management research (King & Lenox, 2001; Rothenberg et al., 2001) and research in strategy (Khanna et al., 1998;

Lado et al., 1997), with coopetition in supply chain research (Li et al., 2011; Pathak et al., 2014; Wilhelm, 2011). We offer important theoretical and managerial implications by integrating these complementary streams of research. The coopetition literature serves as an important perspective to explore how a firm's interface with suppliers, who are also competitors, may affect their environmental management performance. Our multidisciplinary approach is consistent with prior operations management research that has benefited from the use of several theoretical perspectives to examine environmental management topics. For instance, operations scholars have adopted an institutional perspective to examine environmental management research questions (Hofer, Hofer, Eroglu, & Waller, 2011; Liu, Ke, Wei, Gu, & Chen, 2010). These scholars have theorized that a firm's environmental management performance is influenced by social, political, and economic forces (Delmas & Toffel, 2008). Other scholars have used stakeholder theory to explain how stakeholders influence the adoption of environmental training practices (Sarkis et al., 2010). Upper echelons theory has also received attention in explaining how top management support influences environmental management activities (Dai, Montabon, & Cantor, 2014). The competitive dynamics perspective has also been recently integrated into the discussion of why firms are motivated to pursue environmental management activities (Hofer et al., 2012). The theoretical bases discussed above, among many others, have improved our understanding of some of the forces that affect a firm's allocation of resources into environmental management practices. While these theoretical frameworks have valuable insight, we believe the coopetition literature adds a critical new perspective to the environmental operations literature.

Our first finding is that a coopetitor's environmental performance is positively related to a focal firm's environmental performance. Based on insights from the literature (Khanna et al., 1998; Lado et al., 1997), we theorized that firms in our sample learn how to improve their environmental performance due to environmental knowledge spillovers from their coopetitors (Gittelman & Kogut, 2003). It is commonly understood that some focal firms are aware of their competitors' environmental actions through indirect channels, such as publicly accessible corporate sustainability reports. Focal firms are often motivated to mimic competitors' efforts to improve their own environmental performance. However, since a focal firm

does not have direct access to a competitor's operations, a focal firm is unable to directly understand how it can replicate or copy a competitor's environmental management practices. Such knowledge is more likely tacit in nature and better understood via direct interaction. When a focal firm cooperates with its rivals, that firm is able to directly observe and learn about the coopetitor's best practices. A spillover effect occurs when a focal firm interacts with its coopetitor. The coopetition perspective provides us with a basis to understand how the development of cooperative arrangements with one's rivals facilitate inter-firm learning for environmental management. As such, we add to the research on spillovers (Agrawal, Muthulingam, & Rajapakshe, 2017) and coopetition (Chen et al., 2019) in the operations management literature.

Our next empirical finding relates to the moderating role of a focal firm's financial slack. We found support for the hypothesis that a focal firm's financial slack negatively moderate the relationship between a coopetitor's environmental performance and a focal firm's environmental performance. Figure 1 presents a depiction of the interaction effects plotted to show the expected effect on a focal firm's environmental performance at low and high levels[14] of financial slack and low and high levels of a coopetitor's environmental performance. As depicted in Figure 1, firms with lower financial slack are more likely influenced by a coopetitor's environmental performance to improve their own environmental performance. Indeed, firms with lower financial slack presumably may not be as insulated from the external environment compared with firms with higher levels of financial slack (Thompson, 1967). A firm's managers are less resistant to change (Kraatz & Zajac, 2001) and more motivated to improve a firm's environmental performance (Kraatz & Zajac, 2001). Our empirical evidence is also consistent with the competitive dynamics literature that argues firms under greater external pressure are more motivated to take new actions and are not self-satisfied with the status quo (Grimm et al., 2006; Miller & Chen, 1994).

<Insert Figure 1 here>

[14] Low and high values are defined at -1 standard deviation and + 1 standard deviation based on sample statistics.

A focal firm's financial leverage is the next moderating factor we evaluated. In the presence of higher levels of financial leverage, managers are likely encouraged to be more careful in their choices and will avoid engaging in practices for which financial returns are difficult to justify (Jensen, 1986). Drawing upon agency literature (Jensen, 1986; Jensen & Meckling, 1976), we contend that higher levels of financial leverage reduces managerial motivation to invest in pro-social endeavors such as environmental initiatives suppressing the learning from inter-organizational interactions. Figure 2 provides more empirical insight into this finding. As depicted in Figure 2, firms with lower financial leverage are more likely to be influenced by a coopetitor's environmental performance, to improve their own environmental performance.

<Insert Figure 2 here>

Our last important finding concerns the moderating role of leanness. We found empirical support that a focal firm's leanness enhances the positive association between a coopetitor's environmental performance and a focal firm's environmental performance. Figure 3 further illustrates this relationship, whereby as a focal firm's leanness increases, there is a greater effect of a coopetitor's environmental performance on a focal firm's environmental performance. However, in the situation of a focal firm's low leanness, the higher a coopetitor's environmental performance the lower a focal firm's environmental performance. We theorized that a focal firm is in a stronger position to leverage a coopetitor's environmental performance when a firm has achieved high levels of leanness. We view a focal firm's leanness and a coopetitor's environmental management practices as complementary and synergistic resources. We contend that there are complementary effects when a focal firm is able to efficiently manage its operations by reducing waste typically created in the production and distribution process in tandem with the benefits provided by a coopetitor's environmental management activities. Based on previous research, we suggested that lean organizations regularly engage in continuous improvement efforts and, thus, have the coordination infrastructure to implement organizational changes and practices, such as the spillover of environmental management practices from coopetitors (Anand et al., 2009;

Molina et al., 2007). In essence, lean firms have the dynamic capability to learn, adapt, and implement new routines (Anand et al., 2009).

<Insert Figure 3 here>

It is important to note that prior empirical research on buyer–supplier relationships has not controlled for the effects of competition and coopetition when assessing the influence of suppliers on a focal firm's performance. In an effort to compare our research with the findings presented in the prior buyer–supplier literature, we also estimated a buyer–supplier model where we do not control for the effect of competitors and coopetitors (Modi & Mabert, 2007; Sarkis et al., 2011). Indeed, we found a positive and statistically significant effect linking supplier environmental performance to buyer environmental performance. Our study builds upon and extends prior buyer–supplier research by suggesting that the effect of suppliers on a focal firm's performance may be contingent on controlling for these inter-firm ties (e.g., competition and coopetition relationships). Further, our interaction effect analyses demonstrate that the influence of suppliers' environmental performance may be contingent on focal firms' resource position. Specifically, we do find that focal firms that are leaner can benefit from the suppliers' environmental performance. Together, these results are in line with the literature, which indicates that buyer–supplier relationships are heterogeneous, and, therefore, the influence of suppliers' is more nuanced (Lambert, García-Dastugue, & Croxton, 2005), and any spillovers from suppliers is contingent on additional factors (Agrawal et al., 2017; Dyer & Hatch, 2006). Future research should take a closer look at the relationship between supplier and buyer environmental performance. Finally, while our study investigates three critical moderators, i.e. financial slack, leverage, and leanness, it is conceivable that additional important moderators influence the coopetitors' and focal firm's environmental performance relationship. Future research could also explore proximity to coopetition partner, length of relationship, and similarity in products between focal and coopetitor firms.

5.2 Managerial Implications

Our study also has important managerial implications. Our results suggest that a focal firm's environmental performance is impacted by a coopetitor's environmental performance. Because

coopetition reflects a multiplexed relationship, managers should recognize that this type of relationship does provide benefits over and above mimicry of competitors. Indeed, we compared the magnitude of the standardized effects and found that coopetitors' environmental performance has the highest influence, followed by competitors. As such, we provide empirical evidence that relationship pluralism, specifically cooperation with competitors, can benefit firms over and above just competition by itself (Doz et al., 1989). Managers should leverage the opportunity to observe competitor practices when also in a sourcing relationship with them. In such instances, managers should carefully monitor the extent to which coopetitors are improving their environmental ratings and react accordingly. If managers decide to form and participate in these arrangements, managers should establish policies and procedures to regularly review environmental performance metrics and then begin to consider establishing structures to encourage the sharing of best environmental management practices. This does not imply that managers should ignore the competition. We do find that competition helps due to mimicry pressures. Further, we find evidence that suppliers' environmental performance can also be leveraged in instances when focal firms have high leanness. In essence, when internal support structures for implementing complex organizational routines such as lean management are present at a focal firm, they can benefit from a supplier's environmental performance as well.

Our study recognizes that firms need to make a considerable financial investment into internal management systems that can support the integration of a supplier's environmental strengths into a focal firm's environmental management practices. However, while firms with higher levels of financial slack could use their capital position to integrate best practices associated with environmental practices, our finding suggests that managers may become complacent regarding environmental initiatives due to bureaucratic inertia. Indeed, Blau and Schoenherr (1971) suggest that firms with financial slack are more bureaucratic in nature, and these firms tend to add unnecessary layers of management, which can stifle a firm's ability to integrate a supplier's environmental practices into their own organization (Chandy & Tellis, 2000). Additionally, organizational theorists suggest that firms with deeper financial pockets suffer from higher levels of organizational inertia, making them less nimble (Chandy & Tellis, 2000). The

implication is that managers with higher levels of financial resources should implement business processes and systems to improve the monitoring of how funds are allocated to capital-intensive projects such as environmental initiatives. Our study also indicates that such processes may also be needed when firms have high financial leverage. As indicated in the finance literature (e.g., Bathala et al., 1994; Hiwt & Smart, 1994), financial leverage puts constraints on managerial discretion and plays a monitoring role. However, when managers are too constrained, they are less likely to engage in pro-social behaviors and would not be motivated to leverage their coopetitive relationships to improve environmental performance. In summary, the countervailing forces of managerial inertia and constrained decision-making environments need a fine balance by firms.

Our research also suggests that managers should consider how leanness can be used to leverage resources provided by a firm's coopetitive supply network. Lean practices were previously viewed as important to a focal firm's financial performance. Interestingly, our study suggests to managers that leanness should be viewed as an indicator of a firm possessing a strategic resource that can help organizations learn how to improve their environmental performance in a coopetitive arrangements.

Our study also adds to the debate concerning the role of public policy on the promotion of environmental management practices. This study suggests that competitive forces play an important role in the promulgation of environmental actions among coopetitors and focal firms. Focal firms are observing and learning about environmental management practices from their coopetitive partner networks. Future public-policy discussions should continue the debate on the efficacy of public policy initiatives versus competitive forces to motivate firms to improve environmental performance.

5.3 Limitations and Conclusion

As is the case in any study, there are some limitations here that can be explored in future research. Future studies could delve deeper into the findings related to the influence of suppliers' environmental performance. In addition, the focus of our study was on the US publicly traded firms. It is plausible that the influence of coopetition may differ based on international locations; as such, future research should investigate how global differences affect the coopetition–environmental performance relationship. While

we account for potential endogeneity, our model aggregates the variables of interest for coopetitors, competitors, and supplier groups of firms. The idea behind this is that a focal firm is exposed to an aggregate effect from its network. However, similar to Serpa and Krishnan (2017), future research may also explore these effects at the dyadic relationship level. Further, while the focus of our study was on vertical coopetition relationships, future research should examine other forms of coopetition relationships such as horizontal governance structures. In so doing, future research should examine how alternative coopetition arrangements have an impact on other aspects of firm performance such as innovation. Additionally, we had access to relationship data over the time period of 2004–2009, which precluded us from using more recent data for our analysis. With time, changes in industry wherein firms are faced with conditions of coopetition continues to increase. In light of this, future research may evaluate our findings with more recent data to observe how effects change over time (increase/decrease) as well as investigate other moderating factors to advance the academic literature and managerial understanding of coopetition. Finally, in investigating the spillover effects on productivity, we also find that suppliers' productivity has a negative effect on focal firm productivity. The effects of suppliers' productivity on focal firms' productivity have not been explicitly conceptualized and tested in the literature. For example, while a productive supplier can help focal firms by increasing efficiency and lowering cost, high productivity reduces slack, making firms prone to more disruptions and thereby having a negative effect on a focal firm. Future research can delve deeper to analyze this relationship.

In conclusion, this study makes an important contribution to the literature by building upon and extending prior environmental management research (Eroglu & Hofer, 2011; King & Lenox, 2001; Rothenberg et al., 2001) and coopetition research in the operations management literature (Li et al., 2011; Pathak et al., 2014; Wilhelm, 2011). We hope that our study will generate further interest in this important topic.

ACKNOWLEDGEMENTS: The authors would like to thank FactSet Revere for providing the data used in this study

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Table 1: Key features of competition, cooperation, and coopetition relevant to our study

Attribute	Coopetition	Buyer–Supplier Relationships (Cooperation)	Competition
Purpose of relationship	Primary focus is achieving the strategic goal of the partnership.	Primary focus is to ensure availability of quality products to support buyer's operations.	Rivals seek to improve their own market share and firm performance.
Multiplex relationships	Partners in relationship can have multiple roles (e.g., competitor and supplier).	Single role (i.e., either buyer or supplier).	Single role (i.e., firms are competitors).
Coordination activities	Coordination activities facilitate collaboration and coordination on strategic and operational tasks.	Coordination activities primarily facilitate operational tasks.	None.
Access to knowledge-sharing resources	Knowledge-sharing for common (i.e., joint) and private (i.e., unilateral) benefits.	Knowledge-sharing to maximize common (i.e., joint) benefits.	None. Rivals create barriers to protect knowledge resources.
Direction of knowledge-sharing activities	Bi-lateral access to knowledge-sharing resources.	Knowledge-sharing is frequently unidirectional (i.e., from buyer to supplier) and sometimes bidirectional (e.g., joint new product development)	None. Rivals observe others competitive actions but lack knowhow.
Type of benefits derived from the relationship	Common benefits and private benefits	Common benefits only	Private benefits only

Table 2: Unique firms represented in the sample

Panel A – Focal firms by year

Year	Number of Focal Firms
2004	240
2005	243
2006	247
2007	241
2008	246
2009	248

Panel B – Unique number of firms for different firm types in the sample over 2004–2009

Firm Type	Number of Unique Firms
Focal Firms	320
Coopetitors	267
Suppliers	546
Competitors	926

Panel C – Distribution of the number of years that focal firms have nonmissing data in the sample

Number of Years	Number of Focal Firms	Number of Observations
1	27	27
2	24	48
3	44	132
4	33	132
5	26	130
6	166	996

Table 3: Descriptive statistics

N = 1,465	Mean	St. Dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Environmental Performance	-0.0171	0.5373	1													
2 Environmental Strengths	0.1481	0.4951	0.5539***	1												
3 Environmental Concerns	0.1652	0.4890	-0.5379***	0.4039***	1											
4 Firm Size	7.4205	1.8026	-0.0653*	0.3926***	0.4692***	1										
5 Market Share	0.3557	1.7781	0.1613***	0.3686***	0.1960***	0.3397***	1									
6 Employee Productivity	1.4198	10.6909	-0.0065	-0.0123	-0.0053	-0.0089	0.0136	1								
7 Industry Munificence	0.0613	0.0355	-0.0804**	-0.0368	0.0511	0.1041***	-0.0918***	0.0271	1							
8 Industry Dynamism	0.0104	0.0064	-0.0205	0.0375	0.0605*	0.0262	0.0006	-0.0260	-0.0084	1						
9 Industry Concentration	0.0190	0.0211	0.0806**	0.0455	-0.0424	-0.0930***	0.2565***	0.0639*	-0.1477***	-0.0669*	1					
10 Suppliers' Environmental Performance	0.0315	0.6712	0.1542***	-0.0055	-0.1749***	-0.0792**	0.0224	-0.0266	-0.0704**	-0.0773**	0.0419	1				
11 Competitors' Environmental Performance	0.0076	0.5625	0.3340***	-0.0225	-0.3898***	-0.1598***	-0.0073	0.0013	-0.1240***	-0.1391***	0.1126***	0.3102***	1			
12 Financial Slack	0.6801	1.4360	0.0560*	-0.1575***	-0.2210***	-0.4315***	-0.1125***	-0.0052	0.0083	-0.0450	0.0493	0.0732**	0.1553***	1		
13 Inventory Leanness	-0.0416	1.0037	0.0569*	0.1798***	0.1196***	0.1584***	0.0895***	-0.0619*	0.0233	-0.0233	0.0174	-0.0439	-0.0310	-0.1342***	1	
14 Financial Leverage	4.5577	11.6793	0.0236	0.0371	0.0117	-0.0127	0.0014	0.4374***	0.0008	-0.1893***	0.1284***	-0.0486	0.0289	-0.0561*	0.1129***	1
15 Coopetitors' Environmental Performance	0.1598	0.9443	0.2861***	0.0414	-0.2724***	-0.0628*	0.0107	0.0240	-0.1497***	-0.0689**	0.0805**	0.2689***	0.4475***	0.0639*	-0.0666*	0.0316

*** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4: System GMM estimation results

	Model 1	Model 2	Model 3
Independent Variables	DV=Environmental Performance		
Lagged Environmental Performance	0.8176***	0.8091***	0.8065***
	(0.002)	(0.001)	(0.000)
Firm Size	0.0176***	0.0168***	0.0091***
	(0.001)	(0.001)	(0.000)
Market Share	0.0142***	0.0135***	0.0134***
	(0.000)	(0.000)	(0.000)
Employee Productivity	-0.0001***	-0.0004***	0.0009***
	(0.000)	(0.000)	(0.000)
Industry Munificence	0.0468***	-0.1599***	-0.2768***
	(0.017)	(0.014)	(0.006)
Industry Dynamism	4.4761***	4.2335***	4.9250***
	(0.120)	(0.079)	(0.052)
Industry Concentration	-0.4449***	-0.3840***	-0.2115***
	(0.051)	(0.041)	(0.014)
Suppliers' Environmental Performance	0.0010	-0.0124***	-0.0104***
	(0.002)	(0.001)	(0.001)
Competitors' Environmental Performance	0.0455***	0.0442***	0.0361***
	(0.002)	(0.002)	(0.001)
Financial Slack	0.0198***	0.0081***	0.0074***
	(0.001)	(0.000)	(0.000)
Inventory Leanness	0.0100***	0.0062***	0.0077***
	(0.001)	(0.001)	(0.000)
Financial Leverage	0.0001**	-0.0001*	0.0002***
	(0.000)	(0.000)	(0.000)
Coopetitors' Environmental Performance		0.0417***	0.0283***
		(0.001)	(0.000)
Financial Slack x Coopetitors' Environmental Performance			-0.0244***
			(0.000)
Financial Leverage x Coopetitors' Environmental Performance			-0.0010***
			(0.000)
Inventory Leanness x Coopetitors' Environmental Performance			0.0361***
			(0.000)
Wald $\chi 2$ [p-val]	1.6 x 10^6 [0.000]	2.93 x 10^6 [0.000]	1.9 x 10^8 [0.000]
Arellano-Bond test for AR(2) in first differences *p*-value	0.132	0.174	0.196
Hansen test of overid. Restrictions *p*-value	0.113	0.135	0.459
Observations	1,465	1,465	1,465
Number of Focal Firms	320	320	320

Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Time dummy variables included in all estimations

Table 5: **System GMM estimation results for Supplier Only Model and Additional Interactions**

	Model 4	Model 5
Independent Variables	DV=Environmental Performance	
Lagged Environmental Performance	0.8308***	0.6113***
	(0.002)	(0.013)
Firm Size	0.0228***	-0.0062
	(0.001)	(0.009)
Market Share	0.0115***	0.0862***
	(0.000)	(0.009)
Employee Productivity	0.0001***	0.0019***
	(0.000)	(0.000)
Industry Munificence	-0.0489**	-0.3796**
	(0.023)	(0.172)
Industry Dynamism	3.0077***	2.3605**
	(0.146)	(1.068)
Industry Concentration	-0.3166***	-1.9841***
	(0.064)	(0.576)
Suppliers' Environmental Performance	0.0098***	-0.0219**
	(0.002)	(0.010)
Competitors' Environmental Performance		0.0158
		(0.017)
Financial Slack	0.0249***	0.0112**
	(0.002)	(0.005)
Inventory Leanness	0.0130***	0.0078
	(0.002)	(0.006)
Financial Leverage	-0.0002***	0.0002
	(0.000)	(0.000)
Coopetitors' Environmental Performance		0.0250***
		(0.008)
Financial Slack x Coopetitors' Environmental Performance		-0.0122**
		(0.006)
Financial Leverage x Coopetitors' Environmental Performance		-0.0018***
		(0.000)
Inventory Leanness x Coopetitors' Environmental Performance		0.0159***
		(0.006)
Financial Slack x Suppliers' Environmental Performance		0.0090
		(0.007)
Financial Leverage x Suppliers' Environmental Performance		0.0007
		(0.001)
Inventory Leanness x Suppliers' Environmental Performance		0.0151*
		(0.008)
Financial Slack x Competitors' Environmental Performance		-0.1031***
		(0.013)
Financial Leverage x Competitors' Environmental Performance		0.0005
		(0.001)
Inventory Leanness x Competitors' Environmental Performance		0.0283**
		(0.013)
Wald $\chi 2$ [p-val]	9.58 x 10^5 [0.000]	6.4 x 10^3 [0.000]
Arellano-Bond test for AR(2) in first differences p-val	0.131	0.207
Hansen test of overid. Restrictions p-val	0.114	0.794
Observations	1,465	1,465
Number of Focal Firms	320	320

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Time dummy variables included in the estimation

Figure 1: Interaction effect with financial slack

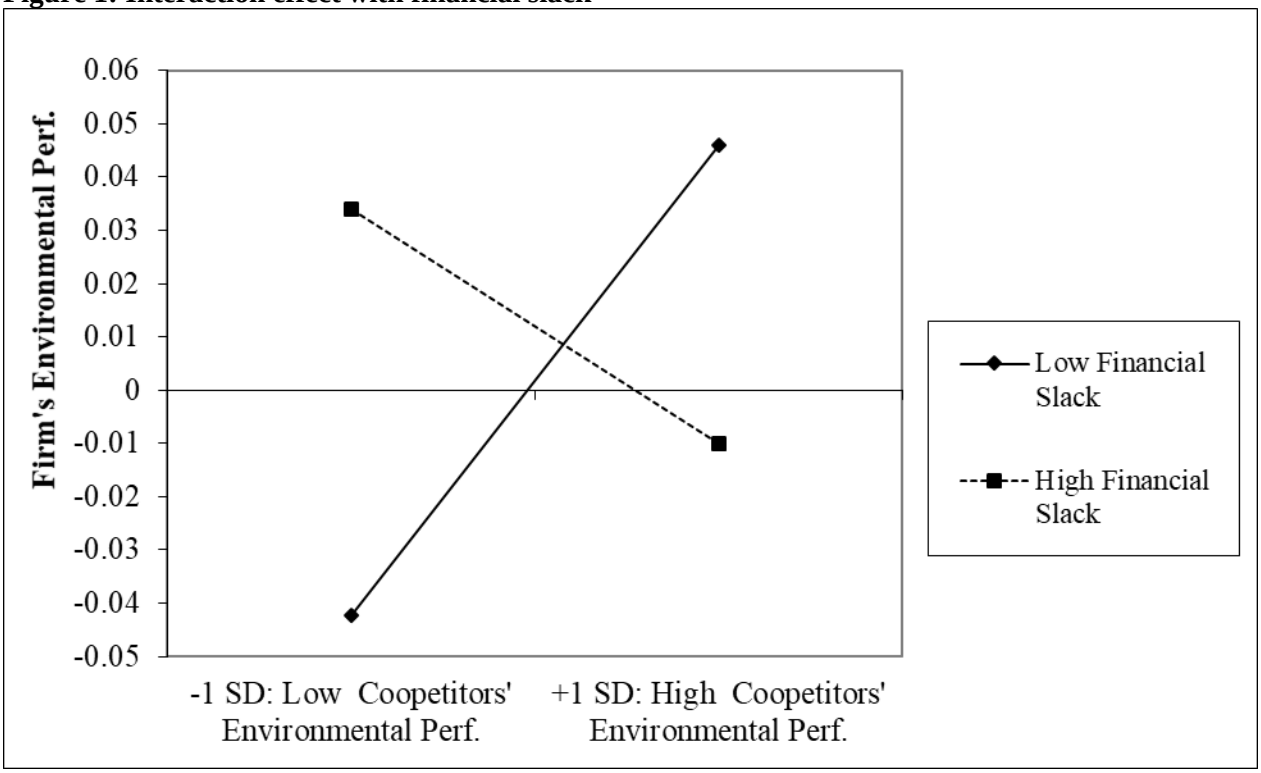

Figure 2: Interaction effect with financial leverage

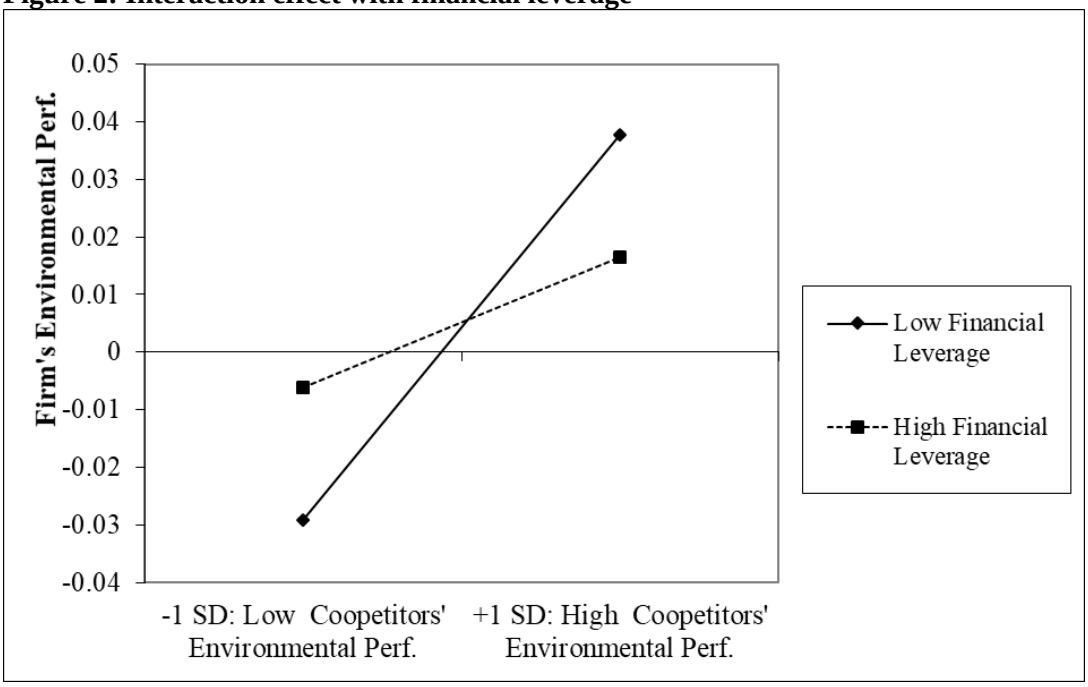

Figure 3: Interaction effect with inventory leanness