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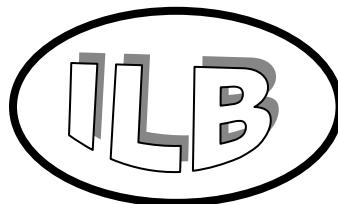
System Dynamics and Innovation in Food Networks 2009

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Agribusiness Firm Reactions to Regulations: The Case of Investments in Traceability Systems

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1. Introduction

Markets for agricultural and food products are characterized by high information asymmetries since producers, processors and retailers are in most cases much better informed about the quality of their products than consumers (Henson/Traill 1993). Often consumers are only at (prohibitively) high costs or not at all able to control important quality criterions such as food safety, nutritional value or region of origin. Such credence attributes can result in market failure due to a lack of credible information in the market (Akerlof 1970). As a result, attempts to protect consumers against food hazards, product adulteration and deception have gained much relevance in food supply chains (Deimel et al. 2008). Besides the more or less voluntary private certification schemes that have been established, large parts of the agrifood sector are already mandatorily regulated, especially in Europe. Therefore, in recent years, food law has been undergoing major changes in the European Union (EU) (Theuvsen/Hollmann-Hespos 2007; Haertel: 2007). General Food Law Regulation (EC) 178/2002 and the so-called EU hygiene package (Regulations (EC) 852/2004, 853/2004 and 854/2004) have strongly contributed to a much more intensive regulation of food production. The farm to fork approach laid down in Regulation (EC) 178/2002 has resulted in the obligation to secure “traceability of food [...] at all stages of production, processing and distribution” (Art. 18).

By now, it is a widely shared view that traceability and related concepts, such as trust and transparency, deserve more attention in agribusiness management (Fritz/Fischer 2007; Hanf/Hanf 2007; Deimel et al. 2008; Jansen/Vellema 2004). According to Hofstede (2003), effective information exchange is the key to improving value chain performance and competitiveness in today's complex and rapidly changing environments. Nevertheless, the implementation of traceability systems is controversially discussed, not only in theory but also and especially in practice. One of the most common complaints is that while regulations result in a huge bureaucratic workload, they offer little advantages for day-to-day operations in the agrifood sector (Schulze et al. 2008; Theuvsen 2005). As a consequence, many members of the food chain did not implement a traceability system voluntarily but have been forced to do so by mandatory regulations, whereas others decided to voluntarily invest in traceability systems that are much more capable than requested by legislation. While the number of in-depth analyses of trust, transparency and traceability in food systems is rising, it is still unclear what exactly determines firms' investments in traceability systems.

Against this background it seemed worthwhile to have a closer look at the investment behaviour regarding traceability systems in food supply chains. The study on hand accomplished this aim by means of empirical data from the German food industry and, as a result, provides in-depth insights into companies' investment behaviour with respect to tracking and tracing systems. The main objective of the study was to detect the investment behaviour of agribusiness companies in terms of introducing a traceability system. As other studies could show, we are confident that beyond legal commitments there are other incentives for enterprises to invest in traceability sys-

tems. These mainly comprise the use of traceability systems in internal risk-management, differentiation strategies and certifications processes. Therefore, it can be expected that despite legal obligations to meet minimum traceability requirements business investments in tracking and tracing systems vary quite substantially.

2. Drivers for Investments in Tracking and Tracing Systems in the Agribusiness

A literature review suggests that important drivers of investments in tracking and tracing systems are legislation, risk management strategies, the requirements of certification systems, improvements in internal and external business processes, differentiation strategies and stakeholder demands (Theuvsen/Hollmann-Hespos 2005a).

Within the EU, article 18 of Regulation EC/178/2002 is the most important legal driver of the improved traceability of food products. Article 18 requires the traceability of food at all stages of production, processing and distribution. Paragraphs 2 and 3 of the article lay down the so-called “one step up—one step down” principle. This means that food business operators must be able to identify any person from whom they have been supplied with a food or a food-producing animal. Furthermore, food business operators must also be able to identify the other businesses to which their products have been supplied. Article 18 mandates that business operators have adequate systems and procedures in place and make information available to competent public authorities on demand. Other legislation, such as Regulations EC/1829/2003 and 1830/2003 on GMO labeling or beef labeling laws, force at least parts of the agribusiness sector to improve the traceability of their products.

Public product recalls are a major threat to food manufacturers. In the short run, product recalls mainly result in fewer sales due to out-of-stocks and higher costs due to backhaul and disposal of defective products, additional laboratory analyses, ad hoc process improvements, compensation payments and crisis communication with supply chain partners and consumers. In the long run, attenuation of brand value, lower customer loyalty and a weaker competitive position may result from product recalls. Additional long-term costs can accompany brand repositioning, developing and implementing new competitive strategies, intensified consumer communication, business process redesign and additional quality control activities. Improved traceability as part of an advanced crisis management system can contribute to cost savings and avoidance of sales and profit losses (Doeg 2005).

In recent years certification systems have been widely introduced into the European agrifood sector (Theuvsen et al. 2007). Solely in Germany, about 40 different systems are used for auditing and certifying farms and firms in agriculture and the food industry (Theuvsen/Gawron/Plumeyer 2007). Nearly all these certification systems include more or less detailed specifications with regard to improved documentation and traceability (Newslow 2001). Since certification has become almost a prerequisite for supplying national retailers in many European countries, certification systems have turned out to be a major driver of investments in tracking and tracing systems.

Improving internal and external business processes through advanced tracking and tracing systems may be another motivation for firms to invest in the improved traceability of food products. A recent study financed by Wal-Mart showed that Radio Frequency Identification (RFID) systems—one of the most promising and rapidly developing tracking and tracing technologies (Clasen 2007)—were able to boost sales in retail stores by 3.4 percent due to their ability to eliminate all out of stocks (Hardgrave 2006). In a recent survey, German food manufacturers certified in accordance with the International Food Standard (IFS) reported positive effects on internal business processes, external logistics, the initiation of a continuous improvement process and improved quality motivation among employees (Gawron/Theuvsen 2007). Differentiation strategies that allow food manufacturers to escape price competition to a certain

degree (Porter 1980) can also be traced to improved tracking and tracing. This is most likely in businesses where firms deal with products, such as eggs, fresh meat and fish, that are subject to higher food safety risks (see, e.g., Luten/Oehlenschlaeger/Olafsdottir 2003). In these industries, customers and consumers may be willing to pay more for improved product safety resulting from more advanced tracking and tracing systems.

Last but not least, external stakeholders may force food manufacturers to improve traceability. Retailers with huge market power often threaten processors with delisting their products if they do not improve their tracking and tracing systems. Lenders, such as banks, may consider state-of-the-art tracking and tracing systems as a way to manage operational risks. This can influence a firm's capital costs due to the high emphasis the so-called Basel II directive places on operational risks. Nongovernmental organizations questioning supply sources, absence of GMOs or comprehensive quality controls may also motivate firms to improve their tracking and tracing systems.

This—presumably non-exhaustive—list of possible motives for investing in tracking and tracing systems raises the question whether they have the same relevance for all firms in the agrifood sector and whether it might be possible to differentiate between firms and cluster food manufacturers according to their prevalent motives and willingness for investments in tracking and tracing systems.

3. Research Framework

The focus of the conceptual framework is a behavioural research model. More precisely, the theoretical framework of the empirical study is the tracking and tracing investment model proposed by Theuvsen and Hollmann-Hespos (2005b). The model presented is based, firstly, on the theory of planned behaviour (Ajzen 1991) and, secondly, on the technology acceptance model (Venkatesh/Davis 2000) developed on the basis of the first-mentioned. The basic assumption of the model is that investment behaviour is influenced by the attitudes of decision makers, who may depend on cost-benefit evaluations and subjective perceptions of food manufacturers concerning the usefulness of tracking and tracing systems. Usefulness depends mainly on perceived external pressures, including those from powerful customers, image effects, relevance of available technology to firm management, demonstrability of results vis-à-vis, for instance, external stakeholders, and output quality, that is, the reliability and technical capabilities of the systems (Figure 1).

Empirical data was collected through a survey. The hypotheses derived from this model were presented to the respondents as statements. The respondents were asked to assess the statements on 7-point Likert scales (from +3, "I fully agree" to -3, "I fully disagree"). To take into account the aforementioned causal relations between the perception concerning the usefulness and the investment in a tracking and tracing system, our paper includes a partial least square model to analyse this particular context. The statistical analysis is accomplished by conducting uni-, bi-variate and multivariate statistics, whereupon, furthermore, cluster analysis is applied to group the companies in terms of their acceptance and investing behaviour concerning traceability systems.

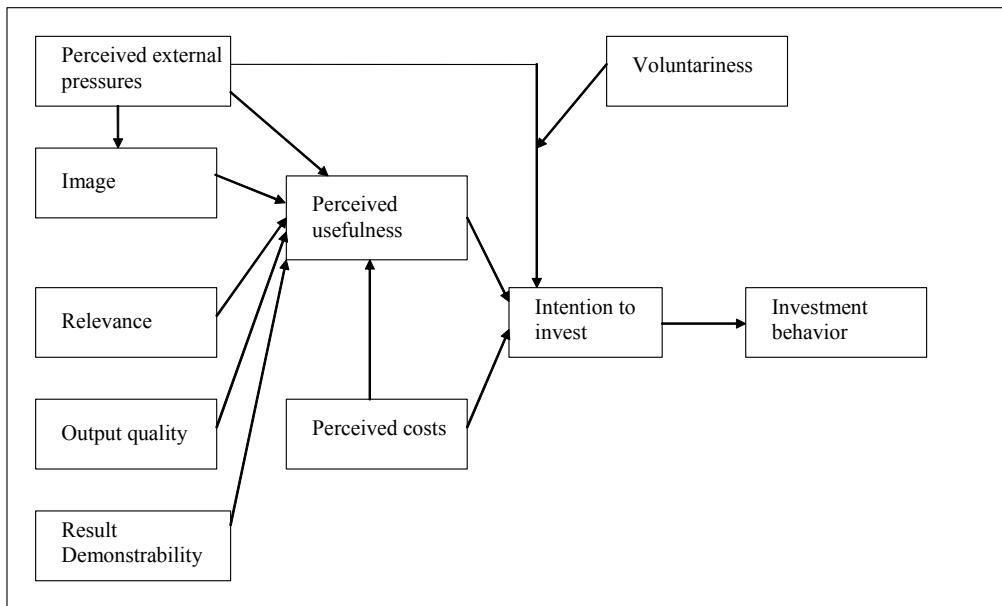


Figure 1. Tracking and Tracing Systems Investment Model (Theuvsen/Hollmann-Hespos 2005b)

4. Data collection

The analysis was conducted on the basis of data obtained from a sample of 234 food manufacturers in Germany. Between October 2005 and February 2006, about 2,800 firms were questioned via an online survey. 234 suitable questionnaires were returned (response rate about 8.6 %). The target group of the survey was the respective quality assurance manager or quality assurance staff.

The companies that participated in the survey represent more than fifteen different sub-sectors of the food-processing industry. The majority belongs to the following industries: meat products (incl. sausages) (23 %), beverages (12 %), deep-frozen food (12 %), sweets and snacks (12 %), fruits and vegetables (12 %), tinned food (12 %) and dairy products (11 %). It is noteworthy that the sample is predominantly characterized by medium-sized companies; two thirds of the companies realize turnovers between 5 and 250 million €. About 20 % have a turnover higher than 250 million €, only 15 % generate a turnover lower than 5 million €. Therefore, our sample reflects the general situation in the German food industry, which is characterized by many SMEs and few very large companies as well as by very diverse subsectors.

5. Results

Descriptive results for the internal variables provided initial impressions of companies' attitudes towards the traceability scheme. About three-fourth of the companies regard traceability as important and reasonable. This is a very positive evaluation compared to studies analysing the acceptance of, for instance, certification schemes (Fitzgerald et al. 1999; Böcker et al. 2003). As a second step, factor analysis was used to identify groups of inter-related variables and understand how they are related to one another (Abdi 2003). After minor modifications for double loading and nonloading items, the measures demonstrated acceptable levels of fit and reliability: The Kaiser Meyer Olkin measure of sampling adequacy showed satisfactory results (0.758). All in all, ten different statements entered the factor analysis and three factors were extracted (Table 1): "Improvement of processes", "stakeholder requirements" and "legal requirements".

The first factor—improvement of processes—summarizes statements that emphasize traceability as part of a firm's risk management strategy, the optimization of its internal and external business processes and the differentiation of food products through improved traceability within its competitive strategy. Obviously, these aspects correlate closely with one another. The second factor—stakeholder requirements—reflects the perceived external pressure from stakeholders, such as nongovernmental organizations, and society in general, represented, for instance, by the mass media. The third factor—legal requirements—summarizes the firms' perceptions of the legal framework with regard to food product traceability.

Besides these factors, a single statement (“Traceability is a precondition for successful certification.”) was used as a cluster variable. In the questionnaires this aspect was represented through that one single statement only, so that its inclusion in the factor analysis did not seem reasonable. Since correlations between this statement and the three factors identified are low, using it as a cluster variable does not create any technical problems.

Table 1. Rotated Factor Matrix (displays only values of 0.35 or more)

Statements	Factor1	Factor 2	Factor 3
Collaboration with our suppliers and customers has improved since implementing a tracking and tracing system.	.880		
The tracking and tracing system has allowed us to improve our internal processes.	.847		
The tracking and tracing system has reduced the risks of public product recalls.	.672		
Improved traceability is part of our advertising and marketing strategy.	.532		
Individuals/firms that are important to our company expect the implementation of tracking and tracing systems.		.846	
We want to meet the rising demands of consumers/ customers with our tracking and tracing system.		.742	
Traceability is perceived as a quality attribute in our industry.		.721	
Regulation (EC) 178/2002 has triggered a more intensive preoccupation with traceability issues.			.823
We have invested in tracking and tracing systems due to new legislation.		.427	.700
Even without new legislation, we would have invested in tracking and tracing systems (recoded).		-.412	.606

In the third step of our study, cluster analysis was applied to group the firms in our sample according to their dominant motives for investing (or not investing) in tracking and tracing systems. First, the single linkage method was applied to eliminate seven outliers from the sample. Then Ward's method was used to determine the optimal number of clusters. Since the elbow criterion did not show clear results, additional plausibility reasoning was undertaken to determine the optimal number of clusters. We came up with a five-cluster solution and, finally, ran a k-means analysis. In doing so, the mean values of the cluster variables were used as starting partitions.

Cluster 1: “Certified companies”: Cluster 1 comprises 36 companies that have implemented tracking and tracing systems mainly in order to successfully pass a third-party audit and get a required certificate (for instance, ISO 9001, BRC Global Standard or International Food Standard). Statements summarized by factor 1—risk management, process improvements and competitive strategies—are of minor relevance for these firms. Most of the companies in this cluster are small and specialized in producing retailer-owned brands. Producers of frozen foods, fish and beverages are frequent in this cluster. Only 15 percent of the respondents have ever

suffered a public product recall. The implementation of tracking and tracing systems has not advanced very far; the technological capacity of the systems implemented is considered rather low.

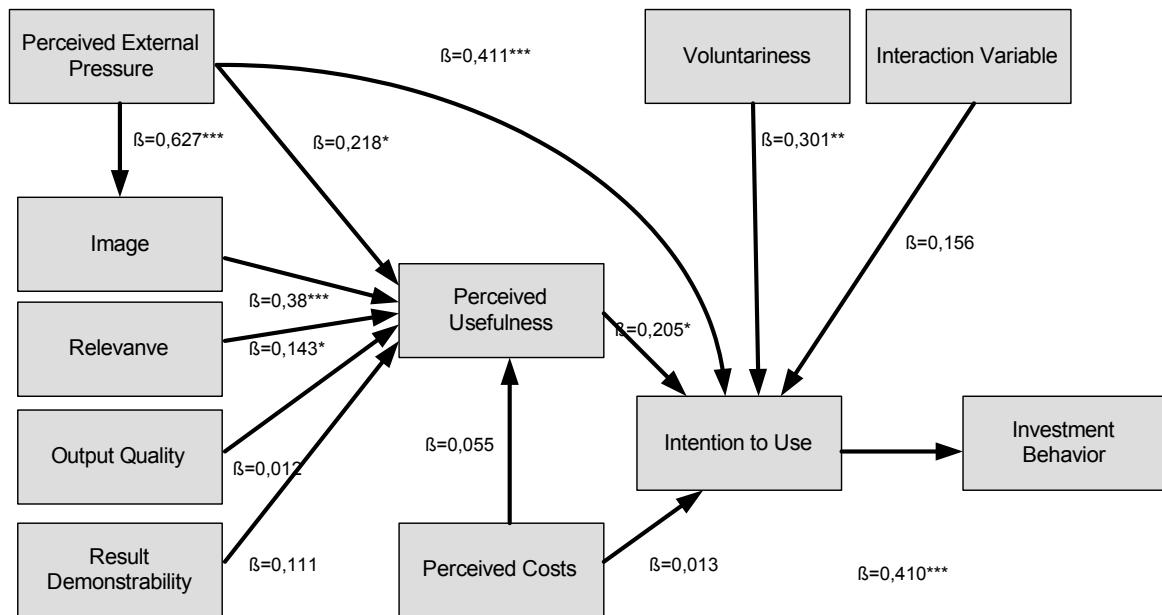
Cluster 2: “Disregardful firms”: The 28 companies in cluster 2 rank the relevance of traceability lowest in our sample and do not attribute high relevance to any of the statements in the questionnaire. Especially stakeholder requirements and legislation are perceived as not very important. The companies in this cluster are very different in size. It is noteworthy that as many as 40 percent of these respondents have already undergone one or more product recalls. Nevertheless, their tracking and tracing systems are not very advanced. Furthermore, a comparatively high percentage of these respondents do not want to implement a dedicated tracking and tracing system at all.

Cluster 3: “Lawful investors”: Twenty-seven respondents state legal and stakeholder requirements as their main motives for implementing tracking and tracing systems. Most of the firms in this cluster are comparatively small. Only 13.4 percent produce retailer-owned brands, which is the lowest percentage in our sample. The tracking and tracing systems used by these firms are characterized by an advanced development status.

Cluster 4: “Image-oriented firms”: In cluster 4 stakeholder requirements are the main reason tracking and tracing systems have been implemented. Improving traceability in order to meet the requirements of certification systems is also important. The firms in this group are of above-average size and often produce retailer-owned brands. The 60 companies in this cluster belong, for instance, to the fruits and vegetables and the dairy sectors. They attribute high benefits to improved traceability.

Cluster 5: “Versatile companies”: The 73 firms in this cluster reveal several important reasons for investing in tracking and tracing systems and consider improved traceability very important. The companies are very different in size and have only rarely suffered public product recalls. The tracking and tracing systems are advanced and the capacity of these systems is considered high.

The fourth issue of the analysis was to better understand causal dependencies between the variables of the tracking and tracing investment model introduced. Therefore, a partial-least-squares path modelling approach has been employed. After several reliability checks, regarding indicator-, construct- and discriminance-reliability (for instance, AVE – Average Variance Extracted; Fornell-Larcker-criteria) have shown satisfying results, we analysed the substantial explanatory contribution (β) for the variables of the tracking and tracing investment model.



($^{***} = p < 0.001$, $t\text{-value} > 3.340$; $^{**} = p < 0.01$, $t\text{-value} > 2.601$; $^* = p < 0.05$, $t\text{-value} > 1.972$)

Figure 2. PLS model

According to Cohen (1988), these values can be interpreted as follows: >0.35 strong effect; >0.15 moderate effect; >0.02 weak effect. In terms of presenting results of the partial-least squares analysis we concentrate on significant causal relations according to t-tests. Concerning the mandatory obligation (perceived external pressure) of implementing tracking and tracing systems, we could detect the following relations:

The higher the perceived external pressure is, the higher is the subjective image of tracking and tracing systems (0.627 ; $t\text{-value } 12.338^{***}$). A high perceived external pressure increases to a considerable degree also the intention to use tracking and tracing systems (0.411 ; $t\text{-value } 4.770^{***}$). Furthermore, a high perceived external pressure to implement a tracking and tracing system enhances the perceived usefulness of these systems (0.218 ; $t\text{-value } 2.545^*$).

With a path-coefficient of 0.38 ($t\text{-value } 4.948^{***}$), the image of tracking and tracing systems has a high positive influence on the perceived usefulness, and, the latter one is also influenced by the relevance of tracking and tracing systems (0.143 ; $t\text{-value } 2.051^*$).

Interesting results of the PLS-analysis could also be detected regarding the factors that influence the intention to use. As shown above, the intention to use tracking and tracing systems is higher if the use is obligatory (0.411 ; $t\text{-value } 4.770^{***}$), but if the use is regarded to be voluntarily many food manufacturers stated to intend to use tracking and tracing systems as well (0.301 ; $t\text{-value } 2.958^{**}$). Furthermore, the intention to use tracking and tracing systems relies, although to a minor degree, significantly on the perceived usefulness (0.205 ; $t\text{-value } 3.042^*$). Lastly, a positive intention to use has an explanatory contribution of 0.410 ($t\text{-value } 4.651^{***}$) on the factual investment behaviour.

6. Conclusions, Implications and Further Research

Although food manufacturers perceive traceability as a useful instrument to ensure product safety, their motivation to invest in a traceability system mainly stems from external pressure rather than an intrinsic sense of purpose. Nevertheless, differences can be detected regarding the sub-sectors and company sizes to which the food manufacturers surveyed belong.

From the data obtained, managerial implications as well as implications for regulators can be derived. From a managerial perspective, long-term oriented shaping of traceability systems using advanced instruments such as RFID can be brought to the minds of decision makers in the agribusiness. For policy makers who want to improve the field of food safety, alternative ideas to strengthen the investment intentions of firms in capable traceability systems can be derived from our study. Whilst external pressure via legal requirements in that context works mainly on SMEs, better communication of the additional benefits of traceability system can enhance positive attitudes towards investments in such schemes in larger companies.

Our contribution highlights a variety of theoretical starting points for the further development of technology acceptance models for food supply chains. Moreover, the study gives initial indications of the positive and negative effects of traceability schemes on the internal processes of food companies. For the long term success of food safety systems, satisfaction and positive motivation are important because a scheme which is recognized as a bureaucratic burden will not necessarily lead to food safety improvements.

Thanks to the comprehensive sample, the results of the study provide a good understanding of the major factors influencing the investment behaviour of companies concerning tracking and tracing schemes. However, this empirical study is limited to the analysis of investments in traceability systems in the German food industry. Future research studies should seek to contrast the data with the investment behaviour in countries with other food law regulations.

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