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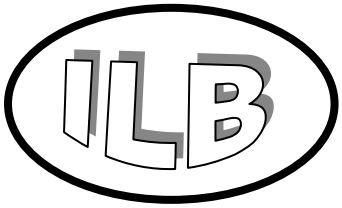

Risk Analysis in Selected European and International Food Chains[1]

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Abstract
The purpose of this study is to assess and evaluate the most important risks in selected European and international food chains from the perspective of the buying company. The primary objective is to identify the "non-acceptable"risks in terms of damage potential and likelihood of occurrence of value chains in the sectors grain, meat, fruit and vegetable, and olive oil. Data was collected by each partner of the European research project "e-trust" (FP6-CT-2006-043056) by conducting 81 qualitative expert interviews with business leaders in Europe (Austria, Germany, Greece, Italy, Slovenia, Spain) as well as in Brazil, Turkey, and the USA. The study focuses on a wider supply chain or network perspective for the risk assessment. Methodically the assessed risks were classified and then evaluated using a risk map matrix. Results point out non-acceptable risks and show the differences concerning the risk evaluation in the different value chains. Results provide interesting supply chain management approaches in theses sectors.
Keywords: risk, risk analysis, supply chain, food, risk map, risk classification

1. Introduction and Problem Description

A number of important trends and changes have had an impact on the European food industry as a whole in the past few years. Rapidly changing consumer demand leads to shorter product life cycles, companies have to deal with globalisation of food markets on the one hand and with higher demand for local products on the other hand. Finally price fluctuations in commodity markets do occur. To meet these challenges most companies try to collaborate closely with their suppliers and customers using Supply Chain Management approaches (Kersten et al. 2006). Despite the big advantages of the these activities, such as reducing transactions costs and optimizing inter-organisational flow of materials, information and capital, new problems occur.
One negative consequence is the growing dependence of the partners on each other due to the concentration efforts within the companies and the food sector as a whole. Efforts to form lean supply chains raise the dependence of the companies on each other and therefore increase risks in the supply chain: The leaner the supply chains, the more likely uncertainties, dynamics and accidents in one link affect others in the chain (Berg et al. 2008). Another negative aspect is that the complexity of the supply chains in general increases. Companies are getting bigger, more complex (due to concentration efforts) and are trading more on an international level. This affects the risk level in a supply chain: The larger and more complex an international supply chain and its adjacent companies get, the higher is the potential exposure for risks in the supply

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chain (see Kersten et al. 2006a). This high complexity is particularly the case for the food industry (e.g. Mènhard, 2004). A high number of companies are involved in the production of food on different levels of the food chain (Connor and Scheck, 1997). Besides the risks caused by increasing dependencies and an increasing complexity, some more general risks occur in the food sector. Dynamically changing market situation leads to supply bottlenecks and price increases in commodity markets. For instance, in 2007 supply bottlenecks occurred for several products in the market of organic food in Austria and Germany, which forced companies to change suppliers or even change production recipes for products (see, Ameseder et al. 2008).
For companies in lean, complex and longer supply chains with uncertain demand and supply, risk handling along the supply chain is an important topic. Souther (2000) furthermore stresses the fact that companies not only should focus on their own risks, but also on risks in the other links of the supply chain. Therefore it's important to know and understand the typical risk in a value chain, in order to avoid its in many cases disastrous ripple effects of minor or major incidents.

2. Objective and research questions

The object of this study therefore is to assess, describe and evaluate the typical risks in four different value chains in the food sector. The primary aim is to identify non-acceptable risks from the point of view of SME business leaders in the food sector in terms of probability of occurrence and the potential damage of a risk for the company. Special focus of the study is on the buying side of the transaction process, with a new supplier in mind. Although the study considers the topic from the subjective point of view of SME's, the goal is to assess all risks for the whole value chain. Therefore companies of different sizes and different levels in nine separate countries were included in the assessment following a heuristic approach. The main research questions targeted by the study are:

- What is a non-acceptable risk in a value chain?
- Which risks in the food sector can be considered as non-acceptable risk?
- Do variations exist in the risk evaluation of the different value chains?

3. Theoretical background

Supply chain management research recently increased its interest in the topic of risk management in supply chains. (Berg et al., 2008; Tapiero and Grando, (2008), Berry and Collier, 2007; Donzelli, P. and Setola, R., 2007; Kersten et al., 2006a, Kersten et al., 2006b; Halikas et al., 2004; Normann and Jannsson; 2004; Christopher and Peck, 2004; Halikas et al. 2002). Winkler and Kalzua (2006) state that risks significantly influence the performance of a supply chain, and are therefore highly important for a supply chain management approach. Many of the authors in the literature furthermore note the importance of a wider supply chain or network perspective instead of only focusing on the company's own risks. However, a comprehensive description of all the possible risks in a supply chain is not feasible, as risks vary from every supply chain (Vogel an Wagner, 2005; Giunipero and Reham, 2004; Boutellier and von Pfuhlstein, 2005). For a supply chain management approach it's therefore important to know the non-acceptable risk, that highly affect the companies and the value chains as a whole.
To assess these risks, a wide arrange of work was published mainly focusing on how the risk is measured. A risk map matrix was widely applied where as quality assurance models were used less frequently (Berg et al. 2008). Business Interruption Value approach was used by Normann and Jannsson (2004) to assess the risk consequences. Furthermore several case studies were published, such as for the automotive industry (Berry and Collier, 2007), for the telecommunica-

tion sector (Normann and Jannsson; 2004) or for e-Government projects (Donzelli, P. and Setola, R., 2007). However in recent years no articles have been found targeting the risks on a supply chain level for the food sector.

"Risk" definitions in literature as well as the measurement tools strongly depend on the field of research (Christopher and Peck, 2004). In traditional decision theory, risk is defined as the variation in the distribution of potential results, their probability of occurrence and their subjective value (Arrow, 1965). Within this definition a "potential" result may be positive as well, but a risk normally is perceived as something negative. Therefore for our purpose more suitable is the definition from March and Saphira (1987 which states that risk is the product of the probability of occurrence of an event and the resulting amount of damage. Kersten et al. (2006b) further developed this general risk definition and defined a risk in a value chain as "the damage – assessed by its probability of occurrence – that is caused by an event within a company, within its supply chain or its environment affecting the business processes of at least one company in the supply chain negatively. This definition includes the origin or the source of a risk (caused by an event), as well as its effect and the affected company. Concerning this definition, five factors are of importance to define a risk in a supply chain:

- The risk itself (what kind of risk)
- The source of the risk
- The effect of the risk
- The probability of occurrence of the risk
- The potential damage of the risk for the companie(s) in the value chain.
- Empirically we used these five factors to assess and measure the risks in the food sector.

4. The Assessment

In this study more than 81 SME`s qualitative expert interviews from six European countries (Austria, Germany, Italy, Slovenia Spain, The Netherlands) and from Brazil, Turkey and the USA were conducted by each partner of the European research project "e-trust" (FP6-CT-2006-043056) in 2008. Interview partners were mainly from the general management or from the purchase department of the companies due to the fact that the study focuses on the buying aspect of the transaction process. Within this study we focused on four different value chains:

- Grain
- Meat
- Fruit and vegetables
- Olive oil

For the expert interviews a questionnaire was prepared. The aim of the questionnaire was to investigate the typical transaction risks along the chain. The specific focus was on the first transaction with a new supplier. Therefore in a first step an open question was asked: "Supposing your company has to find new suppliers, what are the typical threats, uncertainties and risks you face and feel?" The interview partners were asked to name the 5 most important risks or threats. The second step followed the definition of risk used in this study. Respondents were asked for each risk to name the cause of the threat and the effect of the threat (see Table 1. Example for one of the 81 assessments with SME`s1).

Table 1. Example for one of the 81 assessments with SME`s

Which threat	Effect of threat	Cause of threat	Likelihood of occurrence a = very likely e = very unlikely	Potential damage for company 1 = very large 5 = very small
Price fluctuations on commodity markets	Loss of profits	Supply/demand Weather	a	3
Product quality of raw material, contamination	Bad sensoric quality of end product	Change in the weather	e	2
Delay of delivery	Stop of production	Logistic reasons (ships)	d	3
Supplier can't or won't fulfil contract	Search for new supplier, Re-negotiation	Supply bottlenecks, loss of certification etc.	d - e	1.5
Competition from other markets	Low product prices – loss of profit	Rising production in low income countries	c - d	3 - 4

To evaluate the risks, the likelihood of occurrence and the potential damage for the company when occurred were assessed. For these two factors, a school grading system from one to five was applied. As intermediate evaluations were possible (e.g. 2.5), basically a 10-point-scale was used. Summarized in all nine countries the 81 respondents named 365 risks (365 risk entries).

5. Method

As mentioned previously, a comprehensive description of all the possible risks in a supply chain is not feasible, as risks vary from every supply chain. It's therefore important to identify those risks, which were from the business leaders point of view, the most important in terms of potential damage for the companies and likelihood of occurrence. A significant amount of literature refers to the risk map matrix as shown in Figure 1: Risk map matrix (Halikas et al., 2004)1(e.g. Halikas et al. 2004):

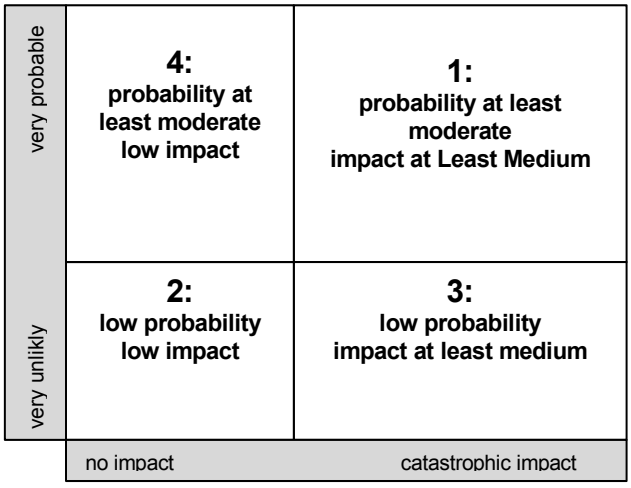

Figure 1. Risk map matrix (Halikas et al., 2004)

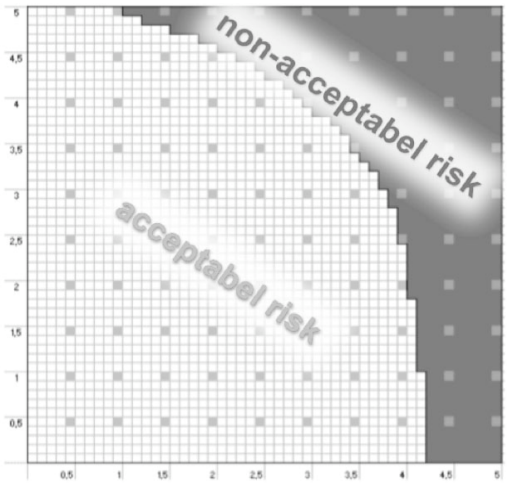

Figure 2. Acceptable and non-acceptable point in the risk portfolio (see Hölscher, 2000)

On the axis of abscissa (X) the potential damage is outlined and on the axis of ordinates (Y) is the likelihood of occurrence. In this isk map the risks have been divided into four segments. The most important risks concerning this risk map matrix are those with an at least moderate probability of occurrence and an at least medium impact (segment in the upper right corner).

Concerning this risk map, these are the risks that have to be managed. For our purpose this risk map matrix was not feasible, as risks with a rather low probability of occurrence but a catastrophic impact are not included in this important segment. To be more precise, risks that lead to a catastrophic impact for a company or a whole supply chains, such as food scandals, would not be important risks concerning this matrix (because catastrophes such as scandals fortunately occur rarely). Therefore this method is not acceptable for the food sector. The risk map matrix according to Hölscher (2000), as shown in Figure 2: Acceptable and non-acceptable points in the risk portfoliio (see Hölscher, 2000)2 was applied for our purpose instead:

The approach from Hölscher uses the same risk map as shown before, and the same measurement tolls to evaluate the risks (probability and potential damage). Instead of dividing the map into four segments, Hölscher only differs between acceptable risk (light grey dots in white area, see figure 2) and non-acceptable risks (white dots in grey area). For our purpose, which is to detect non-acceptable risks in the value chain, this approach is much more feasible due to the fact that this matrix only differs between two different categories of risks (acceptable and non-acceptable risks). In addition, risks with a high damage potential but a low probability of occurrence are in the segment of non-acceptable risks. So very unlikely events but with a catastrophic impact are in the red sector of non-acceptable risks. To be able to apply this risk matrix to our assessed data, a risk classification had to be done first, as the data of the open questions of the qualitative assessment is rarely congruent.

6. Risk classification

The classification of risks is a challenging task because of the diversity of risk-situations in the different kinds of companies in the assessment. For that reason an appropriate classification is needed, where the single risks are allocated and classified. In order to be able to do an appropriate classification, the cause of a risk and its effect as well was used to understand the nature of the risk. The cause of risks was a crucial factor for the classifications; therefore there might be a difference between the risk and the classification to which it's assigned. But due to the cause of risk – which defines the place of origin of the risk more precisely - the allocation was done. The cause of risk describes why the risk occur and therefore it is the most important issue to generate methods of resolution to strengthen trust between business partners according to the following applied method.

Within this analysis, seven different risk groups were compiled: "Product quality risk", "logistic risk", "market dynamic risk", "supplier financial risks", furthermore "political / regulatory risk", "relationship and information flow risk" and "internal risk". In accordance with the general risk classification of Kersten et al. (2008), this seven risk groups can be specified as follows:

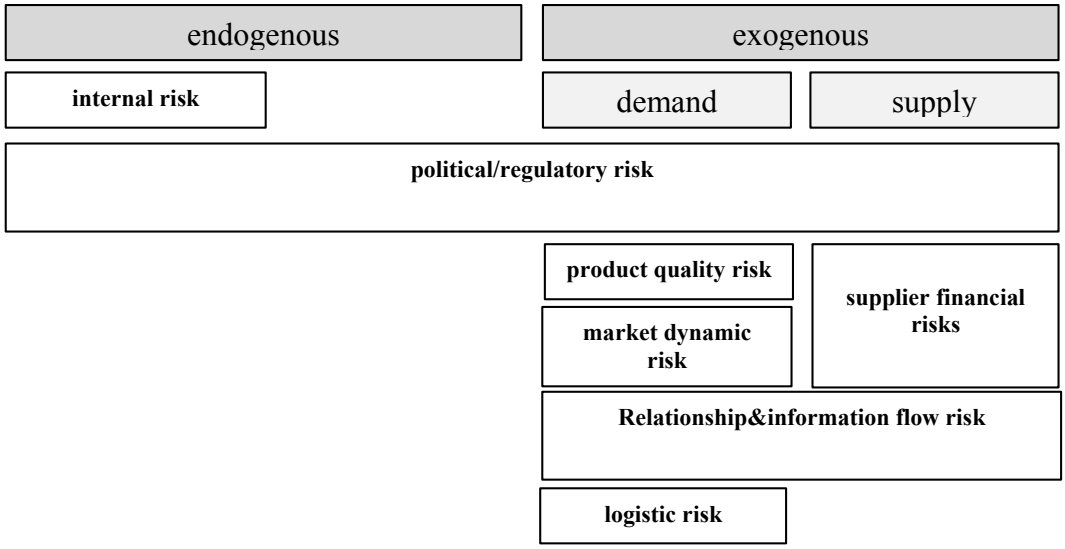

Figure 3. Risk classifications e-trust Source: Kersten er al., 2008

A category named "miscellaneous" or "not applicable" was not created, because all the answers could be categorized and were congruent to one of the seven risk classifications. In Table 2 the classifications of the risks are illustrated, to understand the nature of the 7 risk classifications. Beyond the classification the representative statements are concentrated, therefore not all risks are quoted.

Based on the risk map applied in this analysis and the risk classification the non-acceptable risks can be identified. As Figure 2: Acceptable and non-acceptable points in the risk portfoliio (see Hölscher, 2000)2 shows each yellow or green point represent a possible risk entry in the risk map. In the following the percentage (of total entries in this risk map) of the entries in the red area and the percentage of the entries in the green area can be compared (see Figure 3: Results for market dynamic risks3).

Table 2. Overview of the classified risks

Product quality risk	Logistic risks	Market dynamic risks	Supplier financial risks	Political / regulatory risk	Relationship & information flow risk	Internal risks
Bad product quality	Delivery delay	Change in prices	loss of receivables	Sanitary / safety standards	No relation-ship between partners	Damaged packaging
Quality risk	No delivery	Crisis / scandals	Insolvency of supplier	Specification	Misunder-standing	Production mistakes
Product standard-ization	Transport / logistic problems	Scarcity of product	Insolvency (from customer)	Political regulations	Bad communication	Employee mistakes
Lack of homogenity	Delivery is too late	Crop failure	Credit risk	No declaration	Lack of information	Technical mistakes
Bad raw materials	Delivery of raw materials	Price fluctuation	Delay in payment of customer	Wrong declared product	Cultural differences	Wrong production practice
Quality variance	Cut off delivery	Climate change	Safety in payment	No docu-mentation	Distrust of partner	Sudden strikes
Ullage	Shipping risks	Currency fluctuation	Economic risks	No retrace-ability	Foreign supplier not known	Inattentive-ness of workers

7. Results

Which risks are now the non-acceptable risks in the food chains? Figure 3: Results for market dynamic risks3 shows one of the first results and demonstrates how the results are generated. The percentage of the risk entries in the dark grey area is compared with those in the middle grey area. For all sectors the risk "market dynamic risks" is the most important, as 65 percent of the risk entries are in the non-acceptable area. For further illustration we summed results up as
Table 3 demonstrates. To simplify orientation, non-acceptable risks are marked middle grey, acceptable risks light grey and risks with to little entries (less then ten percent of the sample) are dark grey. As a definition we stated, that a risk is non-acceptable, if more then 50 percent of the risk entries are in the middle grey of the risk map.

Table 3. Results for all sectors

All Levels + Sectors	**Border 37**	
Risk	**Base**	**%**
Market dynamic risks	79	65%
Supplier financial risks	29	52%
Product quality risks	50	48%
Relationship and information flow	65	48%
Logistic risks	70	47%
Political & regulatory risks	50	42%
Internal risks	22	32%
Sum of entries	**365**	

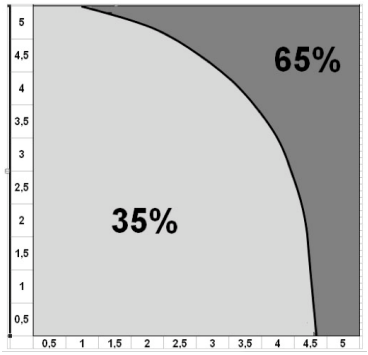

Figure 3. Results for market dynamic risks

The risk group "market dynamic risks" over all three levels (65 %) contains besides other reasons, market changes caused by supply and demand. Also a fluctuation in price, because of low production, scarcity of raw materials caused by environmental disasters, is a reason for market dynamic risks. Another main cause is the change in the currency exchange rate on the international currency market.

When looking at the sectors it is obvious that business leaders from different sectors evaluate their most important risks very differently. It is remarkable to note that within the grain sector no severe risk became apparent. But although all risks are under the border of 51 percent, "market dynamic risks" and "risks concerning relationship and information" flow were rated as important risks by the respondents. Concerning "market dynamic risks" price changes are an important factor for the interviewed firms – especially price fluctuations and increasing fuel prices. Also notable risks are crop failures and consequentially bad product quality.
Within the risk category "Relationship and information flow risks" catchwords like "unreliable suppliers", "misunderstandings in communication", "insufficient cooperation" etc. were mentioned.

When looking at the meat sector, the picture changes completely compared to the grain sector. For business leaders in the meat sector a number of risks were evaluated in terms of likelihood of occurrence and potential damage as non-acceptable risks. "Relationship and information flow risks" (79%) demonstrates the most important risk in the meat sector, besides "market dy-

namic risks" (73%), ""product quality risks (55%) and "logistic risks" (52%). The risk relationship and information flow is mainly caused by human mistakes.

Another risk displays the risk of information about the business partner, lack of information related to material and documentation. Information asymmetries result in misunderstandings in communication. Additionally, the infidelity and reliability of suppliers and customers constitute a further risk of relationship and information flow. The relationship and information flow is badly influenced by non-formal concluded contracts. The "market dynamic risks" are mainly influenced by demand and supply change in the world market, as mentioned before in the general results. The risk "product quality" depends on the quantity and quality of raw materials. Fierce competition among suppliers may cause bad product quality. An insufficient quality standard system of the supplier or a lack of hygiene and variations in temperatures influences the product quality. Besides the contamination of herbicides and pesticides, the wrong product specifications or ullage (shrinking of meat due to water in the meat) depicts a risk of product quality. The "logistic risks" are mainly influenced by transport and logistics problems. The variations of temperature in the cooling chain caused by driver mistakes or technical problems leads to the main logistics risks. Problems according to logistic risks are damages of the packing or/and the product. The outsourcing of the logistic system enforces logistics risks. Especially in the meat sector the transport of living animals is an important issue and depicts logistic risks.

Table 4. Results for each sector

All Levels + Sectors	grain		meat		fruit / veg.		Olive oil	
Risk	**Base**	**%**	**Base**	**%**	**Base**	**%**	**Base**	**%**
Market dynamic risks	26	50%	15	73%	23	65%	15	80%
Supplier financial risks	8	50%	7	57%	8	50%	6	50%
Product quality risks	18	28%	11	55%	13	77%	8	38%
Relationship and inf. flow	14	50%	14	79%	24	29%	13	46%
Logistic risks	19	37%	23	52%	21	52%	7	43%
Political & regulatory risks	12	8%	16	50%	15	60%	7	43%
Internal risks	7	43%	5	20%	2	100%	8	13%
Sum of entries	104		91		106		64	

As well the fruit and vegetable sector a number of risks are of great importance in the supply chain. The product quality is negatively influenced by the lack of knowledge in producing fruit and vegetables and poor grower management. The weather and natural conditions affect the quality and homogeneity of the products. A lack of supplier control or wrong production process demonstrates a risk for product quality. Ullage, the loss of water in fruit or vegetables is an indicator for product quality. The weather or accordingly the climate is one of the numerous "market dynamic risks". A lack of raw material and plant diseases depicts risks for the market and is related to the quality and quantity of the raw material. The saturation of the market and price changes at the world market concerning raw material, energy or oil have impact on the market dynamic risks. Another market dynamic risk depicts the cheaper production in developing countries like China and enforces the global competition. The "political and regulatory risks" at the fruit and vegetable sector presents the risks concerning commercial barriers, non-compliant contracts and law risks. The declarations or a part of documentation is missing and therefore the monitoring of risk traceability is failing. A lack of supplier control leads to a missing product safety. A change of grade of goods and wrongly declared products depicts risks in political and regulatory risks. Concerning the "logistic risks" in the fruit and vegetable sector the variation in temperature and the weather conditions are important for logistics. The longer

the distance from producer to port the higher the transport costs. In addition traffic jams and failure in the transport system cause logistic risks and delays and stock endings.

In the olive oil sector only one risk was evaluated as a non-acceptable risk. The currency fluctuation in the olive oil sector displays the principal "market dynamic risk". Weather conditions like draught or flood lead to bad crop quality and also demonstrate a market dynamic risk. The traditional business way in the olive oil sector is preferential and may cause market ignorance. The unorganized and large number of small-scale producers as well as weak supply and procurement management enforce economic instability.

Last but not least it should be mentioned, that the data was analyzed as well for the different levels of the supply chain with differences between levels obviously present. On the first level of production mainly "product quality risk" occurred (85 %), while on the second level of production this risk was not of significance. On the level of trade (retailers and wholesalers) only market dynamic risks occurred.

8. Discussion

The analysis of the above data followed a heuristic approach. A large variety of companies in nine different countries in different value chains were part of the assessment. To assess and measure risks for a whole supply chain is a challenging task, as supply chains are rather large and complex. Furthermore the data of the open questions of the qualitative assessment is rarely congruent and hard to analyze. Therefore the data here presented a combination of a risk classification (using especially the causes of risks) and the risk map from Hölscher et al. (2000) seem to be a very simple and feasible tool to assess and measure risks on a supply chain level. However, although the analysis demonstrated some interesting results, we recommend for further research to include the "likelihood to detect a risk, before damage happens" as a further variable to evaluate the risks.

It must also be mentioned that the risks assessed here are only a snapshot of the most important risks from the point of view of the interviewed persons in 2008. As most of the respondents worked in the purchase department of the companies, it is no wonder that market dynamic risks were the most important risks. Above all supply bottlenecks and price fluctuations occurred for several products in 2006 and 2007. It can be assumed, that due to the financial crisis, financial risks are getting more important for the companies.

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