



# Interdependence and network-level trust in supply chain networks: A computational study



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## ABSTRACT

We investigate the impact of the supply chain interdependence structure on network-level trust in the supply chain (i.e., supply chain trust). We adopt an opportunism-based definition of trust, according to which trust and opportunism are the opposite of one another, and conceptualize the supply chain as a complex adaptive system (CAS). We thus employ the NK framework to model the supply chain network as a set of interdependent partners (and their decisions) interacting among each other according to a specific pattern reflecting the overall supply chain interdependence structure. In particular, we argue that supply chain networks can reveal in practice the 10 patterns identified by Rivkin and Siggelkow (2007) in a recent study on patterned interactions in complex systems. Thus, we perform computational analysis to evaluate, for each considered interdependence pattern, the risk of opportunism by the participating firms, which allows us to compare the patterns on the level of supply chain trust. We show that supply chain trust is a positive (negative) function of the number of uninfluenced (uninfluential) partners, that are, partner firms whose decisions are not influenced by (do not influence) the decisions made by the remaining partners. We also find that, for each examined pattern, the higher the degree of interdependence in the supply chain, the lower supply chain trust.

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## 1. Introduction

Supply chains are networks of interorganizational relationships among interdependent firms operating along an industry value chain. As competition is increasingly being fought supply chain vs. supply chain, managing the overall supply chain network becomes vital to competitive success (Greis & Kasarda, 1997; Ketchen & Giunipero, 2004). The supply chain is indeed more than its composing dyads, and looking at it as a sum of dyadic relationships does not allow managers and researchers to take into account the complex web of interdependencies which characterizes the supply chain and influences behaviors and performance outcomes in real-world supply chains (Nair, Narasimhan, & Choi, 2009). Thus, doing impactful supply chain management research may benefit from shifting the level of analysis from the dyad to the overall network.

A critical element for achieving effective supply chain management resides in establishing and nurturing trust among the participating organizations (Handfield & Bechtel, 2002; Panayides & Lun, 2009). A significant literature has indeed pointed out the beneficial impact of trust on supply chain management and showed that trust is a powerful antecedent of effective cooperation and a significant predictor of

positive performance outcomes and competitive advantage in supply chain interorganizational relationships (Dyer & Chu, 2003; Johnston, McCutcheon, Stuart, & Kerwood, 2004; Kumar, 1996; Monczka, Petersen, Handfield, & Ragatz, 1998). However, most studies on trust in supply chain contexts have focused on dyadic relationships (Dyer & Chu, 2003; Johnston et al., 2004; Laaksonen, Jarimo, & Kulmala, 2009; Zaheer, McEvily, & Perrone, 1998). Conversely, there has been a paucity of research on trust at the level of the overall supply chain network. For the purposes of this study, network-level trust (i.e., supply chain-level trust, or simply supply chain trust) expresses the extent to which trust is pervasive across the supply chain. We measure it by the level of trust that, on average, supply chain firms hold in the remaining ones.

In line with the need of adopting a network (vs. dyadic) perspective to supply chain research, the present study focuses on supply chain-level trust. This resonates with previous literature suggesting that, in order to reach a better understanding of how trust affects supply chain outcomes, we need to concentrate on network-level trust (Ireland & Webb, 2007). Indeed, when trust is pervasive across the supply chain, ideas, knowledge, products, and services can freely flow to help design, manage, and perform processes and activities aimed at creating value, with positive effects on several performance outcomes (Dyer & Singh, 1998; McCarter & Northcraft, 2007). Commenting upon supply chain management challenges, Galaskiewicz (2011: 6) has put it this way: “the management problem is how to create a social network that would enable the parties to trust one another up and down the supply chain”. To contribute to

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solve this puzzle, we focus on one major factor influencing trust in supply chains — that is, interdependence. Specifically, we investigate the differential impact of different possible supply chain interdependence patterns on supply chain-level trust. By doing so, we aim at providing useful insights for supply chain architects (i.e., individuals, and their organizations, holding influential network positions and endowed with the needed capabilities to design and lead supply chains) and, more generally, for those interested in interorganizational network building and management.

Interdependence refers to whether, and the extent to which, two or more economic actors depend upon one another for product and process accomplishments and/or for strategically relevant resources and capabilities owned by their partners (Pfeffer & Salancik, 1978). Both types of interdependence occur recurrently in supply chains. While previous research has typically looked at the impact exerted on trust by the *degree* (i.e., intensity) of interdependence, we focus on the overall *pattern* of interdependencies that characterizes the supply chain. We adopt an opportunism-based view of trust, according to which trust and opportunism are the opposite of one another (Barney & Hansen, 1994; Gambetta, 1988). Specifically, we assume that the higher the average risk of opportunism across the supply chain, the lower trust at the supply chain level. Based on this, we advance that the supply chain interdependence pattern affects supply chain-level trust by influencing whether, and the extent to which, the local interests of the supply chain members are aligned with the global interests of the supply chain, which in turn impact the risk that partners behave opportunistically.

A notable feature of this study is that it draws on the literature on complex adaptive systems (CASs) (Holland, 1995). Previous scholars suggested that supply chains can be conceptualized as CASs (Choi, Dooley, & Rungtusanatham, 2001; Surana, Kumara, Greaves, & Raghavan, 2005) and that doing so has the potential to move the field of supply chain management studies beyond a dyadic buyer–supplier framework (Pathak, Day, Nair, Sawaya, & Kristal, 2007), thus generating valuable insights into how to manage the overall supply chain network (Nair et al., 2009). However, Pathak et al. (2007) noted that this potential has been exploited by only a small number of scholars and urged the supply chain management research community to leverage the CAS perspective in order to deepen our understanding of the supply chain and its inherent complexity. They also argued that “recent advancements made by Rivkin and Siggelkow (2007) toward extending CAS research of organizations (...) using the NK model of fitness from theoretical biology (...) could have important lessons for the study of supply chains” (see also Choi & Krause, 2006).

Based on the above, we draw on previous research, that has employed Kauffman's (1993) NK framework to analyzing management problems (e.g., Ganco & Hoetker, 2009; Levinthal, 1997), to model the supply chain in terms of the 10 interaction patterns identified by Rivkin and Siggelkow (2007) in their study on patterned interactions in complex systems. We then perform computational analysis to measure, for each examined pattern, the risk of opportunism by the participating firms. This allows us to gauge the level of supply chain trust associated with each pattern and compare the patterns on such a level. Based on our findings, we conclude that supply chain trust is positively (negatively) affected by the number of uninfluenced (uninfluential) partners, i.e., supply chain partners whose decisions are not influenced by (do not influence) the decisions made by the remaining partners. We also find that supply chain trust is negatively affected by the degree of interdependence.

The primary purpose of this study is to contribute to our knowledge of trust in supply chain networks by focusing on the role of the supply chain interdependence pattern. Indeed, although we have a good theoretical understanding of the constructs of trust and interdependence, the relationships between them, and in particular the impact that interdependence patterns exert on trust at the supply chain level, need in-depth investigation. To do so, we leverage the ability of computer simulation to shed light into complex theoretical relationships among

constructs and reveal the outcomes of the interactions among multiple organizational processes (Davis, Eisenhardt, & Bingham, 2007; Mezias & Eisner, 1997). Indeed, detailed empirical analysis of the relationships between interdependence and trust in supply chain contexts would pose considerable and perhaps insurmountable difficulties, such as identifying a number of supply chains whose interdependence patterns resemble several different archetypical configurations and gaining access to confidential information concerning the identified supply chains, their member firms, and their behavior in different circumstances. Therefore, we employ the NK framework to construct a computational representation of the supply chain as a network of interdependent partners (and their decisions) and related performance outcomes, from which we infer the probability that supply chain partners behave opportunistically, that in turn affects the level of supply chain trust. By doing so, in line with Davis et al. (2007), we aim to provide fresh theoretical insights on the phenomena under investigation while avoiding the overriding complexity of extensive empirical research.

## 2. Trust, opportunism, and interdependence in supply chain networks

### 2.1. Trust and opportunism

Trust has largely been examined in management research (e.g., Hoffmann, Neumann, & Speckbacher, 2010; Seppänen, Blomqvist, & Sundqvist, 2007; Thorgren, Wincet, & Eriksson, 2011) and dozens of definitions have been offered in previous studies (Dirks & Ferrin, 2001; Hosmer, 1995; Mayer, Davis, & Schoorman, 1995; Ring, 1996; Rousseau, Sitkin, Burt, & Camerer, 1998). Trust occurs in economic exchange when economic actors are willingly vulnerable to the behavior of other parties because of expected cooperation or benevolence from them (McCarter & Northcraft, 2007; Rousseau et al., 1998). In the case of inter-organizational relationships, trusting organizations are willing to depend on partner organizations whom they trust because they expect those trusted partners will not behave opportunistically (Barney & Hansen, 1994; Bradach & Eccles, 1989). This is consistent with the idea of trust as the probability that economic actors will make decisions and take actions that will not be detrimental to others (Gambetta, 1988: 217). Following this line of reasoning, trust is the opposite of opportunism (Barney & Hansen, 1994: 176). In fact, empirical studies have found that trust and opportunism are substitutes for one another (Cavusgil, Deligonul, & Zhang, 2004; Dyer & Chu, 2003; Zaheer & Venkatraman, 1995). Williamson defined opportunism as “a lack of candor or honesty in transactions, to include self-interest seeking with guile” (Williamson, 1975: 9). In interorganizational relationships, opportunism occurs when one or more parties exploit the vulnerabilities of other parties to seek their own unilateral gains at the substantial expense of the other parties and/or of the overall relationship (Das, 2006; Das & Rahman, 2010; Luo, 2007). Opportunistic behaviors include, among others, violation of written contracts, failing to honor informal agreements, falsification of information, quality shirking, and breach of distribution contracts (see Wathne & Heide, 2000 for a comprehensive review of the original and emergent conceptualizations of opportunism).

### 2.2. Network-level trust in supply chain networks

The present paper focuses on trust among organizations involved in supply chain networks. Previous research that has investigated trust in networks has typically drawn attention to trust within the individual dyadic relationships the examined networks were composed of (e.g., Capaldo, 2007; Zaheer et al., 1998). This perspective has led to major insights concerning, among others, the influence of the overall network on trust in its component dyads (Capaldo, 2014; Coleman, 1990) and the impact exerted by trust-based dyadic relationships on dyad- or network-level outcomes such as innovativeness and competitive advantage (Capaldo, 2014; Dyer & Nobeoka, 2000). Conversely, little attention has been paid to network-level trust and a clear

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