

# Linking forward and reverse supply chain investments: The role of business uncertainty

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Available online 17 January 2007

## Abstract

This paper explores managerial efforts in reverse supply chains (RSC), where the focus is on the capture and exploitation of used products and materials. The RSC can potentially reduce negative environmental impacts of extracting virgin raw materials and waste disposal. If so, investment in the reverse supply chain should not be made in isolation, but instead must be integrated with investments selected to improve the forward supply chain. After defining and operationalizing these constructs, a survey of plant managers was used to empirically assess the linkages between supply chain investments, organizational risk propensity (i.e., willingness to take risk) and business uncertainty. Reverse supply chain investment had two primary dimensions: reconditioning (i.e., high-value recovery) and recycling and waste management (i.e., low- or no-value recovery). Ongoing investment in the forward supply chain was significantly related to investment in recycling and waste management, but not to investment in reconditioning. Moreover, risk propensity was found to mediate the relationship between the external business uncertainty and investment in the forward and reverse supply chain.

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**Keywords:** Reverse supply chain; Supply chain management; Environmental uncertainty; Risk propensity; Supplier development; Structural equation modeling

## 1. Introduction

In today's business climate, managers are facing increased pressures to form sustainable supply chains that address increasing environmental concerns (Klassen and Vachon, 2003), expanding sales opportunities in secondary markets (Meyer, 1999), proliferation of take-

back laws, particularly in the European Union (Fishbein, 1994; Toffel, 2003), and growing consumer pressure for environmentally friendly operations. As these pressures intensify, managers must choose from a daunting array of possible alternatives that develop new capabilities, change interactions with customers and suppliers, and require adjustments in existing supply chain partnerships, which, in turn, affect firm performance.

Given these complex issues, supply chain management must expand from its traditional focus on the forward flow of materials, components and products to explicitly address the disposal, recycling, reconditioning and remanufacturing of used products. The forward supply chain (FSC) is composed of a series of activities

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in the process of converting raw materials to finished goods. The manager's objective of investing in the forward supply chain is to improve performance in areas such as procurement, demand management and order fulfillment, amongst others (Cooper et al., 1997). Improvement initiatives can take several forms, including supplier development programs and customer relationship management.

In contrast, the reverse supply chain (RSC) refers to the series of activities necessary to retrieve a product from a customer and either dispose of it or recover value (Guide and van Wassenhove, 2002; Prahinski and Kocabasoglu, 2006). An obligation to manage this return flow of products, often years after their initial sale, has recently been imposed as the European Union directive for all Waste Electrical and Electronic Equipment (WEEE), which came into force in the last half of 2005. From the perspective of sustainable development, closing the loop between the manufacturer and customers offers the potential to make significant gains in environmental performance. Yet, firms also face enormous risks in their RSC management involvement. Well-developed systems and capabilities can offer greater customer loyalty and product feedback, while poorly designed and operated systems add significant cost and slow responsiveness.

The purpose of this study is to explore investment in the RSC. In particular, we examine the RSC investment as it relates to the FSC, the managers' perceptions of their organization's risk propensity and the managers' perceptions of business uncertainty. Thus, this paper makes three contributions. First, our understanding of the RSC is still very limited. Drawing on earlier case-based research and analytical models, RSC investment is defined and operationalized using a survey instrument. Second, the theoretical basis for the antecedents to RSC investment is identified. Particular attention is paid to FSC investment, as well as contextual factors related to business uncertainty and internal factors related to the willingness to accept the risk resulting from that uncertainty, termed organizational risk propensity. Finally, the relationships between RSC investment, FSC investment, risk propensity and business uncertainty are examined. Collectively, this research lays the groundwork for improved operational practice in designing and managing more effective reverse supply chains, which should yield stronger performance.

This paper is organized as follows. A review of the literature relevant to this study is provided in Section 2. The theoretical model and hypotheses are introduced in Section 3. Data analysis is presented in Section 4. The

discussion of empirical results is presented in Section 5. Conclusions and future research directions are summarized in Section 6.

## 2. Literature

To structure the theory development that underlies our consideration of RSC investment, it is important to note three primary elements related to risk: *inputs* to decision-making (i.e., *perceived business uncertainty*, also termed *perceived risk*); *willingness to accept* or *tolerate risk* (i.e., *risk propensity*, ranging from risk-avoiding to risk-seeking); and *outputs* of the decision-making (i.e., *investments*, also termed *risk behavior*). Similar to the more general definition of risk by Forlani et al. (2002) and March and Shapira (1987), in this study, risk is due to either a large number of potential outcomes or to the relative magnitude of the actual outcome of the forward and reverse supply chain investments.

Past risk studies have examined individual-level perceptions, propensity and behaviors, with the unit of analysis being specific decisions (e.g., Keil et al., 2000; Sitkin and Weingart, 1995) and patterns of behavior (Pettrakis, 2005). Yet, risk management studies can also be extended to the organizational level, based on the perceived business uncertainty and organizational tendencies to reward or punish decisions (Baird and Thomas, 1985; Sitkin and Pablo, 1992; Weber et al., 2002). To date, investigation and application of the risk behavior model at the organizational level has received little attention, with new product development being one exception (Forlani et al., 2002; Tabak and Barr, 1999). In addition, we were unable to find any research that applied the risk behavior model to the study of reverse supply chains.

In the following sections, we review the literature on forward and reverse supply chain investments, risk propensity and business uncertainty.

### 2.1. Supply chain investments

Outcomes, or risk behaviors, are the selection of one alternative from a variety of choices, each with a potentially different result (March and Shapira, 1987). At an organizational level, the allocation of resources, such as the cumulative investments in the supply chain, is one such form of risk behavior (Mittal et al., 2002).

FSC investment indicates management's intention of improving the communication and collaboration among supply chain partners to make the supply chain more efficient or responsive. To this end, on the supplier side,

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