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

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ABSTRACT

The regulatory framework of food production has changed a lot in recent years. As a result, traceability of food products has become mandatory in the European Union, nonetheless leaving room for more advanced solutions. This study answers the question what exactly determines firms' investments in traceability systems by first developing a theoretical framework—the so-called Tracking and Tracing Systems Investment Model—and then analyzing empirical data from the German food industry that provide in-depth insights into companies' investment behaviour. Altogether, 234 companies representing more than fifteen different sub-sectors of the food-processing industry participated in an online survey. The results show that German food firms can be divided into four clusters based on their dominant motives for investing (or not investing) in traceability systems. Moreover, the results of a partial-least squares (PLS) analysis provide a good understanding of the major factors influencing the investment behaviour of companies concerning tracking and tracing systems.

Keywords: investment behaviour, traceability, tracking and tracing, agribusiness, food industry

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, Trail, 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 were forced to do so by mandatory regulations. At the same time, other companies have decided deliberately to invest in traceability systems that are much more comprehensive and effective than those required by legislation (Banterle, Stranieri, 2008).

Whereas the number of in-depth analyses of trust, transparency and traceability in food systems is rising, it is still unclear what exactly determines firms' willingness to invest in traceability systems and why the investment behaviour of agribusiness firms is so diverse despite an almost identical regulatory framework for food manufacturers. Against this background, it is the objective of this paper to contribute to a better understanding of investment behaviour regarding traceability systems in food supply chains. The study at hand seeks to answer this question by first developing a theoretical framework that provides a basis for in-depth insights into companies' investments in tracking and tracing systems and then analyzing empirical data from the German food industry.

As other studies could show, it can be assumed that beyond legal commitments there are other incentives for enterprises to invest in traceability systems. These mainly comprise the use of traceability systems as internal risk-management instruments, integral parts of differentiation strategies, tools for reorganizing vertical relationships in food supply chains and ways of meeting the demands of certification standards. Therefore, it can be expected that despite identical legal obligations to meet minimum traceability requirements, business investments in tracking and tracing systems vary quite substantially. More specifically, it can be assumed that firm-specific motivations that have hardly been analyzed so far strongly influence the investment decisions of food manufacturers.

The paper is organized as follows: the drivers for investments in tracking and tracing systems in the agribusiness are examined in chapter 2; the framework of our research is introduced in "Research framework"; the survey conducted and the methodological issues are examined in "Data and methods"; the results are analyzed in "Results" and concluding evidence is set out in "Conclusions, Managerial Implications and Further Research".

2 Drivers for investments in tracking and tracing systems in the agribusiness

This study is based on the assumption that there are various potential drivers of firms' investments into traceability systems. Besides mandatory, but often not very sophisticated traceability concepts, there are also voluntary traceability systems that provide a higher degree of information associated with a single product (Banterle, Stranieri 2008; Golan et al. 2004). This situation can result in very diverse motivations of food manufacturers to improve their tracking and tracing systems. As a basis for further analyses, a literature review has been undertaken to identify the major potential drivers for investments into tracking and tracing systems. Literature suggests that important drivers of investments into tracking and tracing systems are legislation, risk management strategies, the requirements of certification systems, improvements of 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.

With regard to risk management, 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 (Kumar, Budin, 2006). 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). Nearly all these certification systems include more or less detailed specifications with regard to improved documentation and traceability (Meuwissen et al., 2004; 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 (Bhuptani, Moradpour, 2005)—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 two recent surveys, German as well as European 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; Schulze et al., 2008).

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 et al., 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 that are able to decrease information asymmetries (Hobbs, 2004).

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.

Besides possible motives for investing into traceability systems, the international literature has also focussed on the effects the implementation of advanced tracking and tracing systems has, for instance on the reorganisation of vertical relationships in food supply chains (Menard, Valceschini, 2005; Banterle, Stranieri, 2009), consumer trust in food safety (de Jonge et al., 2008), or consumers' willingness to pay for improved food safety due to more advanced traceability of food products (Dickinson, Bailey, 2005; Hobbs et al., 2005). For an overview over the various facets of research with regard to traceability of food products, most of it being out of the scope of this study, i.e. motives for firm investments, see Trautman et al. (2008).

The 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. What is missing by now is an in-depth analysis of the determinants of investments based on a comprehensive model that allows the derivation of testable hypotheses as a basis for large-scale empirical research.

3 Research framework

The focus of the conceptual framework is a behavioural research model. In detail, the theoretical framework of the empirical study is the tracking and tracing systems investment model proposed by Theuvsen and Hollmann-Hespos (2005b). The model presented is based on both the theory of planned behaviour (Ajzen, 1991) and also on the technology acceptance model (Davis, 1989; Venkatesh, Davis, 2000) developed on the basis of the first-mentioned.

The theory of planned behaviour is rooted in the theory of reasoned action. The latter assumes "that human beings are usually quite rational and make systematic use of the information available to them", i.e. "that people consider the implications of their actions before they decide to engage or not engage in a

given behaviour". Thus, the theory of reasoned action "views a person's *intention* to perform (or not to perform) a behaviour as the immediate determinant of the action" (Ajzen, Fishbein, 1980, p. 5). The intention is a function of a person's attitude toward the behaviour, i.e. his or her positive or negative evaluation of performing the behaviour, and the person's perception of social pressures to perform or not to perform a behaviour. This second determinant is termed subjective norm. Besides attitudes and social norm, the theory of planned behaviour takes into account a third determinant of behaviour, i.e. perceived behavioural control. The latter factor represents the non-motivational factors which determine the ability to perform a behaviour such as requisite opportunities and resources (for instance, time, money, cooperation of others, skills; Ajzen, 1991).

The technology acceptance model is an extension of the theory of planned behavior and was mainly developed as a theoretical background for understanding decisions to use or not to use new information technologies such as graphics systems, email and editors (Davis, 1989). The model assumes that the decision how and when to use a technology is determined by the behavioural intentions of individuals to adopt this technology. The intention is determined by people's attitudes toward this technology. The attitudes are a determinant of "the degree to which a person believes that using a particular system would enhance … performance" (perceived usefulness) and "the degree to which a person believes that using a particular system would be free of effort" (perceived ease of use) (Davis, 1989, p. 320).

Both perceived usefulness and perceived ease of use are influenced by external factors. Venkatesh and Davis (2000) operationalize perceived usefulness by introducing two additional theoretical constructs into an extended version of the technology acceptance model (TAM 2): social influence processes (subjective norm, voluntariness, image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, perceived ease of use).

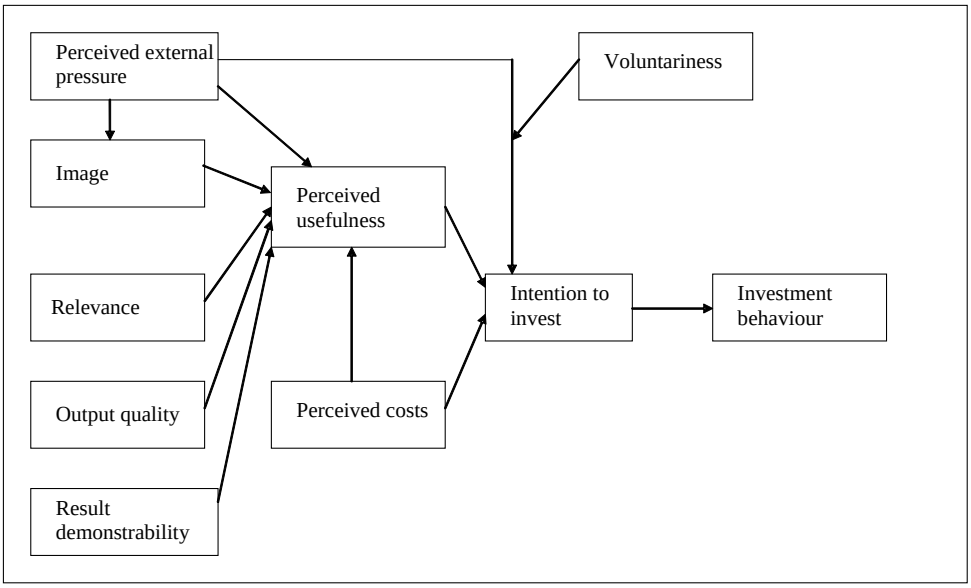


Figure 1.
Tracking and tracing systems investment model
Source: Theuvsen, Hollmann-Hespos, 2005b

This latter version of the technology acceptance model serves as a theoretical starting point for our analysis. For the analysis of firm investments in tracking and tracing technologies, the model needs further refinement. Usage behaviour, that is, the *explanandum* in the TAM 2, becomes investment behaviour in our model; and intention to use is replaced by intention to invest. Furthermore, perceived ease of use (which reflects the attempts of technology users to avoid personal costs, such as time investments) is replaced by perceived costs (which can be considered more relevant for managerial investment decisions) and subjective norm is replaced by perceived external pressures (since we do not take into account only social pressures). 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. The model mainly assumes positive relationships between independent and dependent variables; only perceived costs have a negative effect on perceived usefulness and intention to invest. The theoretical constructs are summarized in the Tracking and Tracing Systems Investment Model (Figure 1).

4 Data and methods

The model outlined above was translated into a questionnaire that was sent to 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. Due to a large number of surveys that are sent to companies every single day, the response rate can be considered satisfatory and reflects longer-term average in online surveys.

The companies that participated in the survey represent more than fifteen different sub-sectors of the food-processing industry. The majority belong to the following industries: meat products (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 small and medium-sized enterprises and a few very large companies as well as by very diverse sub-sectors. Nevertheless, overall the sample is a “convenience sample” (Fowler, 2002) and does not fulfil all the criteria of representativeness.

The hypotheses derived from the research framework 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.

In a pre-test, respondents revealed no difficulties with the questionnaire. For data analysis, firstly, SPSS 14.0 for Windows was used for conducting univariate and multivariate statistics. Furthermore, factor analysis was applied to identify groups of inter-related variables and understand how they are related to one another (Abdi, 2003) and cluster analysis was applied to group the companies in terms of their acceptance and investing behaviour concerning traceability systems. Next, the statistical analysis is accomplished by conducting a partial-least squares (PLS) analysis to take into account the causal relations within our tracking and tracing systems investment model using the statistical program SmartPLS version 2.0.M3, developed by the Institute of Operations Management and Organization of the University of Hamburg (Ringle et al., 2005).

5 Results

Descriptive results for the internal variables provided initial impressions of companies’ attitudes towards the traceability scheme. About three-fourths 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 for identifying groups of inter-related variables. 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). With regard to the research objective outlined above, each factor can be considered a group of closely related arguments for investing in traceability systems and, thus, can help to explain individual firm’s motivation to invest (or not to invest) into traceability systems.

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 this 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.

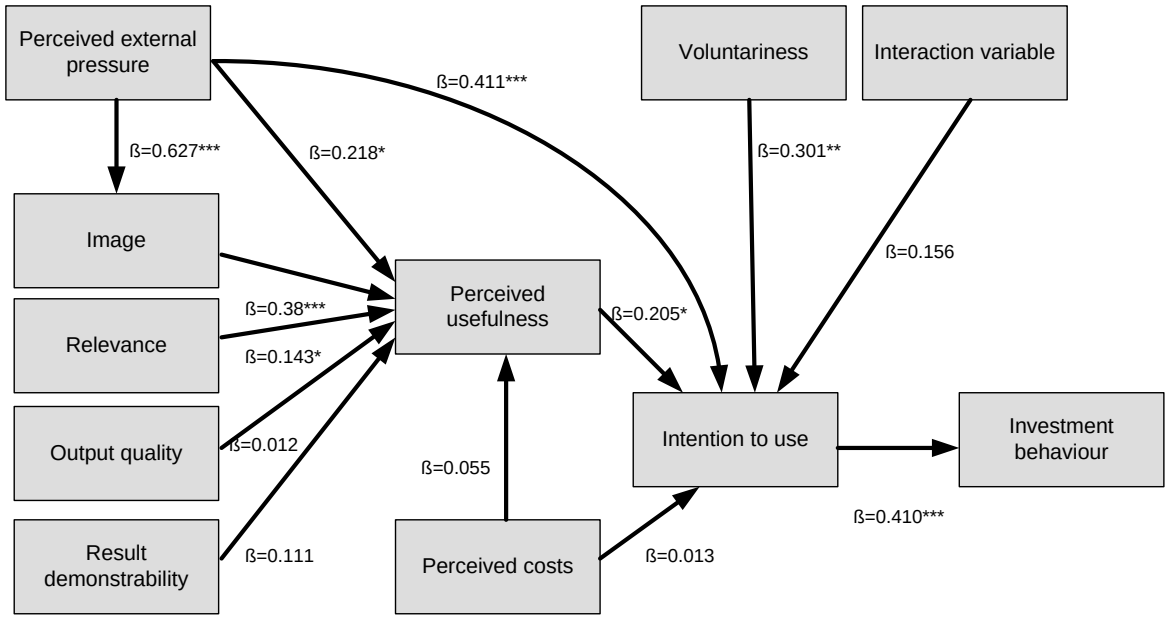
Cluster 3: "Lawful investors": Twenty-seven respondents state legal and stakeholder requirements as their main motives for implementing tracking and tracing systems. Most of the firms in this cluster are comparatively small. Only 13.4 percent produce retailer-owned brands, which is the lowest percentage 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 systems investment model introduced. Therefore, a partial-least-squares (PLS) path modelling approach was employed. After several reliability checks regarding indicator-, construct- and discriminance-reliability (for instance, AVE – Average Variance Extracted; Fornell-Larcker-criteria) showed satisfying results, we analysed the substantial explanatory contribution (ß) for the variables of the tracking and tracing systems investment model. All in all, the PLS analysis provides an empirical test of the theoretical model outlined above and provides new insights into the determinants of firms' investments into traceability systems.



(*** = p<0.001, t-value>3.340; ** = p<0.01, t-value>2.601; *=p<0.05, t-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 the subjective image of tracking and tracing systems (0.627; t-value 12.338***) will be. A high perceived external pressure increases to a considerable degree also the intention to use tracking and tracing systems (0.411; t-value 4.770***). Furthermore, a high perceived external pressure to implement a tracking and tracing system enhances the perceived usefulness of theses systems (0.218; t-value 2.545*).

With a path-coefficient of 0.38 (t-value 4.948***), the image of tracking and tracing systems has a high positive influence on the perceived usefulness, and, the latter is also influenced by the relevance of tracking and tracing systems (0.143; t-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-value 4.770***), but if the use is regarded as voluntary many food manufacturers stated an intention to use tracking and tracing systems as well (0.301; t-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-value 3.042*). Lastly, a positive intention to use has an explanatory contribution of 0.410 (t-value 4.651***) on the factual investment behaviour.

6 Conclusions, implications and further research

The paper has started with the observation that there are various reasons for investing in traceability systems, legal obligations being only one, and presumably not always the most important, among them. Therefore, there might be very diverse motivations for investing into traceability systems in the food industry. Our study reveals that, although food manufacturers perceive traceability as a useful instrument to ensure product safety, their motivation to invest into traceability systems 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. Furthermore, our results imply that there is not a “one size fits all” approach for designing traceability systems, Instead, the specific situation a firm is in, for instance the extent of external pressure and the structures of internal and external logistical processes, can have a strong influence on how much should be invested into traceability systems. This is very much in line with contingency theory that emphasizes that the management decision a firm makes must fit with the internal and external situation this firm is in in order to improve firm performance (Sin et al., 2003; Venkatraman, Prescott, 1990; Covin, Slevin, 1989).

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. While external pressure via legal requirements in that context works mainly on small and medium-sized enterprises, better communication of the additional benefits of traceability system can enhance positive attitudes towards investments in such schemes in larger companies. Furthermore, policy makers should also take into account firms’ motivations to invest into traceability systems. Guaranteeing compliance with new food law is easiest when the intentions of regulators are as good as possible aligned with firms’ intrinsic motivation.

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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