



# An empirical analysis of supply chain risk management in the German automotive industry

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## ABSTRACT

The purpose of this paper is the empirical analysis of supply chain risk management practices. The analysis is based on a survey with 67 manufacturing plants conducted in the German automotive industry. After investigating the vulnerability of supply chains in general and examining key drivers of supply chain risks, the paper identifies supply chain risks by analyzing their likelihood to occur and their potential impact on the supply chain. The results are visualized in the probability-impact-matrix distinguishing between internal and external supply chain risks. Furthermore, instruments for dealing with supply chain risks are investigated. Therefore, the impact of supply chain risk management on performance is tested. In order to distinguish between companies with a high degree of supply chain risk management and those with no or only limited implementation the plants are grouped by means of a cluster analysis based on factors reflecting the instruments of supply chain risk management. In particular, groups are created representing two different approaches to deal with supply chain risks, i.e. reactive and preventive supply chain risk management. The clusters are investigated concerning differences in terms of performance criteria. The analyses reveal that companies with a high implementation degree show a better supply chain performance. Furthermore, the results show that the group using reactive supply chain risk management has higher average value in terms of disruptions resilience or the reduction of the bullwhip effect, whereas the group pursuing preventive supply chain risk management has better values concerning flexibility or safety stocks.

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## 1. Introduction

In a business environment characterized by high complexity and uncertainty, manufacturing companies are forced to manage their supply chains effectively in order to increase efficiency and reactivity. Catastrophes such as 9/11, hurricane Katrina, or the Tsunami in 2004 have raised the attention on this issue. But also everyday problems such as supplier losses or quality problems make supply chain risk management important. It aims at mitigating the negative impact of external disturbances and tries to manage certain risks within supply chains. Especially the automotive industry is well known for their efforts to improve its supply chains according to their demanding business environment.

Since the 1990s, a focus of managing supply chains lies in the improvement of cost-efficiency (Lee, 2004). Companies furthermore try to meet the requirements of competition through the intensive implementation of concepts streamlining supply chain processes (Childerhouse et al., 2003). This, for example, is incorporated in the automotive industry through widely used

concepts such as just-in-time and just-in-sequence in order to create lean supply chains (Svensson, 2004; Thun et al., 2007). The trend towards lean supply chains results in low inventories achieved by close collaboration with customers and suppliers on the one hand, but leads to high vulnerability on the other hand since turbulences in the supply chain can barely be compensated without safety stocks. Another reason for increasing supply chain risks is the trend towards outsourcing due to the fact that additional dependencies are created and the complexity in the network rises (Jüttner et al., 2003). The more complex a network is, the more interfaces do exist and the higher the vulnerability will be (Peck, 2005). In a similar way, globalization increases supply chain risks (Berry, 2004) because aspects such as transportation risks, cultural risks or exchange rate risks gain importance.

Numerous articles address the effects of external events on supply chains and the companies involved (e.g. Chopra and Sodhi, 2004). Especially, catastrophes and their consequences have augmented the attention to risk in supply chains within the last years. For example, after the terrorist attacks of September 11, 2001, Ford and Toyota had to stop their production in their manufacturing plants in the US due to significant delays in delivery of parts coming from foreign countries (Sheffi, 2001). Other examples are delayed deliveries due to quality

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problems or a complete loss of a supplier caused by its insolvency. In December 2001, Land Rover had to worry about the production of its key model Discovery since its only supplier for Chassis, UPF-Thompson, filed for bankruptcy (Sheffi and Rice, 2005). Only by a high expense of goodwill, Land Rover could avert a nine-month disruption of production as well as the loss of 1500 jobs. Another demonstrative example for damage amounting to millions of dollars is the case of the German components supplier Robert Bosch who delivered its customers with defective high-pressure pumps for diesel fuel injection systems in the beginning of 2005. However, a sub-supplier of Bosch was accountable for this mistake and, hence, the entire supply chain was affected.

These examples show that new risks emerge from the dependency and integration of companies in the supply chain. But not only such dramatic incidents disrupt supply chains, also more ordinary and workaday problems might affect supply chains. Often, comparable disruption is provoked by risks related to customers and suppliers as well as infrastructure and network. A well known network risk is a phenomenon commonly referred to as the Bullwhip-effect which describes the amplification of inventory when moving up the value chain (Lee et al., 1997).

Consequences of supply chain disruptions might be financial losses, a negative corporate image or a bad reputation eventually accompanied by a loss in demand as well as damages in security and health (Jüttner et al., 2003). In the light of these risks and their inherent consequences, it can be assumed that the performance of a supply chain will be affected negatively. Although, general statements regarding the financial losses of affected companies and industries involved in supply chain disruptions are neither possible nor reasonable, yet, some examples of companies exist that estimated their daily loss to \$50–\$100 million showing clearly the meaning of such negative incidents (Rice and Caniato, 2003). Altogether, the prevailing developments stress the need for the management of risks within a supply chain.

Although supply chain risk management has gained attention in the past years in academia (Jüttner, 2005), there is a lack of work on this subject matter. There is a need for empirical work in the field of supply chain risk management analyzing the main supply chain risks and investigating instruments for an effective supply chain risk management. The main objective of this paper is to analyze the status quo of supply chain risk management in Germany based on a study conducted in the automotive industry. In particular, the purpose is to investigate the relevance of different risks in terms of their probability of occurrence and their potential impact on the supply chain. Furthermore, several instruments of supply chain risk management are analyzed regarding their potential to cope with supply chain risks. Hence, the relationship between the implementation of these instruments and different performance criteria is analyzed.

## 2. Literature review

Risk management in general is described as the identification and analysis of risks as well as their control. A main particularity of Supply Chain Risk Management (SCRM) contrary to traditional risk management is that it is characterized by a cross-company orientation aiming at the identification and reduction of risks not only on the company level, but rather focusing on entire supply chains.

However, in many industries risk management is still understood primarily as a company-specific task as it is pointed out by Jüttner (2005, p. 131): “Companies implement organization-specific risk management, but there is little evidence of risk management at the supply chain level”. Other studies show that

only a minority of companies have implemented adequate methods for risk management although they are quite aware of the consequences of risks for their supply chain (Tang, 2006). Hence, companies seem to have a huge catch up to do in terms of implementing instruments for risk identification, analysis, and control in order to establish an effective supply chain risk management for creating secure and resilient supply chains.

The impact of an incident on a supply chain depends on the particularity of the incident on the one hand and on the design of the supply chain on the other hand. The latter refers to the aspect of vulnerability of a supply chain. Christopher and Peck (2004, p. 3) define vulnerability as “an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain”. The mitigation and control of vulnerability is the aim of supply chain risk management which 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, p. 201). A special challenge of supply chain risk management lies in the multitude of risks within a supply chain. A central aspect is the identification of the relevance of a particular risk for a supply chain.

In terms of survey research papers deal with supply chain risk. Atkinson (2006) deals with lean manufacturing and global sourcing in the context of supply chain risk management. A survey of purchasing executives shows that only half of all respondents reported monitor supply chain risks often. Furthermore, the study reveals that only the risk management department has a broad view to address risks from one end of the supply chain to the other. Blackhurst et al. (2005) conducted a study in several industries analyzing global sourcing and supply-chain disruptions empirically. They identified critical issues for disruption analysis and mitigation as well as resilient supply-chain design. Craighead et al. (2007) evaluate different kinds of supply chain disruptions based on an empirical study. Besides design characteristics they investigate two categories of supply chain risk management, i.e. the capabilities of recovery and warning.

Based on a sample of 827 disruption announcements, Hendricks and Singhal (2005) investigate the effects of supply chain disruptions on stock prices and equity risks. They conclude that firms do not recover quickly from the negative effects of disruptions. Based on the findings from an exploratory quantitative survey and qualitative group discussions with supply chain managers Jüttner (2005) shows that 44% of the responding companies expect the vulnerability of their supply chains to increase within the next five years. It is argued that the concept of supply chain risk management is still in its infancy although the data reveals a clear need for dealing with risk issues in supply chains.

Kleindorfer and Saad (2005) investigate a data set on accidents in the US Chemical Industry. Based on empirical results they derive implications for the design of supply chain risk management. Although this brief literature review contains a couple of articles dealing with supply chain risk management, it clearly shows that there is still a deficit of academic work in terms of survey based research (see for an exception Wagner and Bode, 2006). Even the link between instruments of supply chain risk management and performance should be investigated empirically in order to give evidence on the question of which instruments are regarded as being effective.

## 3. Hypotheses

### 3.1. Vulnerability of supply chains

Although many companies are aware of risks that might influence their supply chain negatively, managers fail to implement

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