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**SUPPLY CHAIN MANAGEMENT AND FINANCIAL CRISES:  
HOW TO HANDLE THE SUPPLY-SIDE RISK?**

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# Supply Chain Management and Financial Crises: How to Handle the Supply-side Risk?

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*To my lovely fiancée, for her unwavering confidence and support over the years*

*A.H.*



**T**he year when I wrote my master's thesis was challenging on more than one account. First of all, completing the Double-Degree programme, established between the Louvain School of Management (Belgium) and the Norwegian School of Economics (Norway) was not exactly the easiest way to complete my studies at university. Completing two degrees when writing the thesis was definitely well demanding, but it was also the opportunity to meet some wonderful people and to experience a truly different way of living and studying. Being abroad one year meant also leaving people behind me, people who missed me and people I missed (and more than likely those people were the same). It was a big decision in my life, and I will never be able to thank enough my fiancée, my family and my close circle of friends for their flawless support in this adventure. On the academic side, I would also like to express my gratitude to my two advisors, Per Joakim Agrell and Kurt Jørnsten, for their precious help. I am sure it was not always easy for them to supervise me, especially with the distance and the lack of face-to-face meetings. Thank you also to Isabella Fontana and Ole Johan Berge, the Double-Degree coordinators at the Louvain School of Management and Norwegian School of Economics, who helped me from the beginning to the end of this academic programme each time it was needed. Thank you finally to Stephanie and Martin Watts, my British host family, without who I would probably never have been in Norway.

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# Introduction

## 1.1 OVERVIEW

**T**he year 2008 saw the beginning of what finally became one of the biggest financial crises the world was facing in modern times. If the United States had a ringside at first, the rest of the world joined them without delay. The recession was under way. One can realise the magnitude of the phenomenon knowing that among the ten largest bankruptcies of all time identified by *Futures* magazine (McFarlin, 2011), seven are direct or indirect consequences of the so-called global financial crisis. Unfortunately they were not the only ones. In a more globalised world than ever, one side effect of this economic meltdown was the emergence of a new critical supply chain risk. As most companies around the world were not prepared to mitigate this new kind of risk, even healthy businesses were eventually forced to go bankrupt.

Take the example of a healthy international manufacturing company relying on two key suppliers to stock up the raw materials necessary for running its business. Imagine now that consequently from the global financial crisis those two suppliers unfortunately go bankrupt within the same month, forcing the manufacturing company to cease operations. Is it really a new kind of risk? Is it a predictable situation that could be quite easily analysed? Is there any available mitigation strategy to handle this risk? As many grey areas as there are questions.

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A lot of research has been performed in the last thirty years in the field of supply chain risk management and different strategies have been developed through the years to avoid supply chain breakdown. At the turn of the new century, as research progressed, managers seemed increasingly well equipped to avoid known and less known setbacks in their supply chains. And then the infamous financial crisis appeared. It was something that nearly nobody anticipated. It generated risks that almost no existing model included, and this proved to be fatal for many companies. So a question can undoubtedly be raised: *how to handle the risk coming from multiple supplier defaults in the case of financial crises such as the one of 2008?*

### 1.2 PURPOSE AND SIGNIFICANCE OF THE STUDY

Skimming the existing literature quickly reveals the lack of studies connecting financial crises with supply chain risk management. However, it is believed that global financial crises such as the one of 2008 represent quite a new risk for companies on the supply-side. In that regard, the usual strategies used for risk mitigation could maybe not perform as well as expected in that specific situation. The time to challenge the existing knowledge has come.

The purpose of this study is to provide a first insight on how to handle the supply-side risk in the case of a financial crisis. That means not only to develop a better understanding of the phenomenon through the prism of supply chain management, but also to thoroughly examine the relevance of some existing solutions in order to avoid future supply chain breakdowns in the particular case of a global financial crisis.

The significance of the study lies in the extent of the challenges companies need to take up in today's financial and economic turmoil. First, this study can probably be considered as the first one providing a quite complete overview of all the current knowledge regarding supply chain risk management in the context of financial crises. Second, it is also believed that the findings of this study could offer academics and researchers a basis for future quantitative modelling investigation to address financial crises' risk issues.



### 1.3 RESEARCH QUESTIONS

Some background research in the field of supply chain risk management allowed to break the previously mentioned problematic down into three research questions. They are as follows:

- (Q1) Do global financial crises affect supply chain risk management in a new way?
- (Q2) Is there a good technique available to enhance the quality of disruption risk modelling in the case of financial crises?
- (Q3) Which mitigation strategy could be used to avoid a supply chain breakdown in the case of financial crises?

### 1.4 OUTLINE

This master's thesis hinges on five different chapters, the first of them being the present introduction.

**Chapter two** provides the literature review serving as the main database for this study. An overview of the different categories of supply chain risks proposed by different authors is first given. The available literature linking financial crises and supply chain management is then presented, together with a recent case-study performed on the subject. The category of risk offering the greatest similarities with financial crises, namely the disruption risks, is later discussed by presenting concrete supportive examples. A quick overview on risk management modelling and its challenges is also given, together with some general comments on Monte Carlo simulations. Finally, different mitigation strategies that could be used to handle supply chain risks are presented, with a focus on the ones used for disruption risks.

**Chapter three** presents the methodology used to analyse the problematic previously raised in this chapter. First, the three research questions guiding this study are presented together with their respective hypotheses deriving from the literature review. Then, the methodological approach is detailed. The potential approaches available and the details of the *event study* analytical-deductive approach retained for this study.

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**Chapter four** combines the data provided by both the literature review and a recent multi-case analysis for answering the different research questions. Each question is successively examined under the analytical-deductive methodological approach to reveal the findings of this study.

**Chapter five** finally develops a synthesis of the research topic studied. First, the general conclusions giving meaning to the results obtained in this study are presented. Then, some suggestions for forthcoming research are provided based on the results obtained in this study.

# Review of the literature

## 2.1 INTRODUCTION

The purpose of this chapter is to give an overview of what has been already written in the field of supply chain risk management with a focus on its links with financial crises. As it can be guessed, summarising such a broad topic all in one block would be probably both chaotic and unhelpful to support the rest of this paper. As some choices were to be made, it was decided to mainly focus on the following five topics: (1) the different categories of supply chain risks, (2) the financial crises and their impact on supply chain management, (3) the disruption risks, (4) the problem of risk management modelling and (5) the different mitigation strategies to cope with supply chain risks.

Before examining each topic one by one, it could be useful to shortly explain the methods used for the review. The research on supply chain risk management has considerably expanded in recent years (Jüttner et al., 2003), and reviewing all the existing literature available in that field is therefore beyond the scope of this master's thesis. The preliminary investigation was done by using the five following search engines: ProQuest, Ebsco, Jstor, Google Scholar and Science Direct with combinations of the following key words or set of words: *supply chain management*, *risk management*, *coordination models* and *financial crisis*. As the topic studied is

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closely linked to the financial crisis of 2008, the years searched were primarily reduced to the period between 2008 and 2012. Special attention was also paid to the recent issues of the *European Journal of Operational Research* and of the *International Journal of Production Economics*. This first phase of the process led to select about fifteen scientific articles for further investigation. After this initial stage, a paper from Blome and Schoenherr (2011) and one from Christopher and Holweg (2011) stood out as the base of the further research. On the basis of the readings, the searching process was extended to the following key words or set of words: *turbulence*, *catastrophic events* and *Monte Carlo simulations*. This new investigation was performed with the same search engines mentioned above. The timeframe used was however extended backwards until 1980 to broaden the search area.

### 2.2 THE DIFFERENT CATEGORIES OF SUPPLY CHAIN RISKS

As one can easily guess, there is neither a solely kind of risk a supply chain can face nor one classification method for all those different kinds of risks. Chopra and Sodhi (2004) identify for example nine different kinds of supply chain risks: disruptions, delays, systems risks, forecast risks, intellectual property risks, procurement risks, receivables risks, inventory risks and capacity risks (see Figure 1 for an overview of their classification). Zeng et al. (2005) favour a classification that distinguishes capacity limitation, technology incompatibility, supply disruptions, currency fluctuations and disasters (see Figure 2 for an overview of their classification). Tang (2006(a)) proposes for its part to separate risks between operational risks and disruption risks. Trkman and McCormack (2009) divide supply chain risks according to the origin of the uncertainty source: there are risks coming from endogenous uncertainty and risks coming from exogenous uncertainty. The latter category is then divided between discrete events and continuous risks (Trkman and McCormack, 2009). In a recent book, Sodhi and Tang (2012) propose a supply chain risk categorisation made of four types of risk: supply risks, process risks, demand risks and corporate-level risks (see Figure 3 for an overview of their classification).

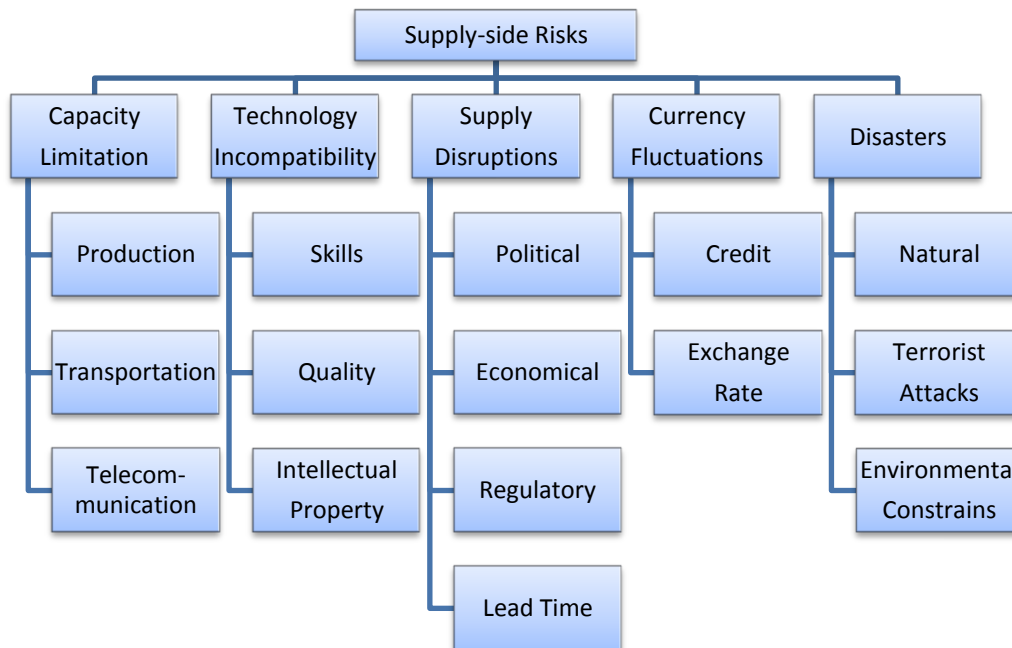
**Figure 1: Supply chain risks and their drivers**  
(Adapted from Chopra and Sodhi, 2004, p.54)

Category of Risk	Drivers of Risk
Disruptions	<ul style="list-style-type: none"> <li>▪ Natural disaster</li> <li>▪ Labour dispute</li> <li>▪ Supplier bankruptcy</li> <li>▪ War and terrorism</li> <li>▪ Dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers</li> </ul>
Delays	<ul style="list-style-type: none"> <li>▪ High capacity utilization at supply source</li> <li>▪ Inflexibility of supply source</li> <li>▪ Poor quality or yield at supply source</li> <li>▪ Excessive handling due to border crossings or to change in transportation modes</li> </ul>
Systems	<ul style="list-style-type: none"> <li>▪ Information infrastructure breakdown</li> <li>▪ System integration or extensive system networking</li> <li>▪ E-commerce</li> </ul>
Forecast	<ul style="list-style-type: none"> <li>▪ Inaccurate forecasts due to long lead times, seasonality, product variety, short life cycles, small customer base</li> <li>▪ “Bullwhip effect” or information distortion due to sales promotions, incentives, lack of supply-chain visibility and exaggeration of demand in times of product shortage</li> </ul>
Intellectual Property	<ul style="list-style-type: none"> <li>▪ Vertical integration of supply chain</li> <li>▪ Global outsourcing and markets</li> </ul>
Procurement	<ul style="list-style-type: none"> <li>▪ Exchange rate risk</li> <li>▪ Percentage of a key component or raw material produced from a single source</li> <li>▪ Industry wide capacity utilization</li> <li>▪ Long-term versus short-term contracts</li> </ul>
Receivables	<ul style="list-style-type: none"> <li>▪ Number of customers</li> <li>▪ Financial strength of customers</li> </ul>
Inventory	<ul style="list-style-type: none"> <li>▪ Rate of product obsolescence</li> <li>▪ Inventory holding cost</li> <li>▪ Product value</li> <li>▪ Demand and supply uncertainty</li> </ul>
Capacity	<ul style="list-style-type: none"> <li>▪ Cost of capacity</li> <li>▪ Capacity flexibility</li> </ul>

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**Figure 2: Supply-side risks**

(Adapted from Zeng et al., 2005, p.144)



**Figure 3: Supply chain risk categorization**

(Adapted from Sodhi and Tang, 2012, p.22)

Supply risks	Process risks	Demand risks	Corporate-level risks
<ul style="list-style-type: none"> <li>▪ Supplier failure</li> <li>▪ Supply commitment</li> <li>▪ Supply cost</li> </ul>	<ul style="list-style-type: none"> <li>▪ Design</li> <li>▪ Yield</li> <li>▪ Inventory</li> <li>▪ Capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Forecasting</li> <li>▪ Change in technology or in consumer preference</li> <li>▪ Receivable</li> </ul>	<ul style="list-style-type: none"> <li>▪ Financial</li> <li>▪ Supply chain visibility</li> <li>▪ Political/Social</li> <li>▪ IT systems</li> <li>▪ Intellectual property</li> <li>▪ Exchange rate</li> </ul>

The five classifications mentioned above represent only the results of some of the most recent papers. Michalski (2000), Zsidisin et al. (2000), Hallikas et al. (2004) and Hunter et al. (2004) among others also present slightly different supply chain risk classification methods. Unanimity seems therefore to be far from the norm in the supply chain risk management literature dedicated to risk classification.

## 2.3 SUPPLY CHAIN MANAGEMENT AND FINANCIAL CRISES

### 2.3.1 General thoughts

As financial crises such as the one of 2008 are complex phenomena both to analyse and to understand, describing all their outcomes would be beyond the scope of this study. What made the global financial crisis of 2008 standing apart from previous ones was mainly its huge immediate international impact. No major region in the world was spared and the crisis effects propagated worldwide in a record time, hitting more or less everyone at the same time (Acharya et al., 2009 and Goodhart, 2008 among others). The interested reader could develop a better understanding of the global financial crisis' causes in Acharya et al. (2009) or Goodhart (2008). For the sake of clarity, it could be however useful to mention here the general definition of a financial crisis proposed by Mishkin (1992, pp.117-118), who associates this incident to *“a disruption to financial markets in which adverse selection and moral hazard problems become much worse, so that financial markets are unable to efficiently channel funds to those who have the most productive investment opportunities”*.

In a supply chain management perspective, the most important consequence of the recent financial crisis is probably the record number of businesses that ultimately went bankrupt. The question is to know why. Murray (2008) explains that more than likely businesses go bankrupt, financial crises or not, because *“they forget or neglect the basic business principles of liquidity, solvency, and viability”*. Liquidity can be defined as *“the degree to which an asset or security can be bought or sold in the market without affecting the asset's price”* (Investopedia, n.a.(a)). Solvency is for its part *“the ability of a corporation to meet its long-term fixed expenses and to accomplish long-term expansion and growth”* (Investopedia, n.a.(b)). Finally, the concept of economic viability could be understood as the ability of a business to generate profits over the long term, even if the business is not profitable every quarter (Murray, 2008). Murray (2008) conclude that there are three basic rules to

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keep in mind for avoiding bankruptcy: (1) “*the business must have enough cash to cover emergencies (liquidity)*”, (2) “*the business must have enough assets so that if loans must be paid off, or taxes must be paid, the business can cover these "calls" on its assets (solvency)*” and (3) “*the business must continue to be profitable, which means that it continues to bring in more income than revenue, thus building up cash and other assets (viability)*”. As it appears that financial crises such as the one of 2008 are clearly more liquidity crises than solvency crises, the liquidity issue should particularly draw the attention here (Acharya et al., 2009 ; Campello et al., 2010 ; Cornett et al., 2011 or Goodhart, 2008 among others). What caused so many trouble for businesses during the crisis was not “*a lack of liquidity but an unwillingness [from the banks] to lend*” (Masnick, 2008). Without an easy access to cash even solvable and viable businesses can face liquidity issues. This can lead in the worst cases to bankruptcy as a failure to fulfil one of the three basic principles stated above.

### 2.3.2 The global financial crisis in the supply chain management literature

If Chopra and Sodhi (2004) take some time to describe each category of risk as mentioned above, they do not mention the case of financial crises in their paper. In its definition of disruption risk, Tang (2006(a), p.453) mentioned “*economic crises such as currency evaluation or strikes*”, but the rest of the paper do not deal with anything related or similar to financial crises. It is the same story for almost every paper in supply chain risk management read to prepare this literature review.

Blome and Schonherr (2011) shake things up a bit by focusing explicitly on supply chain management in financial crises. In their multiple case-study approach, they highlight that “*despite [the] true significance of [supply chain risk management] in economic crises, research in this area has been scarce*” (Blome and Schonherr, 2011, p.46). In their literature review they mention that out of the twenty-three recent studies in the field of supply chain risk management (SCRM) “*only one [deal] specifically with the issue of SCRM within the context of economic crisis*”



(Blome and Schoenherr, 2011, p.46). Even in the article they mention, the focus on financial crisis is limited to just a few lines. Christopher and Holweg (2011) are some of the first to clearly mention the case of the financial crisis of 2008. They state that this event *“saw demand for many goods and services slashed, requiring considerable flexibility to downscale capacity in many sectors”* (Christopher and Holweg, 2011, pp.65-65). They do not only see the financial crisis as a threat, writing that *“as paradoxical as it might sound, [it] is also an opportunity: as we have witnessed at many firms, the crisis aftermath is now permitting managers to question the most fundamental supply chain decisions in the firm”* (Christopher and Holweg, 2011, p.80).

Boute et al. (2011) highlight in their paper the relation existing between the global financial crisis of 2008 and the bullwhip effect. The bullwhip effect is the phenomenon whereby *“while customer demand for specific products does not vary much, inventory and back-order levels fluctuate considerably across their supply chain”* (Simchi-Levi et al., 2009, p.152). Boute et al. (2011, p.1) argue that *“the shockwave throughout the industrial world was caused by the inventory policy adopted by manufacturing companies: due to the de-stocking and re-stocking practices, real demand was distorted along the value chain”*. First, Boute et al. (2011) observe that as a consequence of the financial crisis companies needed to primarily focus on their cash reserves. To meet their need of cash, many of them decided by 2009 to reduce as well investments as capital expenditures or working capital; and one of the easiest ways to achieve this rapidly was to reduce inventories, even if the demand did not shrank (Boute et al., 2011). Second, when the production rose again in the second half of 2010, the bullwhip effect appeared in the exact opposite way (Boute et al., 2011). Even if the demand did not raise a lot, the firms that stopped producing to cut in their stocks then needed to produce more than what they sold to satisfy the demand and offer again an adequate level of responsiveness (Boute et al., 2011).

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The recent book published by Sodhi and Tang (2012) also mentions economic crises, but only to associate them as a kind of supply risk. In conclusion, it can be said that the literature relating supply chain risk management and financial crises is quite scarce at the time this thesis is written.

### Hypothesis

Financial crises affect supply chain management in a new way because, unlike single suppliers defaulting, the whole supply chain could be in trouble simultaneously.

#### 2.3.3 A multiple case-study approach

Even if no proper case-study was especially designed for the purpose of this master's thesis, it does not necessarily mean that there is no field data available that we can rely on for supporting our analysis. Blome and Schoenherr (2011) provide a multi-case study approach to study supply chain management in financial crises. *“Using in-depth case studies conducted among eight European enterprises, [they] develop a set of propositions about how companies manage supply risks in financial crises, highlight how their risk management approaches have shifted, and illustrate how they are related to enterprise risk management”* (Blome and Schoenherr, 2011, p.43). All their findings are not directly applicable to the research questions raised, but some of them deserve to be mentioned here.

First, Blome and Schoenherr (2011) provide information on how the global financial crisis of 2008 impacts the different industries studied. Based on their findings, insolvency risk stands out at the highest priority in risk detection. They mention for example that *“all of [their] sample firms stated that the awareness of supply chain risks has increased especially due to supplier insolvencies”* (Blome and Schoenherr, 2011, p.49). In the same way, they also explain that they *“observed that in the current constrained environment the focus of the supply risk identification phase is changing, which seems to be due to the shifting risk awareness based on the growing number of insolvencies”* (Blome and Schoenherr, 2011, p.49). They confirm

again this fact when they detail that half of the firms analysed “*reported supplier insolvencies in the financial crisis as one of the major or the most important corporate risks*” (Blome and Schoenherr, 2011, p.49). Unlike seeing a supplier failure as a single potential hazard as before the crisis of 2008, firms now really fear the failure of many of their suppliers at the same time. They conclude this part of the study in the following way: “*The current financial crisis increases the comprehensiveness of SCRM in each step of the SCRM process: (a) risk identification, (b) risk analysis, (c) risk mitigation, and (d) risk monitoring*” (Blome and Schoenherr, 2011, p.50).

Second, Blome and Schoenherr (2011) also study how firms decide to protect themselves against the consequences of supplier insolvencies. When firms identify supplier failure as a risk, they have basically the choice between accepting this risk with its consequences or avoiding supply chain disruptions in a proactive manner. The results of the survey performed by Blome and Schoenherr (2011) are in that regard as following: “*The current financial crisis fosters especially a risk acceptance (as opposed to mitigation) approach in direct spend firms. Indirect spend firms are already more focused on risk acceptance approaches and have not changed their behavior*” (Blome and Schoenherr, 2011, p.50).

## 2.4 DISRUPTION RISKS

As it has been seen previously, there is still not a unified risks classification in the supply chain risk management literature. Hopefully, some authors converge on certain points. The category that draws attention here is the one mentioned as ‘disruption risk’ by Chopra and Sodhi (2004) or Tang (2006(a)) and which is also include under ‘disasters’ in Zeng et al. (2005), under the ‘discrete events’ category in Trkman and McCormack (2009) or under the ‘supply risks’ category in Sodhi and Tang (2012). Chopra and Sodhi (2004, p.54) cite “*natural disasters, labour dispute, supplier bankruptcy, war and terrorism, and dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers*” as drivers

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of disruptions. Tang (2006(a), p.453) on the other hand defines supply chain disruptions risks as *“major disruptions caused by natural and man-made disasters such as earthquakes, floods, hurricanes, terrorist attacks, etc., or economic crises such as currency evaluation or strikes”*. Both seem thus to agree on what are disruption risks. The impacts of disruption risks on supply chain management are generally important as they usually lead to supply interruptions, which could be critical (Chopra et al., 2007). Tang (2006(a), p.453) explains also that *“in most cases, the business impact associated [with] disruption risks is much greater than that of operational risks”*. Chopra and Sodhi (2004, p.55) go in the same direction by writing that *“disruptions [...] in the supply chain are unpredictable and rare but often quite damaging”*. Wilson (2007) brings also another precision by explaining that a differentiation should be made between transportation disruptions and other kinds of disruptions because if the former only interrupt the material flow, the latter interrupt also the productions of goods. To better understand how global disruption risks could impact supply chains, the examples of natural disasters and wars and terrorism are examined hereunder together with some others critical disruption risks.

### 2.4.1 Huge natural disasters

Natural disasters are events such as earthquakes, hurricanes, tornados, floods, landslides, volcanic eruptions or other natural hazards. They can lead to disruptions in supply chains because they can force businesses to temporarily stop their production, or even totally destroy some firms' strategic assets. Infamous recent examples of natural disasters hugely impacting supply chains are the 2005 Hurricane Katrina, the 2010 eruption of Eyjafjallajökull or the 2011 Great East Japan earthquake and tsunami that led to the Fukushima disaster. If the consequences of natural disasters often only conduct to local disruptions, it is easily understandable that the extreme events such as the ones previously mentioned could have a global impact by their magnitude. The 2010 eruption of Eyjafjallajökull paralysed for example the whole European air freight during many days.

### 2.4.2 Wars and terrorism

Wars and terrorism can lead to supply chain disruptions for at least two reasons: (1) they can delay or even block transportation and (2) they can cause disruptions in the global outsourcing strategy massively used in the present era (Chopra and Sodhi, 2004 ; Jin et al., 2010 ; Kleindorfer and Saad, 2005 ; Sodhi and Tang, 2012). The most infamous examples of such disruptions are probably the terrorist attacks of 11<sup>th</sup> September 2001 when thousands of merchandises were temporarily blocked at all United States borders, leading to a full stop of several assembly lines in the country (Chopra and Sodhi, 2004 ; Jin et al., 2010 ; Sodhi and Tang, 2012). Others more recent events such as the 2003-2011 war in Iraq or the 2011 Libya civil war heavily disturbed local oil supply chains for example, finally impacting the world oil price. It is for example one of the main reasons why United States of America keep high petroleum reserve within their borders (Chopra and Sodhi, 2004).

### 2.4.3 Other critical disruption risks

If natural disasters or wars and terrorism are probably the most visible disruption risks for regular people, many others examples can harshly affect supply chains. In that regard it is worthwhile to mention the case of a single-supplier default or the case of strikes and other labour disputes. Two of the most commonly used examples regarding the consequences of a single-supplier default are the case of Ericsson in 2000 and the case of Land Rover in 2001. Facing the shutdown of its sole microchips supplier's plant due to a fire, Ericsson suffered months of production disruption and lost sales worth \$400 million (Chopra and Sodhi, 2004 ; Lee, 2004 and Tang, 2006(b)). On the other hand, Land Rover saw the sole chassis supplier of one of its models becoming insolvent and was ultimately forced to lay off 1400 workers as a consequence (Chopra and Sodhi, 2004 ; Christopher and Peck, 2004 and Tang and Tomlin, 2008). The 2002 dockworker's strike in California is another example of a disruption risk that could impact the supply chains of a lot of businesses at the same time. If this strike was anticipated by many firms that build up more stocks than

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usually needed, the closure of 29 ports along the United States West Coast forced ultimately some firms to shut down their factories in the absence of necessary raw materials (Chopra and Sodhi, 2004 ; Christopher and Lee, 2004 ; Lee, 2004 and Wilson, 2007).

### 2.5 RISK MANAGEMENT MODELLING

#### 2.5.1 An overview of the problem

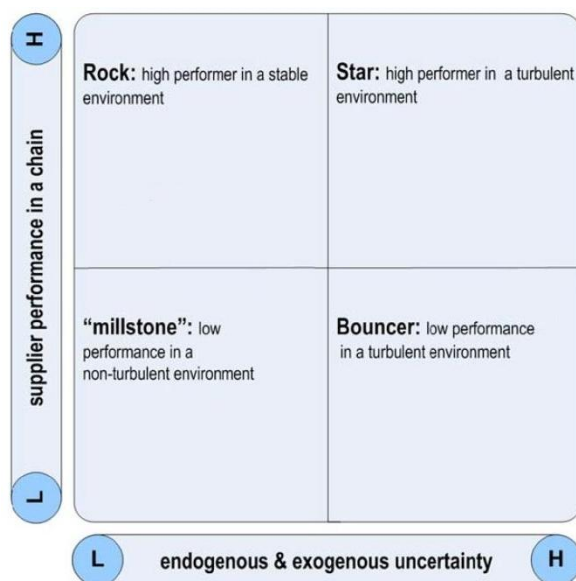
Christopher and Holweg (2011) argue that a change is needed in the way supply chain management should be perceived. *“[The] current [supply chain management] models were all invented during a long period of relative stability, and [...] this assumption of stability no longer hold”* (Christopher and Holweg, 2011, p.64). Some decades ago, the consequences of phenomena such as terrorist attacks, wars, natural hazards, uncertain political climates or even financial crises were indeed virtually not taken into account when designing supply chain. The reason of this was twofold: (1) the probability that such an event causes a major disruption in a local company’s supply chain was too low and (2) as supply chain did not massively use outsourcing as today, the likelihood that such event can affect the supply chain as a whole was rather low. Moreover the models mainly used until today have something interesting in common: they are almost all deterministic models (You et al., 2008). The problem with deterministic supply chain models is that they *“do not take into account the uncertainties or risks in the supply chain planning process”* (You et al., 2008, p.4).

However, risks such as disruptions represent real threats for numerous companies, and their consequences could be hard to predict. Sodhi et Tang (2012, p.7) identify three principal causes for this change: *“(1) [today’s] supply chains have more points of possible disruption than they did in the past; (2) being longer, these supply chains have less visibility, which causes slow decision-making and response in case of a disruption; and (3) local “fixes” create problems in other parts of the supply chain”*.

### 2.5.2 Identifying and quantifying the risk

Araz and Ozkarahan (2007) insist on the critical importance of suppliers' choice and their evaluation to mitigate supplier default risk. They also develop a methodology that *"considers the strategic partnership and concurrent product development concepts to identify the supplier selection criteria rather than the traditional selection criteria"* (Araz and Ozkarahan, 2007, p.603). Trkman and McCormack (2009) confirm that identifying the suppliers that present a disruption risk is becoming a strategic issue due to the uncertainty surrounding today's supply chains. Trkman and McCormack (2009) also develop a framework to both choose and manage the firm's suppliers (see Figure 4). They argue that *"the basic idea of SCRM should [...] be to have in place a proper combination of rocks (that add stability to the chain) and stars (that add a bit of creativity and the possibility to improve)"* (Trkman and McCormack, 2009, p.254). One major problem appears however when firms try to assess their suppliers' resistance to disruption risks: the usual uncertainty surrounding that kind of risk. A track that gained recent interest among authors to tackle this issue is the use of Monte Carlo techniques. This particular approach is discussed in the following point.

**Figure 4: Supplier performance and uncertainty matrix**  
(Adapted from Trkman and McCormack, 2009, p.254)



### 2.5.3 The Monte Carlo Simulations

In general terms, Monte Carlo simulations can be simply defined as “*methods for mathematical experiments using random numbers*” (Dinther, 2008, p.428). Monte Carlo simulations are named after the random results coming from poker and roulette games, as a reference to the Principality of Monaco’s area famous worldwide for its casino (Dinther, 2008 ; Elishakoff, 2003 ; Schneider and Kirkpatrick, 2006). As mentioned by Dinther (2008, p.429), the “*problems studied by Monte Carlo methods can be distinguished in probabilistic and deterministic problems*”. The probabilistic problems could be relevant in supply chain management when “*random variables are used to model real stochastic processes*” (Dinther, 2008, p.429). Monte Carlo simulations can then be used to develop random probability distributions used in modelling. As explained earlier, the main problem with disruption risks is that their likelihood, scope or duration are very hard or even impossible to predict. In such cases, the Monte Carlo simulations and their ability to generate thousands of random scenarios provide an interesting option to deal with all those areas of uncertainty (Christopher and Holweg, 2011 ; Schmitt and Sigh, 2009 ; You et al., 2008).

Among the factors determining a useful and correct Monte Carlo simulation mentioned by Sawilowsky (2003), the five following ones can be highlighted (1) “*the pseudo-random number generator produces values that pass tests for randomness*”, (2) “*the number of repetitions of the experiment is sufficiently large to ensure accuracy of results*”, (3) “*the proper sampling technique is used*”, (4) “*the algorithm used is valid for what is being modelled*” and finally (5) “*the study simulates the phenomenon in question*” (Sawilowsky, 2003, pp.220-221).

If Monte Carlo simulations had been used for a long time in the fields of mathematics or economics, their use in supply chain management is relatively new (Dinther, 2008 and Reiter, 2008 among others). You et al. (2008, p.5) mention that “*a recent popular method to address the uncertainty is to use Monte Carlo sampling in the scenario planning framework*”. As it is attested by the following examples, it seems to be indeed the case. Deleris and Erhun (2005) present a tool that relies on



Monte Carlo simulations to measure the uncertainty in the supply chain. In their paper, they “*focus on a method to estimate the losses in a supply network. [They] do not [however] address the critical issues of risk identification or risk mitigation*” (Deleris and Erhun, 2005, p.1648). You et al. (2008) also use Monte Carlo methods for global supply chain planning under uncertainty. They “*incorporate Monte Carlo sampling in a stochastic programming framework to reduce the number of scenarios for a real world application*” (You et al., 2008, p.3). Schmitt and Sigh (2009) use Monte Carlo simulations to quantify the supply chain disruption risk, together with a discrete-event simulation. Jin et al. (2010) apply the Monte Carlo simulations to build pre-disruptions strategies in war zones. “*Considering the uncertainties (e.g., the outage length of a disruption and the level of resources available to the terrorist), [they] conduct Monte Carlo simulation experiments to numerically investigate the benefits [of] using [their] disruption preparation strategies compared with other strategies*” (Jin et al., 2010, p.2682). Christopher and Holweg (2011) suggest for their part the use of Monte Carlo methods for supply chain modelling because “*these models are easy to build and use, and the ability to run many thousands of simulation runs provides the perfect opportunity to understand the impact of variability on the system*” (Christopher and Holweg, 2011, p.77). Because of their ability to efficiently cope with uncertainty, Monte Carlo simulation methods seem therefore to be a promising tool for disruption risk mitigation strategies modelling.

### Hypothesis

Monte Carlo simulation methods are a good choice for risk modelling in the case of financial crises because of the uncertainties surrounding their specifications (the length of the crisis, the magnitude of the crisis, the recovery time...).

## 2.6 RISK MITIGATION STRATEGIES

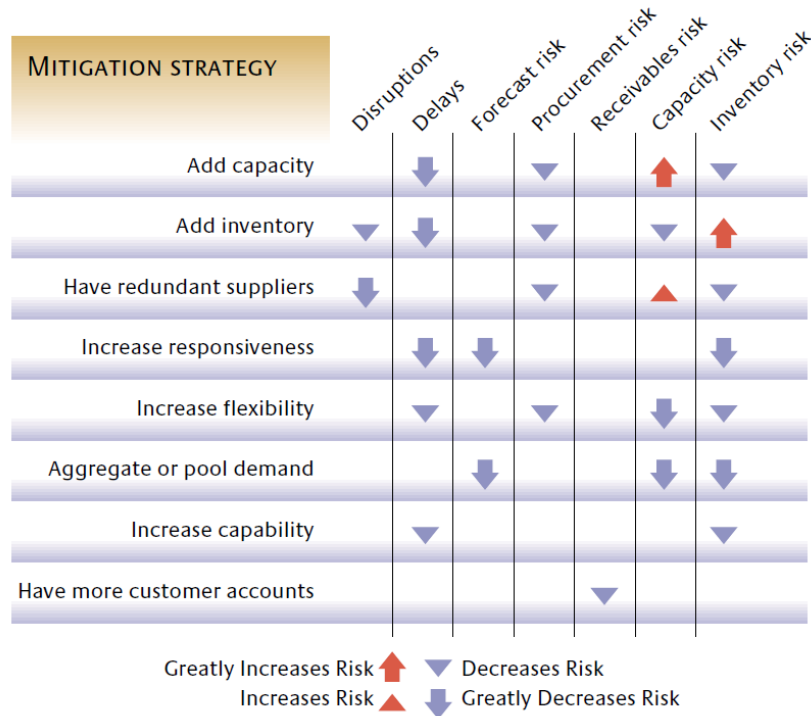
Sodhi and Tang (2012) state that three main approaches exist when facing supply risks: *accept*, *avoid* and *mitigate*. Accepting the risk means that firms do not do anything except supporting the consequences of the risk if it should happen.

Avoiding the risk means that firms implement as many protections as possible to ensure that the potential risk does not occur. Finally, mitigating the risk means that firms try to reduce as much as possible the negative impact of the potential risk (Sodhi and Tang, 2012). It is the latter view that is at the centre of this section.

### 2.6.1 Overview of mitigation strategies

Chopra and Sodhi (2004) do not only provide a classification of the different categories of risks but also give eight common strategies used to protect organisational supply chains: add capacity, add inventory, have redundant suppliers, increase responsiveness, increase flexibility, aggregate or pool demand, increase capability and have more customer accounts (see Figure 5 for a graphic representation). Zeng et al. (2005) mention seven main strategies that could be used for risk management: supplier choice, diversification, stockpiling, pooling resources, legal action, maintenance agreements and residual risks (see Figure 6). Tang (2006(b)) proposes for its part nine different robust supply chain strategies: postponement, strategic stock, flexible supply base, make-and-buy, economic supply incentives, flexible transportation, revenue management, dynamic assortment planning and silent product rollover. Tang extends then his list with two new strategies, namely flexible contracts and flexible manufacturing process (Sodhi and Tang, 2012) (see Figure 7). Simchi-Levi et al. (2009, p.317) mention three tracks that could be followed to manage supply chain risks: *“invest in redundancy”*, *“increase velocity in sensing and responding”* and finally *“create an adaptive supply chain community”*. Sodhi and Tang (2012) also propose three main global categories of strategies to mitigate risk: *“(1) alignment of supply chain partners’ incentives to reduce the behavioural risks within the supply chain, (2) flexibility to reduce not only demand risks but also supply and process risks, and (3) building “buffers” or redundancies”* (Sodhi and Tang, 2012, p.53). If the above examples give a good overview of the different mitigation strategies available to cope with supply chain risks, only some of them could be applied for supply-side disruption risks.

**Figure 5: The impact of mitigation strategies**  
(Chopra and Sodhi, 2004, p.55)



**Figure 6: Risk management strategies**  
(Adapted from Zeng et al., 2005, p.146)

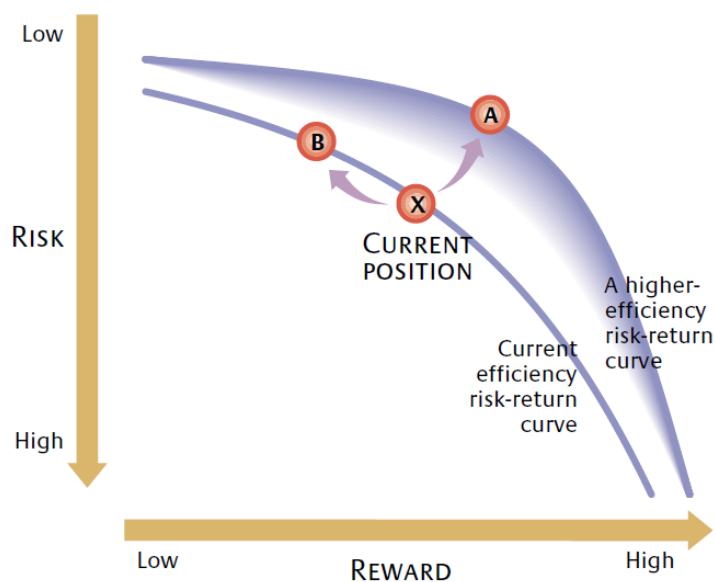
<b>Risk Management</b>	(1) Supplier Choice	Consider suppliers' business continuity planning and financial condition, executive health and vulnerability, management stability, and infrastructure integrity.
	(2) Diversification	Avoid dependence on a single supplier and arrange for backup suppliers of key products and services. Select suppliers from different geographical areas.
	(3) Stockpiling	Keep an inventory of parts and equipment.
	(4) Pooling Resources	Pool resources with competitors so that if disaster strikes one, others will lead a hand. The network helps companies get equipment at a moment's notice from a supplier, minimising the effect of any break in the supply chain.
	(5) Legal Action	An agreement established between suppliers and buyers to address continuity issues, which allows the buyers to switch to other supplier and the supplier to forewarn the buyer of any anticipated disruptions.
	(6) Maintenance Agreements	Agreements help ensure that critical equipment is kept in good working order during normal course of operations.
	(7) Residual Risks	Address and assess the risk that results from the contingency plan itself.

**Figure 7: Robust supply chain strategies**  
(Adapted from Sodhi and Tang, 2012, p.98)

	<b>Robust Supply Chain Strategy</b>	<b>Main Objective</b>	<b>Benefit(s) under normal risk: Improves the company's capability to manage...</b>	<b>Benefit(s) under abnormal risk, i.e., after a major disruption: Enables the company to...</b>
1	Postponement	Increases product flexibility	Supply	Change the configurations of different products quickly
2	Strategic stock	Increases product availability	Supply	Respond to market demand quickly during a major disruption
3	Flexible supply base	Increases supply flexibility	Supply	Shift production among suppliers promptly
4	Make-and-buy	Increases supply flexibility	Supply	Shift production between in-house production facility and suppliers rapidly
5	Economic supply incentives	Increases product availability	Supply	Adjust order quantities quickly
6	Flexible transportation	Increases flexibility in transportation	Supply	Change the mode of transportation rapidly
7	Revenue management	Increases control of product demand	Demand	Influence the customer product selection dynamically
8	Dynamic assortment planning	Increases control of product demand	Demand	Influence the demands of different products quickly
9	Silent product rollover	Increases control of product exposure to customers	Supply and demand	Manage the demands of different products quickly
10	Flexible supply contracts	Increase replenishment flexibility	Supply	Shift order quantities across time
11	Flexible manufacturing process	Increase flexibility in producing different products	Demand	Shift production quantities across internal resources (plants or machines)

To conclude this overview of the different mitigation strategies, it is also worth noting that whatever their names all those mitigations strategies come at a certain cost for firms. As Chopra and Sodhi (2004, p.56) mention, *“perhaps the biggest challenge companies face is mitigating supply-chain risks without eroding profits”* (see Figure 8).

**Figure 8: Chosing supply chain risk/reward trade-offs**  
(Chopra and Sodhi, 2004, p.56)



### 2.6.2 Relevant mitigation strategies for disruption risks

Chopra and Sodhi (2004) point out two different mitigation strategies to protect companies against disruption risks: building inventory and having redundant suppliers, with a preference for the latter (see Figure 5). Sodhi and Tang (2012) also follow the track of the inventory building approach with their strategic stocks. The recommendation of Kleindorfer and Saad (2005) tends for its part to mainly favour the use of multiple suppliers against disruption risks. Zeng et al. (2005, p.147) emphasise two main strategies to answer disruption risks, namely “*using several suppliers (diversification) and pooling resources (establishment of a supply network)*”. Tang (2006(a), p.480) states that “*it appears the multi-supplier strategy is the most common approach for reducing supply chain risks*”. He also recommends that these different suppliers are located in different countries to “*make a supply chain more resilient during a major disruption*” (Tang, 2006(a), p.480). Flexibility is another track that gains popularity those recent years as a mitigation strategy for disruption risks. In that regard, flexibility strategies to deal with disruption risks are recommended by Braunsheidel and Suresh (2009), Simchi-Levi et al. (2009) and

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Tang and Tomlin (2008) among others. Sodhi and Tang (2012) argue that all the eleven mitigation strategies they propose are relevant in the case of disruption risks and give numerous examples to support their statements.

Even if they do not always share the same name among authors, the three most often cited strategies to cope with disruption risks are the following: (1) the 'Inventory Building Strategy', (2) the 'Redundant Suppliers Strategy' and (3) the 'Flexibility Strategy'.

### **The 'Inventory Building Strategy'**

Nowadays, reducing the level of safety stocks by focusing on a 'just in time' delivery strategy is often recommended to improve the quality of supply chain (Simchi-Levi et al., 2009). As its name suggests it, the 'Inventory Building Strategy' consists however of increasing the amount of back-up production to face potential disruptions or even unexpected delays within the supply chain. By doing this, firms hope that their safety stocks will be sufficient to meet demand during the time they work on solving the causes of the disruption issue. The main problem is that it is very hard to assess the amount of safety stock needed because of the uncertainty surrounding disruption risks. Another problem with such a strategy is the cost of handling the stocked goods. On top of the cost of the goods themselves, other potential high costs could be involved. Indeed, building occupation costs or insurance costs are added if the stocked goods are bulky ones, slow-moving ones or very expensive ones (Simchi-Levi et al., 2009). Furthermore, if the unanticipated disruption events have low chance to occur, the extra costs involved in that strategy could overcome its benefits (Sheffi, 2005 ; Sodhi and Tang (2012). The 'Inventory Building Strategy', despite its real effectiveness to mitigate disruptions in some cases, can therefore be used wittingly.

#### Hypothesis

An 'Inventory Building Strategy' could be a good solution to avoid a supply chain breakdown in the case of a financial crisis.

### **The ‘Redundant Suppliers Strategy’**

The ‘Redundant Suppliers Strategy’ is often considered as a good strategy to hedge a business against a supply disruption because *“it is unlikely that all suppliers would be disrupted simultaneously”* (Chopra and Sodhi, 2004, p.55). Zeng et al. (2005, p.147) also mentioned that relying on more than a unique supplier for key processes *“helps not only prevent emergencies, but promotes competitive bidding”*. Zeng et al. (2005) also provide in their paper a method to decide how many suppliers are best for a given supply chain. Chopra et al. (2007) discuss the problem of building a supply chain strategy around an absolutely reliable supplier and another one prone to disruption. If implemented on global scale, with suppliers involved at the same supply chain level spread in different continents, a ‘Redundant Suppliers Strategy’ could help firms to face disruption events hardly affecting only one part of the world at the time such as natural disasters or wars and terrorism.

#### Hypothesis

A ‘Redundant Suppliers Strategy’ could be a good solution to avoid a supply chain breakdown in the case of a financial crisis.

### **The ‘Flexibility Strategy’**

As already mentioned, the ‘Flexible Strategy’ is a track that becomes more and more popular among authors to cope with disruption risks. Braunsheidel and Suresh (2009, p.124) explain that *“manufacturers adopt flexible practices in response to the uncertainty and turbulence in the marketplace and to meet customer expectations without excessive cost, time or disruption”*. However, Sodhi and Tang (2012, p.53) mention that there is not only one flexibility strategy, but *“at least five different types of flexibility strategies corresponding to multiple suppliers, flexible supply contracts, flexible manufacturing process, postponement and responsive pricing”*. They are not the only ones to support this assertion of multiple kinds of flexibility strategies. Tang and Tomlin (2008) mention two kinds of flexible strategies to handle what they call supply risks: flexible supply via multiple suppliers and flexible supply via flexible

supply contracts. Simchi-Levi et al. (2009, p.321) describe a flexible strategy as a combination of “*multiple suppliers and excess manufacturing capacity*”.

The ‘Flexibility Strategy’ – or maybe better named the ‘flexibility strategies’ – could therefore be understood as a combination of multiple other strategies, including the ones explained above. The definition of Simchi-Levi et al. (2009) could be simply understood as a combination of the ‘Redundant Suppliers Strategy’ with excess manufacturing capacity. Notwithstanding the definition provided by Braunsheidel and Suresh (2009), Tang and Tomlin (2008) and Sodhi and Tang (2012) combine also strategies that were not described above. Flexible supply contracts could be defined as the situation when “*the manufacturer is allowed to adjust the order quantity within a pre-specified range, say, a few percent of the order quantity. This helps to mitigate the impact associated with demand risks*” (Sodhi and Tang, 2012, p.53). The manufacturing process is for its part considered as flexible “*if different types of products can be manufactured in the same plant, enabling the manufacturer to reduce supply, process, or demand risks*” (Sodhi and Tang, 2012, p.53). With postponement, “*the firm designs the product and the manufacturing process so that decisions about which specific product is being manufactured can be delayed as long as possible. The manufacturing process starts by producing a generic or family product, which is differentiated to a specific end-product when demand is revealed*” (Simchi-Levi et al., 2009, pp.190-191). Responsive pricing is finally “*an effective tool to mitigate supply or demand risks by manipulating demand when the supply is inflexible*” (Sodhi and Tang, 2012, p.53). The ‘Flexibility Strategy’ seems therefore to be as well a mean of handling the supply risk and a mean of managing the demand risk in the case of disruptions, depending of what is including in it. For that reason, the ‘Flexibility Strategy’ is probably a better choice to mitigate both supply and demand risk at the same time than to only focus on the supply-side risk as it is the case in this study.



## SUMMARY

The supply chain risk management literature relevant to the writing of this thesis is rather scarce and scattered at the same time. To provide the basis of the forthcoming analysis in a clear way, it was decided to organise the available literature in five main categories. First, an overview of the different supply chain risks categories was presented. Some explanations about financial crises and their potential links with supply chain risk management were then provided together with a case-study approach previously performed by other authors. A focus on a specific kind of supply risks, namely the disruption risk, was also given with some supportive examples. Afterwards, explanations on risk management modelling in the case of disruption risks were provided. Finally, some strategies commonly used to mitigate the disruption risks discussed above were also presented to the reader.



# Methodology

## 3.1 INTRODUCTION

**T**he quality of a master's thesis is not only measured by the amount of outcome obtained, but more importantly by the quality of the process leading to the results obtained. Finding the right methodology to achieve the objective pursued is not always obvious. The main aim of this chapter is to give the reader an insight of the procedures used to raise the different research questions and the methodology applied to answer them.

To achieve this goal, the different elements building the foundations of the analysis performed in chapter four are successively presented. At first, the different research questions guiding the inquiry are outlined, together with their adjoining hypotheses. The methodological approach is then explained as comprehensively as possible, detailing which data were needed to answer each research question and how those data were gathered.

### 3.2 RESEARCH QUESTIONS

Since the initial research process, the writing of this master's thesis is guided by a question relative to the field of supply chain risk management: *how to handle the risk coming from multiple supplier defaults in the case of financial crises such as the one of 2008?*

The literature review from the previous chapter allowed the emergence of different hypotheses which were associated to three research questions in order to better handle the main question addressed above. Those three research questions are listed below together with their respective hypotheses.

(Q1) Do financial crises affect supply chain risk management in a new way?

(H1) *Financial crises affect supply chain management in a new way because, unlike single supplier defaulting, the whole supply chain could be in trouble simultaneously.*

(Q2) Is there a good technique available to enhance the quality of disruption risk modelling in the case of financial crises?

(H1) *Monte Carlo simulation methods are a good choice for risk modelling in the case of financial crises because of the uncertainties surrounding their specifications (the length of the crisis, the magnitude of the crisis, the recovery time...).*

(Q3) Which mitigation strategy could be used to avoid a supply chain breakdown in the case of financial crises?

(H1) *An 'Inventory Building Strategy' could be a good solution to avoid a supply chain breakdown in the case of a financial crisis;*

(H2) *A 'Redundant Suppliers Strategy' could be a good solution to avoid a supply chain breakdown in the case of a financial crisis.*

### 3.3 METHODOLOGICAL APPROACH

#### 3.3.1 Potential approaches

Sodhi and Tang (2012) point out that the traditional way to perform research on risk issues is the use of quantitative modelling. However, as the accumulate knowledge in the field of supply chain risk management is still rather scarce, they argue that other kinds of approaches could be more relevant to develop an overview of new problems before “*delving too deeply into quantitative modelling*” (Sodhi and Tang, 2012, p.308). Those alternatives approaches are seven in number and are the following ones: case-study analysis, multi-case analysis, behavioural research, stochastic programming, simulation, scenario planning and event study (Sodhi and Tang, 2012). The process leading to the choice of one of those approaches is detailed below.

Among the four possible master’s theses profiles proposed to students at the Louvain School of Management, this work is written as a *research master’s thesis not linked with research internship*. In that regard, the aim of the work is to modestly contribute to the production of scientific knowledge in the field of supply chain risk management by relying on scientific literature and methodologies. The problematic previously raised asks to create a link between the existing knowledge in the field of supply chain risk management and the financial crisis phenomenon that recently hit many companies around the world.

On the one hand, supply chain risk management is a broad topic that combines “*at least three fields: supply chain management, enterprise risk management, and crisis management*” (Sodhi and Tang, 2012, p.10). The current knowledge in supply chain risk management is rather scattered and relevant literature can be found “*in areas such as organizational behaviour, psychology, decision analysis, empirical analysis, stochastic modelling and mathematical programming*” (Sodhi and Tang, 2012, p.10). On the other hand, the financial crisis of 2008 is a complex phenomenon

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that is still hard to fully understand because not enough time has passed to assess what long-term effects there might be.

Therefore the main question at this stage concerns the choice of an adequate methodology to handle the problematic as efficiently as possible while bearing in mind both the specificities of the master's thesis profile chosen and some practical constraints.

A **case-study analysis** is a good way to develop knowledge in areas where theory is scarce and/or where the event studied is so recent that its effects are still not fully known. The inductive reasoning can suggest some general propositions based on the generalisation of a more specific case. A **multi-case analysis** goes in the same direction but often allows refining the findings by comparing the results obtained across multiple cases. However, the practical constraints related to the academic programme followed makes this approach impossible to achieve. The Double Degree programme is indeed associated with an everyday teaching load all along the academic year and an absence of internship that make it virtually incompatible with that kind of field study.

**Behavioural research** could be a good way to better understand how managers react to the supply chain management challenges imposed by the global financial crisis. Here again the everyday teaching load of the Double Degree programme makes it very difficult to conduct the necessary interviews associated to this approach. Interviews could be of course only conducted by phone, but it is strongly believed that face-to-face meetings are a key component of the quality of the investigation in behavioural research.

**Stochastic programming, simulation, scenario planning** as well as **quantitative modelling** are all relatively common techniques used in the field of supply chain management. If they can provide much targeted and directly enforceable results, they ask however for a minimum of technical knowledge. Having been introduced to the field of supply chain management only via a general

course on the topic, it would have been pretentious to believe that the necessary knowledge for those four approaches would be acquired by self-learning only.

An **event study** examines for its part the relevance and potential effectiveness of different existing strategies for a specific kind of event. In the present case, it means to examine the different available opportunities offered by the supply chain risk management literature to face the case of financial crises. This approach seems both suitable to the initial knowledge of supply chain management developed through an introductory course and appropriate in the case of a research master's thesis.

### 3.3.2 Approach selected

Taking into consideration the opportunities and constraints associated with each of the above methods, the 'event study' track stood out as the best way to analyse the three research questions at the core of this work. The choice was then made to use a two-fold approach for bringing out the findings: (1) an analytical approach supported by (2) a deductive approach. This dual-approach is individually applied to each of the research questions due to the individual needs surrounding each of them. The details of the methodological approach are given below.

The **analytical approach** of this work is fed by the literature review from the previous chapter and by the multiple case-study approach performed by Blome and Schoenherr (2011). On the one hand, the literature review is designed to follow a unifying thread matching the research questions' sequence. In that way, the origin of the most relevant information regarding each research question is easier to track for the reader. On the other hand, the overview of cross-case comparison performed by Blome and Schoenherr (2011) provides some other supportive data for the analysis (see Appendix A). If this contribution surely does not replace a proper case-study related to the research questions of this master's thesis, it helps to fuel the methodological approach with some very useful field observations. The only use of secondary data implies nevertheless to pay attention to the relevance of the data

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collected by others in relation to the topic studied here. As the choice was made to focus this work on the supply-side of the problem only, a selection across the cases studied by Blome and Schoenherr (2011) had to be performed. Among the eight European companies they considered, half of them are service firms (BankingCo, InsuranceCo, EnergyCo and LogisticsCo) while the other half are manufacturing firms (FashionCo, ElectronicsCo, ManufacturingCo and AutomotiveCo). As Blome and Schoenherr (2011, p.50) suggest, “*risk identification [is] of particular importance to manufacturing firms dealing with primarily direct spend, due to the usually more immediate impact on the firm’s operation in case of faulty direct supply*”. It was therefore decided to only retain the data relative to the four manufacturing companies for supporting the analysis of this work, as they were the most relevant for dealing with the supply-side risk generated by financial crises at the core of the problematic.

The **deductive approach** that supports the analytical approach connects for its part the theory, the hypothesis and the field data all together with the specific case of financial crises. The results obtained from this *general to the more specific* process allow drawing some propositions that introduce the findings of this work.

That being said, the main points that deserve attention for each question regarding the use of both the literature review and the data provided by Blome and Schoenherr (2011) can now be highlighted.

*Question 1: Do financial crises affect supply chain risk management in a new way?*

Answering this question asks to compare financial crises with some others kinds of risks. As the literature suggests, the main risk coming from financial crises on the supply-side is due to suppliers’ insolvencies. Among the different categories of supply chain risks, the literature tends to associate financial crises to a ‘disruption risk’. For that reason, trying to compare financial crises to all categories of risk is not really relevant for this study. Instead, financial crises such as the one of 2008 are



compared to other major disruption risks among three dimensions: (1) their duration, (2) their magnitude and (3) their recovery time. The major disruption risks serving as comparison are the same as the ones studied in the literature review, namely huge natural disasters, wars and terrorism and other critical disruption risks.

*Question 2: Is there a good technique available to enhance the quality of disruption risk modelling in the case of financial crises?*

In the absence of literature concerning the risk modelling process in the specific case of financial crises, it was decided to rely on a two-phase analysis. First, the overview of cross-case comparison provided by Blome and Schoenherr (2011) give a better understanding of how firms identify and quantify the risk generated by the global financial crisis. Second, the opportunities offered by the Monte Carlo simulations mentioned in the literature review are discussed on the basis of a very simple risk analysis model used among two of the firms considered by Blome and Schoenherr (2011).

*Question 3: Which mitigation strategy could be used to avoid a supply chain breakdown in the case of financial crises?*

As financial crises were identified as a disruption risk, answering this question asks for a comparison between the different relevant mitigation strategies identified in the literature review for that kind of risk. In that regard, the effects of the two classical mitigation strategies for supply-side disruptions, namely the ‘Inventory Building Strategy’ and the ‘Redundant Suppliers Strategy’, are successively discussed in the case of financial crises. Then, the results obtained from the two strategies analysis are confronted to the case-study performed by Blome and Schoenherr (2011) to examine the potential differences that could exist between theory and practice.

### SUMMARY

In this chapter, the methodology that surrounds the writing of this master's thesis was examined. First were presented the three research questions that drive this work, together with their hypothesis deriving from the literature review. Explanations on the methodological approach used for this study were then given. In a first step the different available opportunities were examined and the reasons of the choice explained. In a second step the application of the methodological approach retained for each of the three research questions was detailed.

# Research findings

## 4.1 INTRODUCTION

**N**ow that the literature proposed as main database has been presented and the methodology underlying the analysis has been explained, it is time to present the different research findings obtained through this master's thesis. As already explained, the analytical part of this work was performed within chapter two. The aim of this chapter is to give the results of the deductive approach that allow to answer the three research questions raised. Each of them is therefore successively addressed in detail below. First, a comparison between financial crises and different other kinds of disruption risks is drawn. By doing this, it should be possible to assess if financial crises affect or not supply chain risk management in a new way. Second, the multi-case study from Blome and Schoenherr (2011) is combined with a discussion around Monte Carlo simulations to see if the latter could be a good solution for risk analysis in the case of financial crises. Finally, a comparison between the different common disruption risks mitigation strategies is performed to see which one turn to be the best answer in the case of financial crises.

#### 4.2 DO FINANCIAL CRISES AFFECT SUPPLY CHAIN RISK MANAGEMENT IN A NEW WAY?

Financial crises such as the one of 2008 could be identified as a disruption risks mainly because of two of their main characteristics: they are unpredictable and they are rare. The global financial crisis of 2008 fulfils those conditions by having been totally unexpected and by having been probably only equalled by the dramatic economic recession of 1873. It is argued that they are however not exactly similar to other common disruption risk but that they rather form a new class of their own. To support that hypothesis, global financial crises are successively confronted to natural disasters, wars and terrorism and some other major disruption risks among three dimensions: (1) their duration, (2) their magnitude and (3) their recovery time. The same examples as the ones described in the literature review are used as illustrations.

##### 4.2.1 Financial crises vs. huge natural disasters

The first difference between global financial crises and huge natural disasters as supply chain disruption risks is their duration. Considering first financial crises, the one of 2008 is here taken as a point of reference. Despite some existing differences, authors agree on the whole to say that what is called the global financial crisis of 2008 already lasted for a period of at least five years. The premises of this crisis came forward in July 2007 with the bursting of the U.S. housing bubble and it seems that this crisis is not completely finished at the time of writing. That duration does not correspond to the amount of time during which the effects of the crisis are being felt but to the length of the event itself. In comparison, the 2005 Hurricane Katrina lasted eight days, the 2010 main eruption of Eyjafjallajökull lasted about one month and the 2011 Great East Japan earthquake that led to a tsunami and ultimately to the Fukushima disaster lasted only six minutes. As showed by the above examples natural disasters tend therefore to be events of quite short duration, in opposition with the global financial crisis.

The second point that differentiates financial crises and huge natural disasters is the magnitude of the phenomenon. The magnitude could be defined in this case by the geographical extent of the disruption risk. The global financial crisis of 2008 as an event directly impacted more than half of the world, essentially North America, Central America, Europe, Russia and Japan. For its part, the 2005 Hurricane Katrina affected essentially the Bahamas and most of eastern North America. The 2010 main eruption of Eyjafjallajökull and its subsequent volcanic ash cloud directly impacted most of Europe and about a third of Russia. Finally, the 2011 Great East Japan earthquake and its tsunami directly impacted a large part of Japan. As showed by the above examples the size of the area directly affected by natural disasters tend to be much smaller than the area directly impacted by a global financial crisis. It is not said here that the consequences of natural disasters do not impact businesses as internationally as global crises do, but the fact remains that the area directly affected by the event tend to be smaller even in the case of important natural disasters.

The recovery time is another point of comparison between financial crises and natural disasters that deserves investigation. Recovery time is defined here as the amount of time needed to recover a level of supply chain effectiveness similar to the pre-disruption level. Regarding the global financial crisis of 2008, a lack of perspective is clearly felt. If this financial crisis is not even over at the time of writing, analysts do not predict a recovery to the pre-crisis level before a few years. For its part, the 2005 Hurricane Katrina destroyed hundreds of business premises, road and railways on its path. If it would be beyond the scope of this study to give exact figures, it can be fairly assumed that some years were needed to rebuild most of the infrastructures destroyed at that time. The 2010 main eruption of Eyjafjallajökull and its subsequent volcanic ash cloud paralysed much of the northern Europe airspace from the 15<sup>th</sup> April to the 23<sup>th</sup> April of that year. Some other extra days during the first half of May could also be added on the top of these nine initial days of airspace closure. If hundreds of flights including airfreight were cancelled or delayed during that period, a complete recovery to the pre-disruption level was

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attained within a few weeks. Finally, the 2011 Great East Japan earthquake and its tsunami destroyed hundreds of business premises, road and railways in a similar way to Hurricane Katrina. Here some years will be also needed to rebuild all the infrastructures destroyed. As showed by the above examples, the recovery time of huge natural disasters can widely vary and in some cases reach the same time horizon as financial crises.

##### 4.2.2 Financial crises vs. wars and terrorism

Once again the first difference between financial crises and wars and terrorism as supply chain disruption risks could be related to their duration. The first example used here is the case of the terrorist attacks of 11<sup>th</sup> September 2001. In that case, less than two hours elapsed from the first plane crash to the collapse of the twin towers of the World Trade Center. Wars are however other stories. The 2011 civil war in Libya lasted for example around eight months. The war in Irak starting in 2003 lasted for its part almost a decade. Wars can therefore be categorised as events of possible longer duration in comparison to the five years time of the financial crisis of 2008. Terrorism acts are for their part almost always of short duration by nature.

The second point highlighted is the magnitude of wars and terrorism in comparison with financial crises. If the example of the terrorist attacks of 11<sup>th</sup> September 2001 is taken, the magnitude is limited to less than one square kilometre. In the case of the 2003-2011 war in Iraq or the 2011 civil war in Libya, the magnitude was limited in each case to approximately one country size. Those examples are of course not representative of all wars or terrorism events, but even the most severe ones are nowadays generally localised in a specific part of a city or in a very limited amount of countries. On the other hand, the magnitude of a global financial crisis could be as large as most of the world.

The recovery time as previously defined is the last point of comparison used here between financial crises and wars and terrorism. The recovery time for terrorist attacks such as the event of 11<sup>th</sup> September 2001 could be quantified in months due

to building or other infrastructures reconstruction. Less destructive cases could reduce this time to days or weeks. Recovery times in the case of wars such as the 2003-2011 war in Iraq are obviously longer. Here it is not only very local business premises, road or railways that need to be rebuilt, but more than likely the ones for an entire country. Civil wars such as the 2011 one in Libya can have on the other hand much more rapid recovery because infrastructures are less likely to be heavily damaged than it is the case with military wars. The recovery time of wars and terrorism could be therefore ranged from a few days to many years. In comparison, the case of financial crises can be located somewhere between these two extremes.

#### 4.2.3 Financial crises vs. other critical disruption risks

Once again the case of financial crises is confronted to some other major disruption risks that can affect a supply chain quite harshly along the three dimensions retained. The case of strikes or labour disputes could be for example analysed. The 2002 dockworker's strike in California lasted ten days. A fairly short amount of time when compared to the five years mentioned above for the financial crisis of 2008. Regarding the magnitude, if the 2002 dockworker's strike was on a very large scale by paralysing 29 ports along the United States West Coast, it is relatively modest in comparison to a worldwide financial crisis such as the one of 2008. When dealing to recovery time, the amount of time needed to recover a level of supply chain effectiveness similar to the pre-disruption level was attained in few weeks, the time needed to absorb the backlog. The difference with the potential multi-year recovery time of a global financial crisis is also quite substantial here.

The case of a single-supplier default is however a little bit trickier. The three-dimension framework used previously is indeed hard to use in this case. It does not really make sense to talk about duration or even about recovery time for the event itself. The supply chain recovery time depend indeed only on the time needed to find another substitute supplier. The magnitude of that kind of event is however quite easy to determine and is generally very small as only one supplier is concerned. In

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the case of a multinational supplier failure the magnitude could be slightly bigger, but still remains relatively limited.

### 4.2.4 Recapitulative thoughts

Though global financial crises such as the one of 2008 share the unpredictability and rareness of any critical disruption risk, they differ from the other disruption risks by their unique combination of three dimensions (see Figure 9). Global financial crises stand out from the common critical disruption risks affecting supply chain management by combining almost the worse case in the dimensions of duration, magnitude and recovery time.

**Figure 9:** Financial crises vs. other disruption risks

	<b>Duration</b>	<b>Magnitude</b>	<b>Recovery time</b>
<b>Huge natural disasters</b>	Short	Small to medium	Short to long
<b>Wars and terrorism</b>	Very short to very long	Small	Medium to very long
<b>Other disruption risks</b>	Generally short	Small	Generally short
<b>Global financial crises</b>	Long	Large	Long

#### Proposition One

Global financial crises such as the one of 2008 affect supply chain management in a new way because, unlike other disruption risks, the entire supply chain could be in trouble for a long period of time, to a large geographical extent and asking for a long recovery period at the same time.



### 4.3 IS THERE A GOOD TECHNIQUE AVAILABLE TO ENHANCE THE QUALITY OF DISRUPTION RISK MODELLING IN THE CASE OF FINANCIAL CRISES?

As it was concluded above, global financial crises such as the one of 2008 seem to impact supply chain management in a new way. Because of that, it is more than likely that firms need to adapt the way they identify and analyse the risk generated by global financial crises. It is argued here that Monte Carlo simulations could be a good choice for risk modelling in the case of global financial crises. To support that hypothesis, the overview of cross-case comparison provided by Blome and Schoenherr (2011) is first used to show how firms actually identified and quantified the risk generated by the financial crisis of 2008 (see Appendix A for the data). In the light of the results obtained, the relevance of using of Monte Carlo simulations to improve firms' ability to react in the case of financial crises is then discussed.

#### 4.3.1 How do firms identify and quantify the risk generated by the financial crisis?

Taking risk identification as a starting point, the importance of suppliers' choice and evaluation to mitigate the default risk in the case of financial crises has been highlighted in the literature. If authors clearly agree on that point, what about the business reality? Among the four manufacturing firms studied by Blome and Schoenherr (2011), all of them increased their risk awareness significantly and three of them (ElectronicsCo, ManufacturingCo and AutomotiveCo) adapted their list of potential supply risks with the global financial crisis of 2008. Two out of the four manufacturing companies (ElectronicsCo and AutomotiveCo) also ranked supplier's insolvency as the priority number one. Regarding the degree of change reached, the results reflect a substantial or radical change in comparison from the pre-crisis period for all the four companies (on a scale ranging from 1 (no change) to 5 (radical change), the degree of change is assessed three times at 4 and one time at 5).

Regarding the risk analysis, tremendous changes have also been made by the four different manufacturing firms. Due to the global financial crisis, three firms

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(FashionCo, ElectronicsCo and ManufacturingCo) increased their comprehensiveness of risk analysis with a focus on financial indicators. The firm AutomotiveCo even initiated a new risk analysis process. In all of the four examples, a larger range of both internal and external data than before is gathered to improve the assessment of suppliers. According to Blome and Schoenherr (2011, p.49), what really changed for manufacturing companies with the crisis was “*the depth of analysis and the use of a multitude of indicators to predict supplier disruptions*”. One surprise was however not to see real change, adaptation or creation of new supply chain modelling in the results of Blome and Schoenherr (2011). Two firms out of the four studied (ElectronicsCo and ManufacturingCo) already had matrix for risk analysis before, but no change due the global financial crisis is mentioned in that area for any of the four firms. If it seems therefore that all the four firms tend to analyse their suppliers performance with more care than before the crisis, with refined data and additional information, nothing is said about an improvement or not of the modelling tools. This information could maybe be available in the primary data collected by Blome and Schoenherr (2011), but nothing in their paper asserts it.

##### 4.3.2 Monte Carlo simulations in the case of financial crises

If the multiple case-study approach provided by Blome and Schoenherr (2011) do not mention anything about the use or not of new techniques for modelling the consequences of supply-side risk over time, the Monte Carlo simulations track raised in the literature review should not be forgotten so far.

One of the simplest ways to perform a risk analysis is to use a matrix combining (1) its probability, (2) its potential impact and (3) its mean time to repair. Such an approach was, for example, already implemented in half of the manufacturing companies studied by Blome and Schoenherr (2011) before the global financial crisis. However, applying that simple kind of risk analysis becomes quite challenging in the case of financial crises such as the one of 2008 because of the high uncertainty surrounding two out of the three parameters concerned. As previously argued,

financial crises could be assimilated to disruption risks mainly because they are unpredictable and rare. The probability of the risk is thus very low and does not really present any difficulty in this case. The potential impact and mean time to repair are though a complete different story. Hundreds of totally different values might be reasonably considered and combined for those two parameters, leading to thousand possible scenarios. Trying to consider only a very limited number of ways in the modelling process could be risky for obvious reasons. Even if the initial situation is known, there are indeed many potential directions in which the disruption risk associated to a financial crisis could evolve. Facing thousands of different possible scenarios, a solution could be to model a real stochastic process representing the evolution of random variable values over time. The random variable values are probably a good way to represent the potential impact and mean time to repair in the case of financial crises because of the uncertainty surrounding the risk. Under such conditions, Monte Carlo simulations are then a good track to follow because, as already mentioned in the literature review, *“these models are easy to build and use, and the ability to run many thousands of simulation runs provides the perfect opportunity to understand the impact of variability on the system”* (Christopher and Holweg, 2011, p.77). Furthermore, the work of Jin et al. (2010) in the case of wars, another disruption risk with variables surrounded by uncertainty, provide a good example on how the benefits of Monte Carlo simulations can be used in supply chain risk management.

#### 4.3.3 Recapitulative thoughts

As the results of the multiple case-study approach provided by Blome and Schoenherr (2011) show, manufacturing companies made some important change on the way they indentify and quantify the risk of suppliers' failure. However there is no evidence that the global financial crisis of 2008 affected their way of modelling the consequences of disruption risks. If we assume that the traditional matrix combining probability, impact and mean time to repair is still used for risk analysis, Monte

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Carlo simulations can then offer great perspective in the case of global financial crises. If Monte Carlo simulations do not offer a new modelling technique per se, they could represent a good additional tool to existing models by their ability to generate and test all possible scenarios deriving from the very uncertain characteristics of financial crises.

### Proposition Two

Monte Carlo simulations could offer a good opportunity to improve risk modelling in the case of financial crises because they provide an easy way to deal with the many different possible scenarios resulting from the uncertainty surrounding many of their parameters.

#### 4.4 WHICH MITIGATION STRATEGY COULD BE USED TO AVOID A SUPPLY CHAIN BREAKDOWN IN THE CASE OF FINANCIAL CRISES?

Even if it was argued that global financial crises form a new class of disruption risk on their own, they nevertheless remain disruption risks. There is therefore no a priori reason that the two most common mitigation strategies for supply-side disruption risks, namely (1) the ‘Inventory Building Strategy’ and (2) the ‘Redundant Suppliers Strategy’, do not offer a good choice in the case of financial crises. However, due to the specific characteristics of financial crises, one of those two strategies could be better suitable than the other. Each of them are therefore successively confronted to the case of financial crises. The multi-case study of Blome and Schoenherr (2011) is also used here to confront the assumptions made to the reality of the business world. In the light of the results obtained, a proposal concerning the best mitigation strategy in the case of financial crises is finally discussed.

#### 4.4.1 The 'Inventory Building Strategy'

The 'Inventory Building Strategy' is quite often used in the case of disruption risks because it is hoped that the back-up production should provide enough time to solve the problem encountered. The main problem in the case of financial crises would be probably the failure of one or more of the business' suppliers. If enough inventories are kept for strategic reasons, the effect of suppliers' failure could then be greatly lowered and could provide enough time to find another supplier. As it was explained in the literature review, this strategy could block huge amount of cash as a consequence. As it was also mentioned before, a global financial crisis such as the one of 2008 is first and foremost a liquidity crisis. This changes actually everything. In this particular condition, building inventory could be more dangerous than helpful, even deadly, because it could simply block the necessary cash needed for running business in the absence of easy bank loans. As stocks are often considered as not being very liquid assets, especially with a high demand uncertainty as it could be the case in a tough economic climate, a real risk exists that a firm could go bankrupt simply because of an 'Inventory Building Strategy'. On the other hand, decreasing inventories along the whole supply chain to keep cash will more than likely result in a greater chance to encounter disruptions. Therefore, all that being said, the 'Inventory Building Strategy' is probably not the best track to follow in the case of a global financial crisis.

#### 4.4.2 The 'Redundant Suppliers Strategy'

The 'Redundant Suppliers Strategy' consists of hedging the supply chain against disruption risks by using redundancy. If the chance that all suppliers encounter problems simultaneously is very unlikely in normal times, this probability drastically increases in the case of a global financial crisis. This mitigation strategy could be then less effective in the case of a global financial crisis than it is usually the case. Does that mean that a 'Redundant Suppliers Strategy' is not really helpful or even not recommended in the specific case studied here? No. It is perhaps even more

recommended than ever. But what could be clever is to choose redundant suppliers by keeping in mind the specificities of a global financial crisis. In opposition to disruption risks such as natural disasters or wars, the location of the redundant suppliers is for example not of central importance here. All regions will probably be affected in a similar way by the effects of a financial crisis, and it could probably be a better bet to favour trust relationships with few suppliers (even if they are in the same geographical area) than trying to gather as many redundant suppliers as possible all over the world. Building relationships with few suppliers and collaborate with them on areas such as cost savings and logistics optimisation could be indeed a good idea. It would probably minimise the risk of disruption as the whole supply chain will then share the same goal: staying alive, knowing that both suppliers and manufacturers depend heavily on each other to pursue their activities. If applied carefully, the ‘Redundant Suppliers Strategy’ could therefore be a good track to follow in the case of a global financial crisis.

### 4.4.3 How do firms mitigate the supply risk generated by the global financial crisis?

An analysis performed on the basis of the literature review suggests that the ‘Redundant Suppliers Strategy’ is probably the best mitigation strategy among the two generally used for supply-side risk. Is that consistent with what happens in the business field? The overview of cross-case comparison provided by Blome and Schoenherr (2011) is used here to give a first answer to this question (see Appendix A for data). Before the financial crisis, the usual risk mitigation strategies used by the manufacturing companies studied by Blome and Schoenherr (2011) consisted of audits, improvement of supplier performance, currency hedging, collaboration, proactive risk mitigation or even simply risk acceptance. The changes due to the financial crisis were not exactly the same in all four companies in regard of mitigation strategies, but Blome and Schoenherr (2011) mention that they all use the crisis as an opportunity to consolidate their supply base. In one case (FashionCo), the

change was made by decreasing the amount of suppliers to focus mainly on strategic ones and by building secondary sources when the firm was highly dependent on very few suppliers. On the other hand, the three other manufacturing companies (ElectronicsCo, ManufacturingCo and AutomotiveCo) helped financially one or more of their suppliers to avoid major supply chain disruptions despite their severe cash restrictions. Helping strategic suppliers was even considered to be crucial for one of the firm (AutomotiveCo). Maintaining links between buyers and key suppliers seem therefore to be more important than ever in the case of a global financial crisis such as the one of 2008.

#### 4.4.4 Recapitulative thoughts

As it was explained above, among the two most common mitigation strategies used for supply-side disruption risks that are ‘Inventory Building Strategy’ and ‘Redundant Suppliers Strategy’, the latter one is the most advisable. Both a deductive analysis based on literature and field study seem indeed to suggest that many firms mitigate the risks inherent to global financial crises by focusing on their key suppliers rather than on inventories building. Furthermore, it was also explained how an ‘Inventory Building Strategy’ could even be dangerous in the case of financial crises. Consequently, a thoughtful ‘Redundant Suppliers Strategy’ is probably the best way to limit the adverse effects of potential multi-supplier failures.

#### Proposition Three

A thoughtful ‘Redundant Suppliers Strategy’ is probably the best way to limit the adverse effects of potential multi-supplier failures resulting from financial crises such as the one of 2008.

### SUMMARY

In this chapter, the three research questions forming the backbone of this master's thesis were answered one by one. It was first explained how financial crises such as the one of 2008 can affect supply chain management in a new way because, unlike other disruption risks, the entire supply chain could be in trouble for a long period of time, to a large geographical extent and asking for a long recovery period at the same time. Then, it was argued that Monte Carlo simulations offer a good opportunity to improve risk modelling in the case of financial crises because they provide an easy way to deal with the many different possible scenarios resulting from the uncertainty surrounding many of their parameters. Finally, it was explained why a thoughtful 'Redundant Suppliers Strategy' is probably the best way to limit the adverse effects of potential multi-supplier failures resulting from financial crises such as the one of 2008.



# Conclusions and recommendations

## 5.1 CONCLUSIONS

The global financial crisis of 2008 set undoubtedly new challenges to the field of supply chain risk management. Among them, the financial crisis call attention to a quite unusual multiple supplier defaults risk. On that basis, three research questions were drawn up in order to better handle the main question of how to handle the supply-side risk. They were as follows: *Do financial crises affect supply chain risk management in a new way? Is there a good technique available to enhance the quality of disruption risk modelling in the case of financial crises? Which mitigation strategy could be used to avoid a supply chain breakdown in the case of financial crises?*

Based on an analytical-deductive approach performed through an event study, it was possible to draw three main propositions which may be understood as tentative answers for the above research questions.

First, the results of a crosschecking of the supply chain risk management literature suggested that though global financial crises share the unpredictability and rareness of any critical disruption risk, they differ from the other disruption risks by their unique combination of dimensions such as duration, magnitude and recovery time of the event.

Second, as the results of the multiple case-study approach provided by Blome and Schoenherr (2011) showed, there was no evidence that the financial crisis of 2008 affected the way companies modelled the consequences of disruption risks. The results suggested Monte Carlo simulations could offer great perspective in the case of global financial crises. Indeed, even if they do not offer a new modelling technique per se, they could represent a good additional tool to existing models by their ability to generate and test all possible scenarios deriving from the very uncertain characteristics of global financial crises.

Third, among the two most common mitigation strategies used for supply-side disruption risks that are 'Inventory Building Strategy' and 'Redundant Suppliers Strategy', it was suggested that the latter one should be the most advisable. Both a deductive analysis based on literature and field study seemed indeed to suggest that many firms mitigate the risks inherent to global financial crises by focusing on their key suppliers rather than on inventories building.

### 5.2 RECOMMENDATIONS

As it is the case with any study, this work does present limitations. Despite the care taken when doing this work, three limitations could indeed be pointed out. They are examined below together with possible ways to overcome them.

First, the results presented in this work are of a very broad nature. The conclusions do not really focus on any specific industry, and one could argue that they are therefore rather limited in their scope. In that regard, a case-study analysis specifically designed for the purpose of the problematic would probably offer a good opportunity to refine the findings.

Second, this study focuses only on the supply-side risks generated by financial crises. Testing similar hypotheses on the other side of the relationship, namely the demand-side, could provide a much more comprehensive understanding of the many ways financial crises affect the supply chain as a whole.

Third, the lack of quantitative modelling also reduces the scope of this study's findings. Without any mean to really quantify the impact of the different mitigation strategies proposed in this work, it is indeed really difficult to draw precise conclusions. Applying the findings of this study to stochastic programming, simulation or scenario planning could therefore be a good way to enhance the scope of this study.

As it can be easily guessed, this study is therefore only the beginning of a long road strewn with many challenges, but also and above all full of tremendous future opportunities for the field of supply chain risk management.



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## Overview of cross-case comparison

The overview of the cross-case comparison provided by Blome and Schoenherr in their multiple case-study approach is presented here for the four companies used in the analysis. This overview is preceded by the case-study demographic information of the concerned firms for fiscal year 2009.

### Case study demographic information for fiscal year 2009

(Adapted from Blome and Schoenherr, 2011, p.47)

	<b>FashionCo</b>	<b>ElectronicsCo</b>	<b>ManufacturingCo</b>	<b>AutomotiveCo</b>
<b>Number of employees at group level</b>	10,001-50,000	100,001-200,000	50,001-100,000	More than 200,000
<b>Annual revenue</b>	Below 10bn€	10bn€-25bn€	10bn€-25bn€	50bn€-100bn€
<b>Organisational structure</b>	De-centralized	Matrix-Hybrid	Matrix-Hybrid	Matrix-Hybrid
<b>Total headcount in purchasing</b>	100-500	100-500	100-500	More than 2,000
<b>Purchasing volume</b>	Less than 1bn€	5bn€-10bn€	5bn€-10bn€	More than 10bn€
<b>Spend structure</b>	Direct spend	Direct spend	Direct spend	Direct spend

### Overview of cross-case comparison

(Adapted from Blome and Schoenherr, 2011, p.53-55)

	FashionCo	ElectronicsCo	ManufacturingCo	AutomotiveCo
Risk identification	<ul style="list-style-type: none"> <li>• Risk identification is part of a detailed three-step supplier selection process</li> </ul>	<ul style="list-style-type: none"> <li>• List of potential risks provided by ERM</li> </ul>	<ul style="list-style-type: none"> <li>• List of potential risks provided by corporate risk management, additional risks are included in a decentralized fashion</li> </ul>	<ul style="list-style-type: none"> <li>• Potential risks derived from historical developments and supplier assessments</li> <li>• Different risk priorities assigned to different purchasing categories</li> </ul>
Changes due to financial crisis	<ul style="list-style-type: none"> <li>• Increased risk awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Increased risk awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Increased risk awareness</li> </ul>	<ul style="list-style-type: none"> <li>• Increased risk awareness</li> </ul>
	<ul style="list-style-type: none"> <li>• Supplier insolvency risks gained importance in risk identification, additional risks have been identified</li> </ul>	<ul style="list-style-type: none"> <li>• Insolvency risk has now highest priority in risk identification</li> <li>• List of potential supply chain risks was modified</li> </ul>	<ul style="list-style-type: none"> <li>• List of potential supply chain risk has been adapted</li> </ul>	<ul style="list-style-type: none"> <li>• Insolvency became corporate priority number 1</li> <li>• List of potential supply chain risks has been adapted and audited</li> </ul>
Degree of change	4	4	4	5
Risk analysis	<ul style="list-style-type: none"> <li>• Risk analysis is integrated into supplier evaluation system</li> <li>• No IT tool-based risk analysis</li> <li>• No probability <math>\times</math> impact matrix for risk analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Different weighting schemes dependent on the (sub-) category procured</li> <li>• Supply chain risks as an important part of company risk exposure</li> <li>• Probability <math>\times</math> impact <math>\times</math> mean time to repair matrix for risk analysis</li> </ul>	<ul style="list-style-type: none"> <li>• IT tool-based risk analysis</li> <li>• Insolvency risks assessed based on a mix of internal and external financial and non-financial indicators</li> <li>• Probability <math>\times</math> impact <math>\times</math> mean time to repair matrix for risk analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Risk analysis is using a multiple step portfolio approach being comprised of likelihood and severity, but also incorporating the dependency on the supplier</li> <li>• No explicit probability <math>\times</math> impact logic, rather: integration into supplier management</li> </ul>



	<b>FashionCo</b>	<b>ElectronicsCo</b>	<b>ManufacturingCo</b>	<b>AutomotiveCo</b>
Changes due to financial crisis	<ul style="list-style-type: none"> <li>• Comprehensiveness of risk analysis increased, especially relating to the assessment of suppliers' financial stability</li> <li>• A larger range of internal and external indicators are analyzed</li> <li>• Extra financial data for Asian suppliers are gathered as Western databases lack information</li> <li>• No systematic risk analysis of financial supplier risks before the financial crisis, now an elaborated approach exists</li> </ul>	<ul style="list-style-type: none"> <li>• Comprehensiveness of risk analysis increased, especially relating to the assessment of suppliers' financial stability</li> <li>• Combination of internal and external indicators (e.g., Dun&amp; Bradstreet) for the assessment of suppliers' financial situation</li> <li>• No systematic risk analysis of financial supplier risks before the financial crisis, now an intensive approach based on almost all available information</li> </ul>	<ul style="list-style-type: none"> <li>• Comprehensiveness of risk analysis increased, especially relating to the assessment of suppliers' financial stability</li> <li>• A new tool for risk assessment has been introduced to make the rating more efficient, since the workload for risk assessments in the financial crisis has been high</li> </ul>	<ul style="list-style-type: none"> <li>• New risk analysis process initiated: continuous and cross-functional</li> <li>• Financial risks are assessed by a separate financial audit team with the help of an exhaustive list of internal and external indicators</li> <li>• No systematic risk analysis of financial supplier risks before the financial crisis</li> </ul>
Degree of change	4	4	4	5
Risk acceptance/mitigation	<ul style="list-style-type: none"> <li>• Every purchasing manager decides risk mitigation strategy on their own</li> <li>• Main risk mitigation strategies are audits, phase-out and continuous improvement of supplier performance</li> </ul>	<ul style="list-style-type: none"> <li>• Proactive SCRM with suppliers with more than 100,000€ purchasing volume</li> <li>• A wide range of risk mitigation strategies from currency hedging to collaboration</li> </ul>	<ul style="list-style-type: none"> <li>• For non-strategic suppliers, the goal is a reduction in their total number</li> <li>• Helping out suppliers with cash is possible, even though it is the last resort</li> <li>• Proactive risk mitigation for strategic suppliers</li> </ul>	<ul style="list-style-type: none"> <li>• The portfolio of risk mitigation approaches is significant</li> <li>• The predominant focus has historically been on risk acceptance (reacting to problems very quickly)</li> <li>• Financial support to supplier, if insolvency is looming, is inevitable in the short term</li> <li>• Multi-sourcing used as a means to reduce risk impact</li> </ul>

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Changes due to financial crisis	<ul style="list-style-type: none"> <li>• The crises is used to decrease the number of suppliers and to pool spend volume with strategic suppliers</li> <li>• Helping supplier with problems became even more seldom in the crisis</li> <li>• Risk mitigation mainly means the building of secondary sources in cases of high dependence</li> </ul>	<ul style="list-style-type: none"> <li>• The focus has changed; financial support has been utilized to a greater extent before the crisis</li> <li>• Negative impacts of risks can oftentimes only be reduced by reacting very quickly</li> </ul>	<ul style="list-style-type: none"> <li>• Strong growth of efforts and resources to prevent the negative effects of insolvencies, since the number of insolvencies has increased</li> <li>• Additional human resources have been necessary</li> <li>• A lot reactive countermeasures have been introduced</li> <li>• The crisis is used to consolidate the supply base for non-strategic suppliers</li> </ul>	<ul style="list-style-type: none"> <li>• The portfolio of risk measures stayed the same, but the focus has shifted</li> <li>• The firm tries to establish a proactive risk management approach, but follows it only in some cases due to its own cash restrictions</li> <li>• The crisis is used for a consolidation of the supply base</li> </ul>
Degree of change	3	4	4	5

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Score for degree of change: 1=no change; 2=minimal change; 3=average change; 4= substantial change; 5=radical change







# Supply Chain Management and Financial Crises: How to Handle the Supply-side Risk?

**Purpose** – The purpose of this study is to provide a first insight on how to handle the supply-side risk in the case of a financial crisis. That means not only to develop a better understanding of the phenomenon through the prism of supply chain management, but also to thoroughly examine the relevance of some existing solutions in order to avoid future supply chain breakdowns in the particular case of a global financial crisis.

**Methodology/approach** – A two-fold approach was used through this work for bringing out the findings: (1) an analytical approach supported by (2) a deductive approach. This dual-approach is individually applied to each of the research questions due to the individual needs surrounding each of them.

**Findings** – (1) Global financial crises affect supply chain management in a new way because, unlike other disruption risks, the entire supply chain could be in trouble for a long period of time, to a large geographical extent and asking for a long recovery period at the same time, (2) Monte Carlo simulations could offer a good opportunity to improve risk modelling in the case of financial crises because they provide an easy way to deal with the many different possible scenarios resulting from the uncertainty surrounding many of their parameters and (3) a thoughtful ‘Redundant Suppliers Strategy’ is probably the best way to limit the adverse effects of potential multi-supplier failures resulting from financial crises such as the one of 2008.

**Originality/value** – The significance of the study lies in the extent of the challenges companies need to take up in today’s financial and economic turmoil. First, this study can probably be considered as the first one providing a quite complete overview of all the current knowledge regarding supply chain risk management in the context of financial crises. Second, it is also believed that the findings of this study could offer academics and researchers a basis for future quantitative modelling investigation to address financial crises’ risk issues.

**Keywords** – Supply chain management, enterprise risk management, financial crisis, Monte Carlo simulations

**Paper type** – Master’s thesis