Do motivations affect different voluntary traceability schemes? An empirical analysis among food manufacturers

1. Introduction

The number of quality certifications adopted by food firms is growing constantly (Karapidis et al., 2009; Beatty, 2006). Such certifications are used to improve the quality and safety of products (Manning and Baines, 2004) and to enhance collaboration among supply chain partners. Indeed, they are considered as important firm strategic elements because they entail an efficient reorganization of chain relationships and enhanced food quality and safety management (Trienekens and Zuurbier, 2008). The other aims of these certifications are linked to the improvement of environmentally friendly and socially responsible practices. The feasibility of a certification is directly related to the adoption of specific traceability schemes capable of increasing and guaranteeing the transparency of the supply chain. Traceability, therefore, plays a crucial role because it represents a fundamental tool for certification adoption.

Nevertheless, there are different kinds of traceability schemes. In the EU, food traceability is mandatory. Regulation 178/2002 obliges all firms to trace suppliers, customers and the quantity of product exchanged. Such traceability is simple and entails a low level of transparency and precision (Charlebois et al., 2014). The EU requires more severe rules for the traceability of meat products through Regulations 1760/2000 and 1337/2013. This scheme entails the unique identification of goods and makes it possible to reconstruct the complete history of meat products. In between these mandatory rules, economic agents are also free to choose among a wide range of voluntary traceability schemes that can be adopted to guarantee both the safety and/or quality characteristics of food products. More precisely, voluntary traceability can refer to different levels of complexity, i.e., from simple rules to complex procedures.

The adoption of different certifications requires the implementation of specific traceability schemes. Nevertheless, there is a certain degree of freedom for firms in the choice of different levels of traceability complexity to implement certification requirements. More precisely, the choice of the level of traceability depends on a number of factors, such as the type of product category, the supply chain considered and the cost of implementation (Shamsuzzoha et al., 2013). Moreover, Karlsen et al. (2013) noted the relevance of a firm's strategy in its willingness to invest in different kinds of traceability. Following this consideration, certification represents a strategic choice of the firm that is linked to a set of motivations (Karlseasiolin, Donnelly and Olsen, 2011; Hooker and Caswell, 1999). Our hypothesis is that the level of the traceability complexity depends on the motivations that lead firms to adopt specific certifications (figure 1).

Many studies have revealed the presence of different motivations affecting firms' decision to implement quality certifications (Karipidis et al., 2009). To the best of our knowledge, no study has investigated the relations between the motivations for quality certification adoption and the level of voluntary traceability complexity adopted to fulfill the certification requirements. This paper aims to fill this knowledge gap through an analysis of the links between the motivations leading firms to adopt quality certifications and the kinds of voluntary traceability implemented to comply with such requirements. Specifically, our analysis focuses on the voluntary traceability implemented to accomplish certification requirements addressing environmental and social sustainability.

To reach our goal, we conducted a survey through an ad hoc questionnaire in 2015. The sample was composed of 131 firms. Structural equation modeling (SEM) with Partial Least Squares (PLS) was used to analyze the relationships between the motivations of sustainability certification adoption and the kind of traceability implemented.

PLEASE INSERT HERE 'FIGURE 1: MOTIVATIONS AND LEVEL OF TRACEABILITY COMPLEXITY'

2. Traceability and sustainability certifications

2.1. Food traceability definitions

Traceability refers to the ability to trace products (Karlsen et al., 2013). This concept has been largely adopted at a regulatory level to strengthen food safety after the occurrence of repeated food scandals. European legislation on food traceability is one of the most complete normative framework (Charlebois et al., 2014). Regulation 178/2002 introduced a mandatory traceability based on the principle of 'one step back'–'one step forward', which obliges food firms to be able to identify from whom a food product is supplied and to whom it is sold (Karlsen, Donnelly and Olsen, 2011). This regulation allows a degree of flexibility for business operators in the implementation of traceability schemes because it specifies the information to be traced without suggesting the way to comply. The meat sector has been regulated in a stricter way due to frequent safety scandals and frauds that have characterized this sector, such as the BSE scandal, the avian flu, and the recent horsemeat scandal. The mandatory Regulation 1760/2000 obliges operators to implement traceability able to identify the product flows within the bovine meat supply chain and within the firms' part. This kind of traceability allows us to reconstruct the complete history of meat products. This kind of traceability has been extended to most meat products by Regulation 1337/2013.

At an international level, it is also possible to find different definitions of traceability. The International Standard organization (ISO) in 1994 defined traceability as the '...ability to trace the history, application, or location of an entity by means of recorded identifications' (ISO, 1994). ISO-22005:2007 refers to traceability as the 'ability to follow the movement of a feed or food through specified stage(s) of production, processing and distribution'. In addition, the definition of traceability is highly debated in the literature. Opara and Mazaud (2001) describe it as 'the collection, documentation, maintenance, and application of information related to all processes in the supply chain in a manner that provides a guarantee to the consumer on the origin and life history of a product'. Tavernier (2004) describes traceability as a 'process that requires the documentation of information within the supply chain'. Bollen, Riden, and Opara (2006) define it as 'means by which the information is provided'. From these definitions, it is possible to identify some common key features. First, the aim of traceability is to record information flows within supply chains. Second, traceability refers to the systems that allow firms to identify the supply chain operators.

In the literature, traceability is also conceptualized on the basis of some dimensions that can help to explain the differences among existing schemes. Moe (1998) distinguishes two kinds of traceability: supply chain and internal traceability. The first one relates to the identification of the external links that connect the various sectors of the supply chain. The second type of traceability refers to the transparency inside a firm. Golan et al. (2004) introduced three different dimensions to identify differences among existing traceability schemes, i.e., the breadth, the depth, and the precision of traceability. The breadth refers to the amount of information traced, the depth refers to the sectors traced, and the precision is associated with the degree of assurance with which the traceability can pinpoint a particular product's movement or characteristics (Bosona and Gebresenbet, 2013; Ruiz-Garcia, Steinberger, and Rothmund, 2010).

In the European food sector, the minimum level of traceability breadth is that required by Regulation 178/2002. In addition to the mandatory information, food operators can choose to add voluntary information, such as information on harvests, processing methods, the scientific and commercial names of the species traced, and additional supplier details (Asioli, Boecker, and Canavari, 2014). The depth of traceability can range from internal traceability to the recording of all the sectors of the traced supply chain, i.e., the input sector, agriculture, the food industry and retailer. The precision of traceability refers to the dimension of the tracking unit used to implement traceability. The smaller the tracking unit, the higher the probability is of reconstructing the complete history of a single product within the supply chain and the lower the costs are in the case of food safety recalls. McEntire et al. (2010) introduced another dimension to describe traceability, i.e., the traceability speed. This relates to the effectiveness of traceability in transferring the information traced (Badia-Melis, Mishra, and Ruiz-García, 2015). In general, the higher the breadth, depth, precision and speed of traceability, the more complex the related implemented scheme is in terms of rules and procedures applied. On the other side, the lower the breadth, depth, precision and speed of traceability, the more flexible the traceability is because only a few rules and procedures are applied.

Complex traceability leads to high supply transparency, an improved ability to guarantee the truthfulness of information certified, and the possibility to prevent or manage food quality and safety failures (Golan et al., 2004). However, the adoption of complex traceability faces some barriers associated with the costs of its implementation and the difficulty of applying stringent rules to certain food products and to certain supply chains (Canavari et al., 2010a; Chiesa et al., 2011).

2.2 The motivations for sustainability certifications

Currently, food quality certifications are among the main drivers for the implementation of voluntary traceability (Heyder, Hollmann-Hespos, and Theuvsen, 2010). Thus, the decision of firms on the kinds of voluntary traceability to adopt to meet the requirements depends also on the motivations leading firms to adopt these certifications (Dabbene, Gay, and Tortia, 2014; Meuwissen et al., 2003). In the last few years, the proliferation of sustainability certifications with different requirements has increased globally (Castka and Corbett, 2014). Certifications addressing environmental and social sustainability have been widely introduced also into the European agri-food supply chains (Bush et al., 2013; Banterle, Cereda and Fritz, 2013).

Existing studies have identified different motivations for the implementation of sustainability certifications. Such incentives can be synthetized into the following groups: *i)* confidence-related motivations, *ii)* profitability-related motivations, *iii)* normative motivations, and *iv)* supply chain motivations.

The confidence-related motivations address drivers related to the strengthening of stakeholders' trust. They relate to food safety risk management (Spadoni et al., 2014; Chira, Chira, and Delian, 2012), food quality differentiation (Elham and Nabsiah, 2011), and the fostering of a positive corporate image (Jin and Zhou, 2011; Johnson, and Bruwer, 2007). Specifically, effective food safety management allows firms to improve their reputation towards suppliers and retailers (Pouliot and Sumner, 2013) and achieve higher consumer confidence due to the minimization of perceived risks (Frewer, de Jonge, and van Kleef, 2009). The certifications and labeling of product characteristics lead to an increased consumer confidence towards the quality of food. Different studies have demonstrated a positive association between food labeling and the improved quality perceived by consumers (Röhr et al., 2005). Moreover, growing interest in sustainability-related activities has been revealed among food firms. Corporate social responsibility activities are adopted to reduce the firm's reputation risks and to build trust among stakeholders (Fombrun, 2005).

Profitability-related motivations refer mostly to profitability incentives. The existing literature has highlighted several motivations related to the adoption of sustainability certifications, which are linked to the firm's willingness to improve its revenue generation, such as the reduction of product life cycle costs (Bursh and Lawrence, 2005), an increase in firms profits (Bhaskaran et al., 2006), and the possibility to apply higher product prices because of price premiums for sustainability-related product characteristics (Blomquist, Bartolino, and Waldo, 2015).

The normative motivations relate to the firm's willingness to comply with international standards and regulations (Fouayzi, Caswell, and Hooker, 2006). Herzfeld, Drescher and Grebitus (2011) divided these normative requirements into two different groups. The first one refers to rules imposed by governments on food imports, such as WTO rules. Compliance with such rules is necessary to access international markets. The second group entails private standards imposed by big retailers (McEachern and McClean, 2002). Specifically, these private standards are considered useful instruments to enable exchanges within global food value chains because of the standardized rules on production conditions (Chkanikova and Lehner, 2015). Retailers' standards have two main goals. First, they aim to guarantee the safety of food products (Trienekens, and Zuurbier, 2008). Moreover, they facilitate the differentiation of food quality (Fulponi, 2006).

Supply chain motivations address the efficiency of supply chain relationships. Deaton (2004) outlines that information related to food quality attributes is asymmetrically distributed within the supply chain. This situation leads to an increase of the probability of firms acting opportunistically during vertical exchanges. The increase of supply chain transparency (Wognum et al., 2011) and the better liability management among the supply chain partners (Chkanikova and Lehner, 2015) have shown to be drivers reducing transaction costs and strengthening the supply chain relationships.

To the best of our knowledge, the relationships between the motivations for the adoption of environmental- and social-related certifications and the level of voluntary traceability implemented have not yet been empirically explored. On the basis of the existing literature, we hypothesize the effects of the following motivations for sustainability certifications adoption on the level of traceability complexity (table 1): confidence-related motivations (H1), profitability-related motivations (H2), normative motivations (H3), and supply chain motivations (H4).

PLEASE INSERT HERE 'TABLE 1: HYPOTHESIS'

3. Methodology

3.1 Data collection

The hypotheses were tested on the Italian food processing firms adopting environmental- and social-related certifications. Given the difficulty of defining sustainability certifications, to construct our sample, we proceeded as follows. First, we selected certifications on the basis of the online platform Standard Map (Standardmaps.org). In 2015, this operational tool provided information on more than 200 sustainability certifications around the world. Second, we selected the sustainability certifications that were present in the Italian territory. Third, we considered only those certifications that were linked to an online dataset of certified firms. The above selection process led to the analysis of the following certifications: RSPO certification (Roundtable on Sustainable Palm Oil), Fair Trade, Friend of the Sea, BRC (British Retailing Consortium), and FSSC22000 (Food Safety System Certification Scheme). These certifications are extensively described in the next section.

For each certification selected, we downloaded the list of the firms certified. In total, 2,600 firms were listed. 35% of the firms were excluded because of non-response due to unobtainable telephone numbers or non-response after the 2nd call. Before interviewing started, firms were asked to declare if they already adopted voluntary traceability, apart from that implemented for the investigated certification. If the answer was affirmative, firms were excluded from the survey. Due to the lack of firms' participation availability (refusal rate of 33%), the final sample was composed of 131 firms.

The survey was based on telephone questionnaires with closed questions (5-point Likert scale, ranging from 1-totally disagree to 5-totally agree, except for one variable). At the beginning of the survey, interviewed were asked to refer to the main firm product, which was regulated by the quality schemes under investigation. The interview was approximately 20 minutes long. The survey was conducted from January to June 2015. Before the survey, we conducted a pilot test on 10 certified firms to verify the level of understanding of the questions asked and to capture the suggestions of firm managers on additional relevant motivations to be considered in the survey. Those interviewed were managers in charge of the management of sustainability certifications applied by the firms.

3.2 Description of certifications selected

The analysis concentrates on environmental and social food-related certifications. The environmental aspects of certifications address activities that focus on the protection of the environment, i.e., the efficient management of natural resources, effective energy use in food processing, the reduction of food waste, and the minimization of environmental costs linked to the transport of agri-food products (Gilbert, Rasche, and Waddock, 2011). The social aspects of food schemes refer to the maintenance of food safety and quality, the provision of equal opportunities for workers, and the adoption of supply chain practices that safeguard the conditions of small producers and their survival in the market (Pullman, Maloni, and Carter, 2009).

These certification schemes are characterized by different requirements in terms of the information traced. However, most of the existing sustainability certifications do not specify the level of traceability complexity firms should adopt to comply with certifications requirements. Firms are free to choose among different levels of traceability complexity to achieve the certification rules on the basis of the following factors: existing traceability already implemented in the firms, the strategic orientation towards certifications adoption, the costs of traceability implementation, the type of products considered, the firms characteristics and the stage of the supply chain involved (Asioli, Boecker, and Canavari, 2014).

Among the certifications selected, *RSPO* is a multi-stakeholder initiative that brings together growers, processors, traders, manufacturers, financial investors, retailers, and environmental and social NGOs. The aim of this certification is to regulate the cultivation of palm oil by creating rules and principles related to environmental responsibility, the conservation of natural resources and the responsible consideration of employees and of communities (Rival et al., 2016). With regard to the traceability breadth, the certification requires tracing the following information: the use of chemical inputs, soil utilization, water management, the safeguarding of human rights and local communities, and working conditions. The certification does not give precise details on the other traceability dimensions. The certification states that firms have to map supply chain stakeholders at a minimum. Thus, certified firms are free to choose the level of traceability complexity on the basis of their own motivations.

Fair Trade aims to improve the living conditions of workers in developing countries (Dragusanu, Giovannucci, and Nunn, 2014). Specifically, the certification requirements aim to guarantee a minimum price for producers and enhance contract stability. The information to be monitored relates to working conditions, the use of child labor in agricultural production and the non-use of chemicals and GMOs in agricultural production (Raynolds, Murray, and Heller, 2007).

Friend of the Sea certification includes criteria for sustainable aquaculture. It comprises parameters on safeguarding biodiversity and reducing the impact of fishing activities on critical habitats (McClenachan, Dissanayake, and Chen, 2016). The information to be traced relates mostly to fish farming and capture methods. Specifically, the certification requires the adoption of selective fishing methods that do not impact the seabed and the avoidance of the use of hormones in aquaculture activities (friendofthesea.org).

BRC was introduced by retailers to standardize the rules for suppliers with regard to food safety and quality (Halkier and Holm, 2006). This certification also introduces rules related to environmental and social sustainability. The environmental aspects relate to the reduced use of chemicals in production processes and to efficient waste and water management within the food supply chain. The social aspects of this certification are based on respect for work conditions with regard to labor rights and work safety issues. The certification suggests the implementation of HACCP and a quality management system. Moreover, it requires the establishment of a traceability scheme able to manage recall events, but it does not specify the complexity of the traceability to implement (Lombardi et al, 2011).

FSSC22000 is an initiative promoted by the world's leading food safety experts from retail, manufacturing and food service companies, as well as international organizations, governments, academia and service providers to the global food chain. The aim of the certification is to strengthen supply chain relationships through better safety management (Condrea et al., 2015). The certification entails criteria on environmental and social sustainability, i.e., on waste management, water quality, energy use, human rights and working conditions (Soares, Martins, and Vicente, 2016). The certification suggests that the implementation of HACCP and a quality management system. In terms of traceability dimensions, the certification explicitly requires the establishment of a system able to trace inputs and information related to animal feeding and welfare (Standardmap.org). There is no clear imposition on the level of traceability complexity to adopt.

3.3 Measurement model

Our questionnaire was based on a multiple choice format with a rating scale. We used a 5-point Likert scale to quantity firms' perceptions on the motivations of implementing sustainability certifications and the levels of traceability complexity adopted (table 2). Interviewees were asked to express a judgment by declaring their level of agreement (from a minimum of 1 and a maximum of 5) with the statements described below. Only in one case (that is TRAC1) the scale assumed a different meaning.

To measure the level of traceability complexity, we used four variables aimed at capturing the dimensions identified by Golan et al. (2004) and McEntire et al. (2010). Specifically, the depth (TRAC1) was measured by asking interviewees which sectors were covered by voluntary traceability (where 1 is only the food industry; 2 is the food industry and agricultural sector (only harvest/breeding or cultivation/farming); 3 corresponds to the food industry and agricultural sector (harvest/breeding and cultivation/farming); 4 is the food industry, the agricultural sector and agricultural inputs; and 5 is agricultural inputs, agriculture, the food industry, and retailing. The precision of the traceability scheme (TRAC2) was measured by investigating the reduction of the size of product recall after the adoption of voluntary traceability (level of agreement from a minimum of 1 and a maximum of 5). The speed of information (TRAC3) was measured by asking about the increase in the speed of information exchanged within the food supply chain (level of agreement from a minimum of 1 to a maximum of 5). The breadth of voluntary traceability (TRAC4) was measured by asking about the increase of information traced within the supply chain after the introduction of voluntary traceability (level of agreement from a minimum of 1 to a maximum of 5).

The confidence-related motivations were measured by investigating the drivers identified in the literature, i.e., better food safety risk management (M1), the diversification of food quality characteristics (M2), and the strengthening of reputation towards retailers (M3) and towards consumers (M4).

Profitability-related motivations were investigated through the following incentives: the increase in firm profit (F1), the improvement of firms' value added (F2), the increase of the final price of the product (F3), and the enhancement of firm efficiency (F4).

The normative motivations were measured by three statements. The first one investigates the compliance with retailer private certification (REG1). The second regards the willingness of the firms to comply with future normative requirements (REG2). The third variable investigates the role of international public regulation on certification implementation (REG3).

The supply chain motivations investigate if a better distribution of liabilities among the agents of the supply chain (SUPPLY1) and an increase in supply chain transparency (SUPPLY2) are important motivations for adopting sustainability certifications.

PLEASE INSERT HERE 'TABLE 2: PROPOSED ITEM MEASURES'

3.4 Model specification

To test the hypotheses, we employed SEM. This technique is usefully to test theoretically supported linear and additive causal models (Henseler, Ringle, and Sinkovics, 2009).

The structural equation includes two sub models: the inner model, which is the relations between dependent and independent latent variables, and the outer model, which is the relations between latent variable and their indicators.

There are different approaches to SEM. In this study, we used the Partial Least Squares (PLS-SEM) (Wold, 1985; Lohmöller, 1989). In this approach, the explained variance of the endogenous latent variables is maximized by estimating partial model relationships in an iterative sequence of OLS regressions (Hair et al., 2014). The PLS-SEM represents an effective alternative to the covariance structure estimation procedures that used LISREL (Linear Structural Relationships).

The advantages of PLS-SEM are related to the following aspects. First, PLS-SEM does not imply assumptions on data distribution. Second, it works well also with small samples. Third, it can be used for exploratory research, whereas covariance-based SEM is mostly used for confirmatory analysis. Fourth, PLS-SEM supports constructs with single items or few items, compared to covariance-based SEM, which supports constructs with at least three items. Fifth, PLS-SEM supports datasets with missing values, whereas covariance-based SEM needs to address missing values before the analysis. Finally, PLS-SEM supports both reflective and formative constructs. In contrast, the covariance-based SEM supports only reflective constructs (Hair, et al., 2014). In the PLS-SEM, the model's choice depends on theoretical reasons (Diamantopulos and Winklhofer, 2001).

In our study, the relationships between latent variables and indicators were defined by using reflective measure specification. In a reflective model, the latent construct exists independently of the measure, and any change in the latent variable does not imply a uniform change in probabilities across the indicators. Each manifest variable is assumed to be generated as a linear function of its latent variable and its residual (Henseler, Ringle, and Sinkovics, 2009). The outer relations depend on the predictor's specification, and they assume that no correlations exist between outer residuals and the latent variable of the same block.

To estimate the significance of the path coefficients and the item loadings, PLS-SEM relies on a nonparametric bootstrap procedure (Davison and Hinkley, 1997), which allows us to test the significance of the paths. The explanatory power of the model is tested by examining the sign, size, and statistical significance of the path coefficients between constructs (Staples, Hulland, and Higgins, 2006). The predictive capacity of a PLS model can also be assessed by examining the variance explained (e.g., R2) in the dependent or endogenous constructs.

The analysis was conducted using Smart PLS 2.0 software (http://www.smartpls.de/). The algorithm for missing value imputation was the mean replacement. To assess the indicator reliability, the loadings of all the PLS analysis reflective indicators were examined.

4. Results

The firms are located throughout Italy, with higher concentrations in Emilia-Romagna, Lombardy, Tuscany and Veneto. Among the 131 food processing firms, 81 are small enterprises (61.8%) with less than 50 employees, 32 (24.4%) are medium size firms, and 18 (13.8%) are big firms with more than 250 employees. Such asymmetry in firm size is in line with the average dimension of the Italian food processing firms, where big and micro firms coexist together in the market. According to the most recent census of the Italian industry and services in 2011 (Istat, 2011), there were approximately 55,000 food processing firms and 98.6% of such firms were of small dimensions. In our sample, the number of medium and big firms is more representative, because it is more difficult for small firms to adopt certifications. Thus, this distribution is probably linked to the purpose of the analysis. In addition, the distribution of the different sectors seems to be affected by the aim of the survey. 88% of the sample is represented by 7 sectors: fruit and vegetable (28%), wine (18%), confectionery (12%), backed products (11%), processed seafood (9%), processed meat (5%) and dairy (5%). The sample shows an over representation of the fruit and vegetable and wine sectors with respect to the Italian situation. In contrast, the bakery sector is under represented. This is because the need for certification is stronger for certain kinds of food products, such as perishable food. Indeed, safety and quality management for these products is more difficult and requires standardized rules.

With respect to the number of firms interviewed for each certification, 74.8% of the sample is composed of processing firms with B2B sustainability certifications, i.e., FSSC 22000 (32.1%), BRC (29.8%), and RSPO (13.0%). 25.2% is represented by B2C sustainability certifications, i.e., Fair Trade (17.6%) and Friend of the Sea (7.6%) (table 3).

PLEASE INSERT HERE 'TABLE 3: PROFILE OF COMPANIES THAT PARTICIPATED IN THE SURVEY'

4.1 Checking Reliability and Validity

Before performing the structural model, we verified the reliability and the validity of the measurement model.

To check the reliability, we analyzed the outer loadings and the reliability numbers. The outer loadings measure how the indicators chosen act for the underlying latent variable. Acceptable values for these indicators are 0.7 or higher (table 4). For the measurement of the internal consistency, the Composite Reliability was used. This value assesses the inter-item consistency, which should also be higher than 0.7. To test the internal consistency of the measurement scales, we used Cronbach's alpha. The minimum cut-off score recommended is 0.7 (Henseler, Ringle, and Sinkovics, 2009). As shown in table 5, all values of Cronbach's alpha are higher than 0.8.

The construct validity was checked by assessing the convergent validity and the discriminant validity (Ping, 2004). The Average Variance Extracted (AVE) identifies the percentage of variance explained by each factor and it is applied for each latent construct. The value must be greater than 0.5. In our analysis, all measures ranged from 0.68-0.89, and they confirmed the convergent validity.

PLEASE INSERT HERE 'TABLE 4: OUTER LOADINGS'

PLEASE INSERT HERE 'TABLE 5: QUALITY CRITERIA'

For the discriminant validity, two measures have been employed, i.e., the square root of AVE and the correlation of latent constructs. The correlation values for each construct should be lower than the square root of AVE to obtain validity in the measurement model (table 6) (Afthanorhan, and Ahmad, 2013). In addition, the Variance Inflation Factor (VIF) coefficients were verified to exclude multicollinearity. None of the values of VIF exceeded the recommended threshold, demonstrating that multicollinearity is not an issue in the analysis.

Henseler et al. (2014) introduced the Standardized Root Mean Square Residual (SRMR) as a goodness of fit measure for PLS-SEM, which can be used to avoid model misspecification. A value of less than 0.10 or 0.08 is considered a good fit (Hu and Bentler, 1998). In our case, the value was 0.075.

PLEASE INSERT HERE 'TABLE 6: MEASUREMENT MODEL RESULTS'

4.2 Model testing and discussion

We tested the hypothesized model using a step-by-step procedure that gradually eliminated the less significant links, and we ran the model to re-estimate its parameters until the estimates converged into the final model. The path coefficients represent standardized regression coefficients that connect latent variables, and they quantify the direct impact of each explanatory variable (figure 2).
The results confirmed H1, highlighting that confidence-related motivations can affect the level of traceability complexity. Indeed, the higher the probability is of adopting sustainability certifications for the enhancement of stakeholder confidence, the higher the probability is of implementing a higher level of traceability complexity (0.311, t=5.166). This is in line with the findings of Pouliot and Sumner (2013), who show that increased traceability protects the reputation of food firms by reducing the size of recalls and thus increasing the trust of economic agents towards a certain firm. Moreover, the positive relationship established for H1 highlights that when firms aim at efficiently managing food safety and quality, they will adopt complex traceability (table 7). Such results suggest that the guarantee of food safety and quality is considered as a strategic issue, probably because of possible market consequences in the case of product non-compliance. Thus, firms prefer to invest in complex traceability to maintain consumer trust and their product market share. This result is in line with the literature, which highlights a positive link between food safety management and the adoption of complex traceability (Folinas, Manikas, and Manos, 2006; Galliano and Orozco, 2011).
In addition, H2 is confirmed in our analysis. Specifically, the model highlights a negative and significant relationship between profitability-related motivations and the level of traceability complexity implemented (-0.544, t=7.239). This is probably because when firms adopt sustainability certifications to save production costs or to reach specific marketing objectives, such as the increase of profit or the augmentation of the product final price, their willingness to invest in complex and expensive traceability will not be in line with their main motivations. For example, if the aim of the firm is to increase the product price with the adoption of sustainability certifications, the firm will prefer to invest in activities that produce market recognition for the certified product, instead of implementing costly traceability. This is probably because consumers see traceability as a useful tool to achieve certain goals (e.g., food safety, control of the origin) in terms of quality and they are possibly willing to pay for the quality attribute they want but not for the tool. Traceability is typically a tool that makes it possible to provide something given for granted and is not part of communication to consumers, because it is mandatory at a basic level, even if it makes information management possible; therefore it can contribute to added value (Hobbs, 2004; Spadoni et al., 2012; Canavari et al., 2010b).
In this case, firms will prefer to invest, for example, in the promotion of labeling initiatives and brand image upgrading, instead of investing in supply chain transparency and related complex traceability. Moreover, if the motivation of food firms relates to production costs management, they will probably implement internal traceability without improving the transparency of supply chain relationships through a high level of traceability breadth, depth and precision (Moe, 1998).
H3 is not confirmed in our model. H4 is confirmed. The results show a positive relationship between supply chain motivations and the level of traceability complexity implemented (0.251,

t=5.622). These findings suggest that when firms implement certifications to foster supply chain efficiency, the traceability that they will implement has a high level of complexity. Indeed, when firms want to reduce unfair practices and opportunistic behavior of economic agents, they will adopt certifications aimed at efficiently managing these events through complex traceability rules (Trienekens et al., 2012).

This result also suggests that when firms are looking for more efficient food supply chain co-ordination, they will prefer a complex level of traceability. Thus, the more complex the traceability is in terms of rules and procedures introduced, the higher the level of positive changes will be in the co-ordination of vertical relationships (Hartmann, Frohberg, and Fischer, 2010). This research finding is aligned with the literature that considers quality and safety certifications as alternative forms of transaction governance, whose aim is to introduce rules to better organize vertical relationships (Canavari et al., 2010a).

The variable 'employees' is significant and negative (-0.103, t=3.047), highlighting that small firms are more likely to implement a high level of traceability complexity. This supports the idea that firms of small dimensions and with a low bargaining power within the supply chain tend to adopt rules and procedures able to protect them from the opportunistic behavior of economic agents. Complex traceability implies a higher transparency and, thus, a higher probability of conducting transactions fairly and defending firm reputation towards retailers and consumers. This is in accordance with Beatty (2006), who stressed that the implementation of schemes for food safety and quality management are useful instruments for small food producers to compete on the market. Even if these kinds of certifications are costly (Aggelogiannopoulos, Drossinos, and Athanasopoulos, 2007), small firms tend to adopt them to increase their adaptability to the changing business environment (Banterle et al., 2014).

PLEASE INSERT HERE 'TABLE 7: TOTAL EFFECTS'

PLEASE INSERT HERE 'FIGURE 2: PATH MODEL'

5. Concluding remarks

Most of the existing voluntary traceability schemes aim at managing the information required by the quality certifications. This paper investigates if the motivations related to sustainability certification adoption have an influence on the level of traceability complexity that firms decide to implement. The hypotheses are tested through an SEM with PLS approach on a sample of 131 firms.

The results show that most of the motivations related to the adoption of sustainability certifications are statistically linked to the level of traceability complexity implemented. Such findings add to the existing literature on the theoretical developments of food traceability. According to Karlsen et al. (2013), there is still little understanding of the determinants leading firms to choose among different kinds of traceability. This analysis revels that motivations for sustainability certifications are among the determinants that guide firms to decide the traceability to adopt. More precisely, confidence-related and supply chain motivations are positively related to the level of traceability complexity, whereas profitability-related motivations are negatively associated.

Moreover, the paper adds to the existing knowledge by giving some insights on the reasons behind the effectiveness of traceability in terms of improved supply chain efficiency. Some studies showed a positive effect of implementation on vertical relationship efficiency due to the increase of transaction transparency (Mol, 2015; Trienekens et al., 2012). Other studies did not reveal this association (Fischer et al., 2010). The empirical analysis shows that traceability can be considered an effective tool for improving the functioning of supply chain transactions when its implementation is guided by confidence-related or supply chain motivations. Indeed, in these cases, the adoption of a complex scheme of traceability leads to a higher level of transparency along the supply chain. In contrast, if traceability is guided by profitability incentives, such as the minimization of production costs or an increase of the product price, no effects on the efficiency of supply chain exchanges are revealed. These results add to the findings of Manning and Baines (2004) by highlighting the reasons behind the presence of differences in the effectiveness of quality certifications.

The paper also has practical implications. Specifically, it suggests the presence of two different firm strategies when implementing voluntary traceability. On the one hand, if the firm wants to increase its financial performance with the adoption of quality certifications, the traceability to implement will have a low level of complexity and will produce small supply chain reorganization. A simple traceability will allow the firm to adapt to changing market conditions and to modify firm marketing objectives to maintain firm profitability. On the other hand, if the adoption of a sustainability certification relates to the achievement of a more integrated supply chain, firms will implement complex traceability, which implies a reorganization of supply chain relationships and activities. In this case, firms will implement traceability capable of enhancing the information, safety and quality management within the food supply chain.

This study presents some limitations. First, the analysis conducted does not take into consideration the interaction effects of different motivations on the kind of traceability to adopt. Second, the analysis refers to only some of the existing sustainability certifications because we focused on those that are widespread in Italy. This selection limits the generalizability of results. The analysis needs to be confirmed on a greater number of certifications. For this reason, future research will extend the survey to a greater number of certifications and countries. Furthermore, dedicated methods can be employed to study the interactions among motivations in the decision made on the kinds of voluntary traceability to adopt. Finally, the future availability of more comprehensive datasets providing panel data could enhance our understanding of the dynamics between firms' strategic motivations and traceability schemes.

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Table 1: Hypotheses

H1	Confidence-related motivations can affect the level of traceability complexity
H2	Profitability-related motivations can affect the level of traceability complexity
H3	Normative motivations can affect the level of traceability complexity
H4	Supply chain motivations can affect the level of traceability complexity

Table 2: Proposed item measures

Dimension	Item	Item description	Mean	SD	Min	Max
Level of traceability	TRAC1	Sectors traced	2.56	1.52	1	5
	TRAC2	Size of product recall	2.73	1.44	1	5
	TRAC3	Speed of information traced	2.66	1.37	1	5
	TRAC4	Information traced	2.72	1.43	1	5
Confidence-related motivations	M1	Food safety risk management	2.61	1.48	1	5
	M2	Food quality characteristics	2.74	1.23	1	5
	M3	Reputation toward retailers	2.98	1.39	1	5
	M4	Reputation towards consumers	2.78	1.39	1	5
Profitability-related motivations	F1	Firm profit	3.03	1.47	1	5
	F2	Firm value added	3.16	1.44	1	5
	F3	Price of final product	2.79	1.53	1	5
	F4	Firm efficiency	2.68	1.39	1	5
Normative motivations	REG1	Compliance with retailers standard	3.18	1.68	1	5
	REG2	Future normative requirements	2.62	1.53	1	5
	REG3	International public regulation	2.69	1.55	1	5
Supply chain motivations	SUPPLY1	Liability among supply chain agents	3.32	1.37	1	5
	SUPPLY2	Supply chain transparency	3.22	1.31	1	5

Table 3: Profile of companies that participated in the survey

	Number of firms	Percentage		Number of firms	Percentage
Certifications			**Turnover (mio euro)**		
FSSC 22000	42	32.06	<1	11	8.40
Fair Trade	23	17.56	1-2	25	19.08
BRC	39	29.77	2-5	21	16.03
RSPO	17	12.98	5-9	18	13.74
Friend of the sea	10	7.63	10-20	26	19.85
Sectors			20-50	13	9.92
Fruit and vegetable	37	28.24	50-200	14	10.69
Wine	23	17.56	>200 mio euro	3	2.29
Sugar and confectionery	16	12.21	**N. employees**		
Bakery	15	11.45	<5	11	8.40
Processed sea food	12	9.16	5-10	23	17.56
Processed meat	6	4.58	10-20	19	14.50
Dairy	6	4.58	20-50	28	21.37
Coffee	5	3.82	50-100	22	16.79
Canned food	3	2.29	100-250	10	7.63
Other sectors	8	6.11	>250	18	13.74

Table 4: Outer loadings

	Level of traceability	Confidence-related motivations	Profitability-related motivations	Normative motivations	Supply chain motivations
TRAC1	0.980				
TRAC2	0.942				
TRAC3	0.931				
TRAC4	0.937				
M1		0.872			
M2		0.853			
M3		0.867			
M4		0.819			
F1			0.877		
F2			0.744		
F3			0.881		
F4			0.810		
REG1				0.917	
REG2				0.899	
REG3				0.916	
SUPPLY1					0.873
SUPPLY2					0.947

Table 5: Quality criteria

	Composite Reliability	Cronbach's Alpha	Average Variance Extracted
Level of traceability	0.972	0.962	0.898
Confidence-related motivations	0.914	0.875	0.728
Profitability-related motivations	0.898	0.851	0.688
Normative motivations	0.936	0.897	0.829
Supply chain motivations	0.907	0.803	0.830

Table 6: Measurement model results

LV Correlations /AVE^0.5	**1**	**2**	**3**	**4**	**5**	**6**
Level of traceability (1)	1					
Confidence-related motivations (2)	0.163	1				
Profitability-related motivations (3)	0.277	0.093	1			
Normative motivations (4)	0.161	0.076	0.023	1		
Supply chain motivations (5)	0.155	0.160	0.322	0.040	1	
Employees (6)	0.151	0.136	0.211	0.123	0.056	1

Table 7: Total effects

	Total Effect	t	p-values
H1 Confidence-related motivations -> Level of traceability	0.311	5.166	0.000
H2 Profitability-related motivations -> Level of traceability	-0.554	7.239	0.000
H3 Normative motivations -> Level of traceability	-0.096	1.875	0.061
H4 Supply chain motivations -> Level of traceability	0.251	5.622	0.000
Employees -> Level of traceability	-0.103	3.047	0.002