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Managing country disruption risks and improving operational performance: risk management along integrated supply chains

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ABSTRACT

Increasingly complex supply chains and heightened disruption risks are bringing risk management to the forefront of managerial and research efforts. We examine how country disruption risks are related to the adoption of combined risk management and external supply chain integration practices, and how these combinations in turn are related to operational performance. We frame our propositions using information processing theory and complementarity theory. We combine primary data from the 6th International Manufacturing Strategy Survey on 21 countries, and secondary data on country level disruption risks to study these links. Our results indicate that companies in riskier countries, characterized by high operational contingencies risk, natural hazard and terrorism and political instability, use combined arcs of external supply chain integration and risk management practices. Such a combined approach is also related to higher operational performance. The findings suggest to managers that companies adopting risk management practices in combination with external integration achieve best operational results. We extend the *arcs of integration* concept to include also risk management practices thus showing that holistic risk management approaches along supply chains are positively related to operational performance. The combination of primary and secondary data, as well as the focus on exogenous risks distinguishes our approach from previous, mostly conceptual, studies on risks.

1. Introduction

With the implementation of lean manufacturing, increased outsourcing, shorter product life-cycles and time-based competition, supply chains are more fragile to disruption risks, such as operational contingencies, market and technology changes, natural hazard, terrorism and political instability (Zsidisin et al., 2005; Trkman and McCormack, 2009; Tang and Musa, 2011) and these are also becoming costlier (Bhattacharyya et al., 2010) and affecting operational performance (Blome and Schoenherr, 2011). Unfortunately, more and more unexpected events affect not only single companies, but their whole supply chain, often at global scale. Well known examples range from the fire at a Philips plant in New Mexico in 2000 that disrupted the supply chains of both Nokia and Ericsson (Chopra and Sodhi, 2004), to the earthquake, tsunami and nuclear disaster that affected Japan in 2011 with consequences on supply chains at global level (Park et al., 2013). As a result, risk management along supply chains has become a key industry concern (Blome and Schoenherr, 2011; Khan and Burnes, 2007).

The main challenge of environments characterized by high disruption risks is related to the impossibility for the firms to plan and operate deterministically, due to lack of information and its reliability (Bode et al., 2011). Information-related problems have been extensively investigated through the information processing theory and two main strategies have been proposed to deal with these issues (Galbraith, 1973): i) reducing the needs to processing information through slack resources and ii) increasing the information processing capability through investing in information sharing. In traditional competitive environments, firms adopted risk management practices aiming to reduce information needs: Possible sources of risk were identified and faced with buffering strategies. These buffers typically included inventories, excess capacity cushions, and multiple and back-up suppliers (Newman et al., 1993). In today's dynamic and complex competitive environments, an alternative approach suggested to face disruption risks is to increase the firm's information processing capability through increased control over operational activities, also

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outside the firm boundaries (Jüttner et al., 2003; Kleindorefer and Saad, 2005). This external integration typically refers to supply chain integration (SCI) practices including coordination and collaboration practices with suppliers and customers (Frohlich and Westbrook, 2001; Schoenherr and Swink, 2012).

In line with complementarity theory (Milgrom and Roberts, 1995), these two sets of practices are not mutually exclusive and can be complementary (Bode et al., 2011), contributing to operational performance. For example, a firm may detect risks and increase internal buffers to face them while increasing supplier integration and through it collect information about the external environment, thus enhancing also its risk detection efforts in the process. Complementarity theory argues that activities or groups of them are complements if increasing one activity increases the benefits of doing more of the other activity (Milgrom and Roberts, 1995), i.e. an activity provides greater returns in the presence of another activity (Zhu, 2004).

We believe that it is important for managers to understand the options they have for managing risk. It is also important to understand the impact which these options have, implemented in isolation or combined, on the operational performance of the firm. In the past, most research has examined each of these options independently (Zsidisin, 2003; Flynn et al., 2010). We feel that there is both a practical and theoretical need to address the combination of these options to understand the formulation of an effective risk management strategy. Specifically, our research aim is to investigate *whether the combined use of risk management and integration practices is associated with greater levels of country disruption risks in the focal company environment, and whether such combined approaches lead to higher performance*. As supply chain managers strive for chains with both efficiency and competitiveness as well as responsiveness (Nooraie and Parast, 2016), we assume that according to the level of risks that firms are facing, they may identify the best integration approach fitting to their environment and risk management practices.

To achieve our goal, we combine primary firm level survey data and secondary country level risk indexes. This combination of two types of data is an important contribution. There are increasingly calls to use more secondary data in supply chain research (Rabinovich and Cheon, 2011) yet few examples of secondary data analysis, or of its combination with primary data exist (e.g., Vachon and Mao, 2008; Wiengarten et al., 2014 and in press).

Through our aims, this study contributes to both risk management and SCI literatures. Most previous literature on risks is conceptual or descriptive (e.g., Zsidisin, 2003; Christopher et al., 2011) and the literature on risk management has in many cases disregarded an important division of risks based on their origin: from within a chain (endogenouos risks) or from the outside environment (exogenous risks) (Trkman and McCormack, 2009). Despite limited research focused on the role of exogenous disruption risks to which a firm is exposed, they may be critical (Kleindorfer and Van Wassenhove, 2004), and shape the intensity of risk management efforts along the supply chain a firm adopts. Therefore we focus on these risks and investigate them in relation to the adoption of risk management practices (i.e. detection, prevention and mitigation and integration), along the supply chain.

The paper is structured as follows. First, we present a literature review on risk management, external SCI and disruption risks and performance. We present propositions on the relationships between these concepts. Secondly, our methods and data are described. Third, results of statistical analyses are presented. Discussion and conclusions summarize the study.

2. Literature review

Below, we will discuss the literature on risk management and external SCI practices and their relation with country disruption risks and operational performance.

2.1. Risk management and external SCI

Supply chain risk management is defined as *"the identification and management of risks for the supply chain, through a co-ordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole"* (Jüttner et al., 2003; 201). This approach is developed through the adoption of different risk management practices, which entail four basic facets: (1) assessment of risk sources, (2) identifying risks through definition of consequences, (3) tracking of these risks in the chain and (4) mitigation (Jüttner et al. 2003).

The main issue related to risk management is the unpredictability of the environment and the lack of reliable information to plan and operate deterministically (Bode et al., 2011). In line with the information processing theory (Galbraith, 1973), the approaches developed by companies to manage such an issue range from the most reactive ones – aiming to reduce the needs to process information, to the most proactive ones – aiming to increase the capability of the organization to process information. According to a path analysis study by Colicchia and Strozzi (2012), early stages of risk management research took a reactive approach to supply chain risks. Often, firms have used buffering mechanisms to handle the uncertainty of complex environments. These buffers typically include inventories, quoted lead times, excess capacity cushions and back-up suppliers (Newman et al., 1993). These buffering strategies reduce the information processing needs related to a specific relationship through redundant and slack resources (Bode et al., 2011). More recently, Kleindorfer and Saad (2005) mark a turn towards a more proactive, mitigative approach that extends throughout the whole chain (Colicchia and Strozzi, 2012). This new stream of research emphasizes the role of external SCI in risk mitigation (e.g. Zsidisin and Smith, 2005; Tachizawa and Gimenez, 2010). Among them, Tang (2006) suggests that coordinated/collaborative mechanisms along the supply chain - supply, demand, product and information management – are a powerful risk mitigation approach. External SCI allows increasing information processing capabilities to cope with risks. It is an effort to manage resource dependencies and enlarge a firm's influence over supply chain partners, accessing reliable and timely information about disruptions and their consequences (Bode et al., 2011).

Flynn et al. (2010; 59) define SCI "*as the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes*". SCI can be categorized into multiple dimensions considering the width of the integration, most prevalently into internal, customer and supplier integration, the latter two together forming the concept of external SCI (Schoenherr and Swink, 2012; Wiengarten et al., 2014). Specifically, external SCI can be defined as "*the degree to which a manufacturer partners with its external partners to structure inter-organizational strategies, practices and processes into collaborative, synchronized processes*" (Flynn et al., 2010, p. 59). Supplier and customer integration respectively involve core competencies related to coordination and collaboration with critical suppliers or customers (Flynn et al., 2010). The extent to which firms invest in supplier and customer integration has been operationalized in the concept of *arcs of integration* by Frohlich and Westbrook (2001) who found 5 types of arcs depending on the width of integration done by the focal firm (i.e., inward-facing, periphery-facing, customer-facing, supplier-facing and outward-facing). These were later re-validated by Schoenherr and Swink (2012).

Here we attempt to expand the concept of *arcs of integration* by Frohlich and Westbrook (2001) to examining how risk management can be developed along supply chains as the combined adoption of traditional risk management practices and arcs of external SCI practices. Specifically, we investigate whether different combined risk management and integration practices are adopted in relation to different levels of firm disruption risks at the country level, and how these different risk management approaches along the supply chain