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Firms' strategies and voluntary traceability: an empirical analysis in Italian food chains

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Abstract. In international food markets, voluntary traceability systems have increased their role in guaranteeing high safety and quality standards for the consumer. Such systems are also among the strategies firms employ to differentiate products and strengthen competitive advantage in both the national and international market.

Voluntary traceability has significant implications on the organisation of economic relationships within food supply chains. This paper focuses on this aspect and analyses the effects of voluntary traceability on vertical co-ordination using a transaction cost perspective. The analysis makes reference to the Italian situation where the national standard organisation has introduced standard rules for voluntary traceability (UNI 10939; ISO 22005 at the international level).

A survey was conducted by questionnaire to assess changes in transaction key factors (degree of asset specificity, uncertainty and frequency) and transaction costs after the introduction of voluntary traceability. The sample represents all Italian firms certified UNI 10939, and consists of 190 firms. Respondents are 146. Factorial and Cluster Analyses were applied to highlight groups of firms with similar features. The empirical results reveal four different clusters in terms of a vertical reorganisation of transactions.

Keywords : traceability, firms' strategies, transaction cost economics, food chain.

1. Introduction

In the context of the European food policy, traceability systems have been introduced to improve the degree of food safety in food supply chains. A “comprehensive and integrated approach” to food safety policy, provided by the European Commission (2000) in the White Paper ⁽⁶⁾, has led to mandatory traceability for the beef sector (Reg. 1760/2000) and for all other agri- food products (Reg. 178/2002).

The improvement in food safety due to the traceability system is connected to the growth of information throughout the food supply

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The paper presents the results of a survey on voluntary traceability conducted in Italy. The results concerning the meat sector were presented at the 99th EAAE seminar “Trust and Risk in Business Networks” (8-10 February, 2006, Bonn) and those concerning the dairy sector were presented at the “7th International Conference on Management in Agri-food Chains and Networks” (31 May - 02 June, 2006, Ede- Wageningen).

chain, and to the attribution of specific liabilities to agents of the supply chain ^(2, 3).

In addition to mandatory traceability it is possible, in the EU, to outline a second traceability system level which is voluntary, and which provides a higher degree of information associated to a single product. This voluntary traceability system is regulated by a number of European organizations accredited to deliver food safety standards, like AFNOR (Association Française de Normalisation) in France, BSI (British Standard Institute) in the United Kingdom, UNI (National Standards Organization) in Italy. Recently, within the framework of ISO 22000/2005, a specific voluntary traceability standard has been designed also at the international level ⁽¹⁵⁾.

This paper concerns the application of a voluntary traceability system in Italy, where the Italian standard organization has set down specific rules for such a system (UNI 10939/2001). A survey was conducted by a questionnaire to all firms certified UNI 10939/2001 operating in food processing.

The paper analyses the effects of introducing a voluntary traceability system within the organization of economic relationships throughout Italian food chains. We utilized the theoretical approach of transaction cost economics ⁽²⁷⁾ in order to test whether traceability can lead to variation in the degree of vertical co-ordination.

The paper is organised as follows: the economic implications of traceability and the theoretical framework of transaction cost economics are examined in section 2; the survey conducted and the methodological issues are examined in section 3; the results are analysed in section 4 and the concluding evidence is set out in section 5.

2. Traceability and transaction costs

2.1. Concepts and features of traceability systems

In general, the definition of traceability refers to the ability to trace, and follow, a food product throughout all the stages of its production, processing and distribution ^(15, 20). Thus, traceability is connected to an information procedure aimed at following a product along its food supply chain.

Following Golan et al.⁽⁷⁾ the main characteristics of traceability systems depend on their breadth, depth, and precision. Breadth represents the amount of information the traceability system can record; depth describes which sectors are involved in the food supply chain; precision is associated with tracking unit dimension; indeed, large analysis units result in poor precision. Therefore, different kinds of traceability systems can be distinguished, depending on the amount of information recorded and the tracking unit.

In Europe there are mainly two different kinds of traceability systems ⁽²¹⁾, these depending on product flow management in the different stages of the supply chain (precision) and on the amount of the information recorded (breadth):

- *supply chain traceability system* ,
- *supply chain and product traceability system* .

Supply chain traceability is based on an information procedure aimed at identifying the economic agents of the supply chain. This system is mandatory and is regulated by Reg. 178/2002, where, in article 18, it is established that at all stages of production, processing and distribution the operators shall be able to identify any person from whom they buy products and other operators to whom they sell products. For this purpose the operators have to implement procedures which allow the availability of this information to the competent authorities.

The main purpose of this system is to improve the food product safety level. This is achieved by growth in the information level along the supply chain, and better liability distribution to the agents of the supply chain. However, in this system the information is not associated with a specific product and it is not possible to design the history of the single product.

Instead, *supply chain and product traceability* is a much more complex system. It is characterized by the management of raw materials and products in separate batches, and by procedures that attribute specific information to each single batch. Management by separate batches is laid down in both the company processing and in the transactions among the economic agents in the supply chain ⁽²⁾.

The separation, and the identification, of single batches with specific codes is carried out at two specific moments in the firm production process: at storage or at the arrival of raw materials, and at the packaging or the storing when the products are ready to be exchanged ⁽²¹⁾.

The system is applied in the beef sector by Reg. 1760/2000 ⁽²³⁾, but for other food products its adoption is voluntary, representing a strategic choice of the firms. Therefore, excluding the beef sector, there are two levels of traceability in the EU: the general mandatory traceability system provided by Reg. 178/2002 (supply chain traceability) and, at a second level, a voluntary traceability system (supply chain and product traceability) which makes reference to national or international standards.

Examples of traceability standards are AFNOR V01 020 (“Lignes directrices pour l’établissement d’une démarche de traçabilité dans les filières agricoles et alimentaires”) and the BSI 85:2000 (“A quality management system to ensure the integrity and traceability of primary products in the agri-food chain”). Moreover the International standard organization recently outlined specific standards for traceability through the rules ISO 22005:2005.

In Italy, voluntary traceability takes as its reference the rules 10939:2001 introduced by the National standards organization (UNI). Italian voluntary traceability allows the reconstruction of a specific product's history all along the supply chain. Thus, compared to mandatory traceability, the system results in a higher degree of increased information and a more specific allocation of liabilities.

2.2. Economic implications of voluntary traceability

The economic effects on firms of the traceability system provided by UNI 10939/2001 mainly concern three aspects: food safety, food quality, and vertical co-ordination in the food supply chain.

Referring to food safety implications ^(18, 25), voluntary traceability, given its specific production rules and controls, allows a higher level of safety than mandatory traceability. Indeed, in the case of food contamination, separate batches management within the firms part of the traced supply chain allows an efficient organisation of material flow, and the firm is able to withdraw only the tainted batches. Thus, voluntary traceability can lead to a reduction in recall expenses and the attribution of liability to specific agents of the traced supply chain.

Food quality implications connected to the introduction of voluntary traceability refer mainly to the guaranteeing of quality standards for food products ⁽¹⁴⁾, due to the fact that the firms of the supply chains adopt specific production rules and implement specific controls.

With regard to the effect of voluntary traceability on vertical co-ordination ⁽²⁾, the system leads to the reorganisation of the vertical relationships along the food supply chain connected to:

- the implementation of specific agreements, called *supply chain agreements*,
- *centralisation* of the traceability system management.

Supply chain agreements represent a new form of governance for transactions within the supply chain, providing specific production rules for food safety and product quality. Moreover, the agreement establishes procedures for recording product batch information and assigning specific liability to the supply chain agents.

The *centralization* of the management of the traceability system is due to the fact that a firm supports the introduction of traceability into the supply chains. This firm then acts as the leader of the supply chain, coordinating the activities of the other agents, and is in charge of the certification of the system. Thus, the design of the supply chain agreement, the management of information and the planning of the controls are centered in this firm. Therefore, the introduction of a voluntary traceability system leads to a centralized mode of organization for the activities within the supply chain ⁽¹⁷⁾. In our survey we considered only firms operating in the food industry in Italy as leaders, but the

supply chain leader could be a firm operating in the retail sector or in an agricultural cooperative.

The reorganization of the vertical relationships in the food supply chain is related to the changes in the characteristics and costs of transaction, as underlined in the next section, considering that the level of transaction uncertainty decreases while the bilateral dependency of the agents of the chain grows ⁽⁹⁾.

Voluntary traceability is a choice made by both the leader firm and the other economic agents of the food supply chain, thus the introduction of the system depends on the advantages the firms will achieve. Such advantages are connected to improvement in food safety and quality, premium prices, brand image of high value traced products, the expansion of sales, efficiency in distribution, reduction of recall costs, and adaptation to the standards required by retailers at the international level ⁽⁷⁾.

Thus, the advantages of voluntary traceability can regard both the business to consumer relationship and that of business to business. At the single firm level an assessment is needed of whether the advantages of introducing voluntary traceability exceed its relative costs (cost of implementing the management of separate batches, cost of information procedures, and so on).

2.3. The transaction cost approach

After introducing a voluntary traceability system like the UNI 10939 standard, more transparent and efficient vertical relationships can be achieved through a reorganisation of the material and informative flow along supply chains. Thus to analyse the voluntary traceability effects on supply chain co-ordination we utilised the theoretical framework of transaction cost economics, and tried to verify whether the implementation of this food safety instrument would lead to any variation in the transaction characteristics and costs of transacting.

Transaction costs are present within a market, in a vertically integrated firm ⁽²⁸⁾, and in “all the ways of harmonising the vertical stages of production and marketing” ^(9, 19), because of market failure associated with information asymmetry among economic agents ⁽¹⁾. According to Williamson’s theory, economic subjects conduct vertical relationships by trying to minimise the costs involved in transactions ⁽⁵⁾.

There are different kinds of transaction costs, depending on when they arise in the transaction. Information or search costs arise *ex ante*, and are related to the level of transaction transparency and the limited rationality of economic agents within a market. Negotiating costs take place during transactions, and are mainly connected to the difficulty in settling agreements. Monitoring and enforcement costs occur after the exchange has been negotiated, and are correlated to the level of bilateral

dependency between subjects as a consequence of specific investments necessary to respect the conditions of transactions ⁽¹⁰⁾.

Williamson ^(27, 28) states that the consequent governance of transactions depends on transaction costs and on some key transaction factors: the level of asset specificity, the level of uncertainty surrounding the transactions and the degree of frequency. In particular, he distinguishes three possible forms of transaction governance: market, hybrid and hierarchy. The use of one of these three forms depends mainly on the level of asset specificity of transactions ⁽²²⁾.

The asset specificity of transactions is correlated to the bilateral dependency of economic agents, due to the resources invested to conduct transactions. Transaction costs, and the need to safeguard transactions through more formal vertical co-ordination alternatives, increase as the degree of transaction asset specificity increases ⁽²⁹⁾.

The level of uncertainty depends on the degree of information asymmetry among economic agents, on the random nature of some events and on the bounded rationality of subjects ⁽¹⁾. It is strictly connected to the probability that subjects will respect contractual obligations.

However, the level of transaction uncertainty affects only conditionally the transaction governance, that depends mainly on the degree of asset specificity ⁽²⁷⁾. If, for example, the level of bilateral dependency among economic agents is low, the degree of transaction uncertainty will not be important in choosing the transaction arrangements. In this case, market governance should be preferred to hybrid forms or vertical integration despite the degree of transaction uncertainty ⁽¹¹⁾. On the contrary, if asset specificity increases, the level of transaction uncertainty will become important to the choice of the transaction governance structure. In such a case, the higher the level of transaction uncertainty, the higher the probability that the subjects will choose hybrid governance or hierarchy to conduct the transactions.

With reference to Williamson's theoretical framework, our hypothesis is that implementing a voluntary traceability system leads to a growth in transaction asset specificity, a decrease in the degree of transaction uncertainty and variation in transaction costs. Thus it can be expected that there will be an increase in monitoring costs due to growth in asset specificity for the implementation of the system, and a reduction in information costs due to the reduction in information asymmetry among economic subjects ^(2, 3).

These variations in transaction characteristics and costs lead to a reorganisation of transactions based on *supply chain agreements*. This new hybrid transaction form increases the degree of control between buyers (food processing firms in this case) and sellers (agricultural raw material suppliers) and leads to changes in the vertical organisation of transactions. According to Williamson, in formulating these agreements the subjects can decide whether to introduce economic incentives,

through an increase in the price of raw materials, or provide more contractual support ⁽³¹⁾.

3. Data and method

A survey was conducted during the spring and summer of 2005, in order to test changes in the vertical relations after the introduction of a voluntary traceability system.

The sample represents all Italian firms certified UNI 10939, which are specialized in food processing. The questionnaire consisted of 30 questions subdivided into three parts.

Part 1 contains questions relating to the general characteristics of the company, paying particular attention to its legal shape, turnover, employees, level of vertical co-ordination, certification systems and motivations to introduce voluntary traceability.

Part 2 focuses on the changes verified in the transaction key factors following the introduction of the standard, UNI 10939. The demands are related to the variation in asset specificity of the transaction (changes in site, physical, intangible and human assets) and the variation in the uncertainty degree of transactions, in terms of frequency, quantity and accuracy of information exchanged.

Part 3 is aimed at defining the variation in the transaction costs associated with the introduction of the voluntary system (UNI 10939), and especially considers monitoring costs as the exact quantification of all the transaction costs is extremely complex due to the many organisational costs that are not measurable.

Monitoring costs are quantified by means of questions relative to the variation in both the supplier activity controls and the raw material controls.

A multiple choice, rating-scale format was used to obtain answers as numerical variables ⁽¹⁶⁾.

The sample consisted of 190 firms certified UNI 10939, and the respondents were 146. Most are concentrated in four sectors: 21% of those interviewed are specialised in meat processing, 25% in the fruit and vegetable sector, 22% in the dairy sector and 12% in the wine industry.

We applied factor analysis and then cluster analysis to identify homogeneous groups of firms in terms of different approach to voluntary traceability. Carrying out factor analysis before cluster analysis reduced the number of variables and highlighted significant factors.

Principal Component Analysis (PCA) for 21 variables was used to extract the factors ⁽⁸⁾. This is a linear transformation of the variables that assumes those factors able to explain all the variance in each variable.

We extracted 8 factors with eigenvalues greater than 1 and that together account for 66% of total variance. Orthogonal rotation (Varimax) was carried out after the initial extraction of the factors. The factors produced by SPSS were used for cluster analysis.

For Cluster analysis we utilized a hierarchical approach. Similarity between cases was measured by Pearson's correlation, and the between-groups linkage method was used to combine nearest clusters into broader groups. This technique led to the identification of 4 clusters that seem the best results in terms of some important criteria, like the minimum number of firms for each cluster; the degree of distances between clusters (small coefficients indicate the merging of fairly homogeneous clusters, whereas large coefficients indicate that clusters containing quite dissimilar members are being combined) and the different characteristics of the resulting clusters.

4. Results

4.1. General evidence of the survey

The main reasons related to the introduction of voluntary traceability in the food supply chain were the assurance of product quality characteristics (76%) and the introduction of a correct liability system among supply chain participants (65%). Among those interviewed 54% introduced traceability to enhance communication among subjects part of the supply chain, and 51% of the firms stated that traceability represents an important standard to guarantee food safety (figure 1).

The sample consists of both big and small firms: 45% have a turnover of less than 10 million Euro, 23% between 10 and 25, 13% between 25 and 50 and 19% higher than 50 million. Most of the firms show a high level of vertical co-ordination. The results reveal that 40% of the firms are vertically integrated, the most of which are co-operatives, 18% own some agricultural farms and 43% have no farm ownership. It was found that 34% of the sample are co-operatives, the remainder private companies (table1).

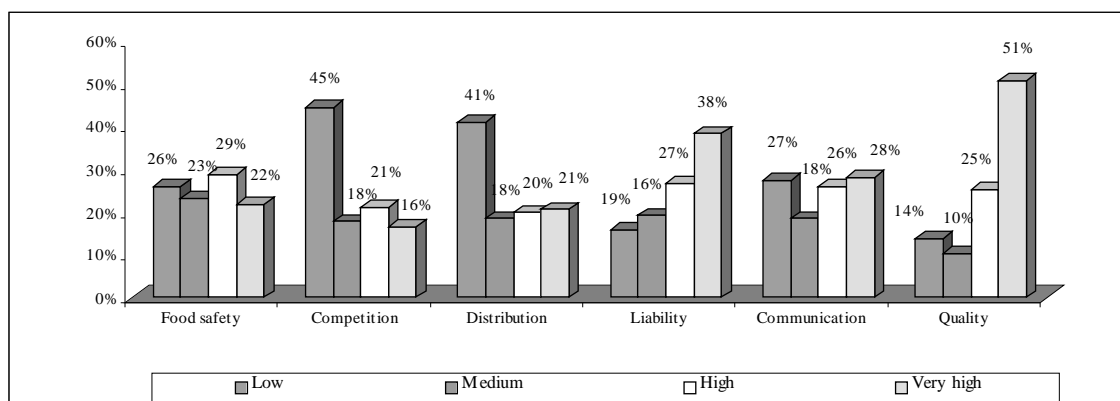


Figure 1. Level of agreement of firms regarding motivation in implementing voluntary traceability

Source: own survey

Table 1. Firms and traced supply chains characteristics

Firms characteristics	Employees											
	<20		20-50		50-100		100-150		>150		Total	
	n.	%	n.	%	n.	%	n.	%	n.	%	n.	%
Turnover (000.000 euro)												
<1	13	100,0	0	0,0	0	0,0	0	0,0	0	0,0	13	8,9
1-10	29	54,7	17	32,1	2	3,8	1	1,9	4	7,5	53	36,3
10-25	11	32,4	10	29,4	10	29,4	3	8,8	0	0,0	34	23,3
25-50	3	15,8	4	21,1	5	26,3	5	26,3	2	10,5	19	13,0
50-100	0	0,0	0	0,0	2	40,0	2	40,0	1	20,0	5	3,4
>100	0	0,0	1	4,5	1	4,5	3	13,6	17	77,3	22	15,1
Legal shape												
Private firms	40	41,2	18	18,6	14	14,4	11	11,3	14	14,4	97	66,4
Cooperatives	16	32,7	14	28,6	6	12,2	3	6,1	10	20,4	49	33,6
Level of vertical integration												
Low	27	43,5	11	17,7	10	16,1	7	11,3	7	11,3	62	42,5
High	6	23,1	6	23,1	4	15,4	4	15,4	6	23,1	26	17,8
Very high	23	39,7	15	25,9	6	10,3	3	5,2	11	19,0	58	39,7
Total	56	38,4	32	21,9	20	13,7	14	9,6	24	16,4	146	100,0

Source: own survey

With regard to the characteristics of the traced supply chains, 43% of the interviewed firms implemented the voluntary system in the agricultural sector and in food processing, 24% extended traceability to agricultural input sector, agricultural sector and food processing, and 33% included also distribution. Almost 25% of the firms limited the application of the voluntary traceability to 20% of their agricultural suppliers, whereas 35% included all the suppliers in their traceability system. The other firms implemented it on 20% to 80% of their chain's suppliers (figure 2).

Most of the big firms extended the voluntary traceability system to only part of the sectors and subjects involved in the chain, whereas a lot of small firms decided to improve their voluntary traceability by applying it to all the sectors and the agents of the supply chain. The different implementation strategies of the small and big firms depend mainly on the costs involved in applying the voluntary traceability standard, which are definitely influenced by the firms dimensions.

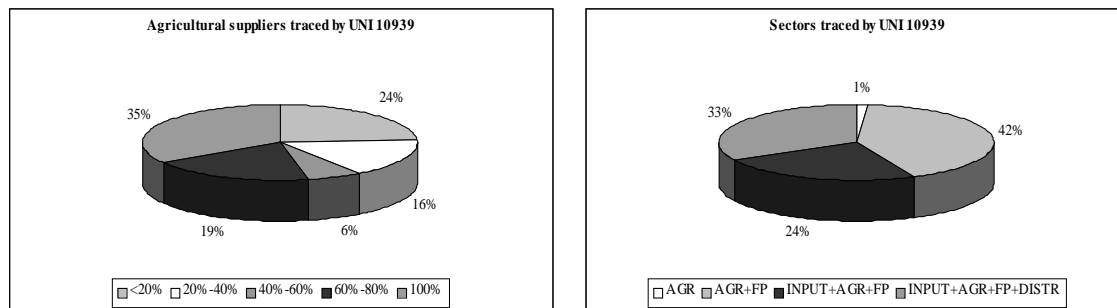


Figure 2. The characteristics of traced supply chains

Source: our survey

The survey underlines an increase in the level of human, physical, intangible and site asset specificity. The results show that (table 2):

Table 2. Firms' perceptions about the effects of voluntary traceability on transaction characteristics, costs and vertical co-ordination

	Variation of transaction characteristics (%)				
	Low	Medium	High	Very high	Total
Asset specificity variation					
<i>1) Human asset specificity variation</i>					
Long business relations with suppliers	4.8	8.2	24.0	63.0	100.0
Difficulty in substitution of suppliers	32.2	19.9	20.5	27.4	100.0
Traning of suppliers	7.5	11.0	34.2	47.3	100.0
<i>2) Physical asset specificity variation</i>					
Processing facilities variation (*)	62.3			37.7	100.0
<i>3) Geographical asset specificity variation</i>					
Certified suppliers closeness	8.9	21.2	35.6	34.2	100.0
<i>4) Intangible asset specificity variation</i>					
Certification (**)	69.9	22.6	4.8	2.7	100.0
Implementation (**)	81.5	11.6	4.1	2.7	100.0
Uncertainty variation					
Frequency of information flow variation	10.2	6.8	27.2	55.8	100.0
Quantity of information flow variation	7.5	8.2	15.8	68.5	100.0
Precision of information flow variation	9.6	4.1	24.7	61.6	100.0
Transaction costs variation					
<i>Monitoring costs variation</i>					
Suppliers activity controls variation	13.0	2.7	31.5	52.7	100.0
Raw materials controls variation	22.6	8.2	32.2	37.0	100.0
Proxies of vertical relationships variation					
Raw materials price variation (*)	71.9			28.1	100.0
Liability degree variation	5.5	9.6	25.3	59.6	100.0
Production rules enforcement	17.8	21.2	27.4	33.6	100.0

Source: our survey

(1) Questionnaire answers are scored from 1(low) to 4 (very high)

(*) Answer options are yes (2=high) or no (1=low)

(**) low <20.000 euro; medium 20.000-50.000 euro; high 50.000-100.000 euro; very high >100.000 euro

Source: own survey

- a) a long term business relationship is an important factor to decide which suppliers can be part of a traced supply chain (87% of answers);
- b) the substitution of certified suppliers is more difficult than for normal suppliers (48%);
- c) most of the participants involved in the certified supply chain have undergone specific training (82%);
- d) the implementation of the voluntary traceability system requires some material investment (38%);
- e) most of the certified suppliers are located near the firm (70%);
- f) investments, though not very high, are needed for certification and the implementing of the system.

A decrease in the uncertainty degree throughout the supply chain is also observed. Firms interviewed have recorded an increase in the frequency (83%), quantity (84%) and precision (86%) of information flow. Moreover, the firms show an increase in monitoring costs to control supplier activities (84% of answers) and raw materials (69%).

4.2. Factorial and cluster analysis

Factor analysis was applied to summarise the important variables that can explain the organisational changes within the food supply chain after the introduction of a voluntary traceability system. The rotated factor matrix was calculated to permit the interpretation of the eight factors (table 3).

The first factor explains the information expressed by the variation of intangible assets and the characteristics of the firms i.e. the costs of the certification (0.868) and management (0.835) of the voluntary system and the number of employees (0.497). The second factor are the variables describing the level of the firms' vertical co-ordination variation, i.e. the legal shape (0.891) and the level of vertical integration (0.883). The third factor explains the variation in the uncertainty degree of transactions, and in the physical asset specificity, after the introduction of the voluntary traceability system, i.e. the increase in the quantity (0.849) and accuracy (0.679) of information flow and the introduction of new processing facilities (0.490). The fourth factor is mainly connected to variables explaining the variation of transaction safeguard conditions, i.e. production rules enforcement (0.811) and agents' liability conditions (0.568) after the introduction of the supply chain agreements. The fifth factor summarises the information connected to the monitoring costs, i.e. supplier activity (0.844) and raw material control variations (0.758). The sixth factor explains variation in final product price (0.848) and raw material price (0.633), whereas the seventh factor represents the human asset specificity variation (the variable explaining long business relationships is 0.752). The last factor summarises the firms' sector (0.772) and the site asset specificity variation (0.649), i.e. the closeness of certified suppliers.

Cluster analysis (CA) applied to the above described components reveals the presence of four groups of firms. These groups differ, one from the other, in terms of the firms' characteristics and the voluntary traceability effects on vertical co-ordination. Each cluster is composed by firms that chose different organisational solutions to promote continuity and safeguard transactions.

To facilitate the interpretation of the clusters we calculated the average factorial coefficients of the firms in each cluster for each component (figure 3).

The first cluster is composed by 45 small firms, most of which used oral agreements for the exchange of raw materials before the introduction of the traceability system. Some of them are private vertically integrated firms and produce their own raw materials (the level of vertical co-ordination is 0.31). These firms state that the quality assurance of products has been an important element for the introduction of voluntary traceability as they have no other quality certification systems. The voluntary system is extended almost to all the suppliers of agricultural raw material (60%-80% of suppliers).

The firms grouped in this cluster (cluster 1), which is explained by the factor of safeguards variation (0.61), register an augmentation of monitoring costs (0.40) and a reduction in information costs thanks to a slight increase in transaction transparency (0.19). The increase in monitoring costs and the absence of formal agreements lead to the introduction of new contractual supports (0.61) between economic agents, like liability variations and production rules enforcement. Thus, an increase in vertical co-ordination among agents is observed.

Table 3. Rotated component matrix

	Intangible asset var. and employees	Level of vertical coordination	Uncertainty level var. and phys.asset var.	Safeguards var.	Monitoring costs var.	Price var.	Human asset specificity var.	Sector and site asset specificity var.
Firms characteristics								
Employees	0.497	0.233	-0.293	0.056	-0.044	-0.012	0.262	-0.367
Legal shape	-0.141	0.891	0.051	-0.018	0.105	-0.067	-0.002	0.114
Sector	0.071	0.098	-0.047	-0.122	-0.043	-0.141	0.065	0.772
level of vertical integration	0.027	0.883	0.013	-0.023	-0.101	-0.091	-0.118	0.147
contracts formalisation	0.193	0.294	0.158	-0.447	0.037	0.371	0.388	-0.031
final product price variation	0.024	0.053	-0.062	0.036	0.102	0.848	0.033	-0.136
% of traced suppliers	0.025	0.152	0.145	0.041	0.003	-0.316	-0.695	-0.194
Asset specificity variation								
<i>1) Human asset specificity variation</i>								
Long business relations with suppliers	-0.151	-0.040	0.181	0.151	-0.046	-0.032	0.752	-0.119
Traning of suppliers	0.200	-0.045	0.154	0.315	0.385	-0.225	0.152	0.073
<i>2) Physical asset specificity variation</i>								
Processing facilities variation	0.429	-0.065	0.490	-0.093	0.057	-0.097	0.239	0.049
<i>3) Geographical asset specificity variation</i>								
Certified suppliers closeness	-0.289	0.294	-0.107	0.117	0.047	-0.001	-0.040	0.649
<i>4) Intangible asset specificity variation</i>								
Certification	0.868	-0.076	0.115	-0.026	0.039	-0.018	-0.124	0.043
Implementation	0.835	-0.064	-0.036	0.098	-0.029	0.040	-0.127	-0.112
Uncertainty variation								
Frequency of information flow variation	0.040	-0.044	0.215	0.473	0.188	0.383	0.008	0.151
Quantity of information flow variation	-0.042	0.046	0.849	0.020	0.093	0.114	-0.059	0.000
Precision of information flow variation	0.028	0.081	0.679	0.355	0.162	-0.042	0.140	-0.269
Transaction costs variation								
<i>Monitoring and enforcement costs variation</i>								
Cost of implementing the system	0.868	-0.076	0.115	-0.026	0.039	-0.018	-0.124	0.043
Cost of managing the system	0.835	-0.064	-0.036	0.098	-0.029	0.040	-0.127	-0.112
Suppliers activity controls variation	0.051	0.038	0.019	0.073	0.844	0.150	0.045	0.061
Raw materials controls variation	-0.097	-0.022	0.140	-0.116	0.758	0.030	-0.139	-0.096
Proxies of vertical relationships variation								
Raw materials price variation	-0.053	-0.246	0.082	0.076	-0.010	0.633	0.142	-0.040
Liability degree variation	-0.016	0.055	0.151	0.568	0.367	0.043	0.346	-0.043
Production rules enforcement	0.054	-0.008	-0.001	0.811	-0.180	0.079	-0.010	-0.110

Source: our survey

The second cluster, which is explained by the factor of sector and site asset specificity variation (1.10), consists of 23 firms. Most of these are small co-operatives with an annual turnover of less than 10 million Euro and an average number of 25 employees. Almost all these firms belong to the wine industry, show no increase in human asset specificity (-0.27) and do not register a greater quantity and precision of exchanged information (-0.37). The firms grouped in this cluster have no quality certification systems like ISO 9000 or PDO certification, and utilise the voluntary system to implement a quality standard management for production through the introduction of specific suppliers and raw material controls (the factor representing monitoring costs is 0.45). In accordance with Williamson's theoretical framework, the firms grouped in this cluster do not report any variation in vertical co-ordination; this is because their transactions are already internally safeguarded and there is no need for any strengthening of transaction governance through economic incentives (-0.59) or contractual support (-0.79), although an increase in monitoring costs is observed.

The third cluster groups 48 medium firms not vertically integrated (-0.31) that use contracts for exchanges. Most of them state that the reason for implementing the voluntary system is mainly connected to the right attribution of liabilities among the economic subjects of the supply chains. Thus, the traceability system is extended to most of the chain's

suppliers (40%-60%). In this case, the introduction of a traceability system determines a reduction in the transaction uncertainty degree (0.49), and an increase in intangible (0.59) and human (0.16) asset specificity. Monitoring costs do not register a positive variation (-0.69). In this cluster no economic incentives (0.06) or contractual safeguards (-0.18) are introduced to safeguard the higher bilateral dependency of economic subjects after specific investments, because transactions become more transparent due to the voluntary system and the probability of situations of moral hazard or adverse selection is reduced. In most of the firms in this cluster the increase in the supply chain transparency is sufficient to safeguard transactions and to ensure the correct execution of transactions.

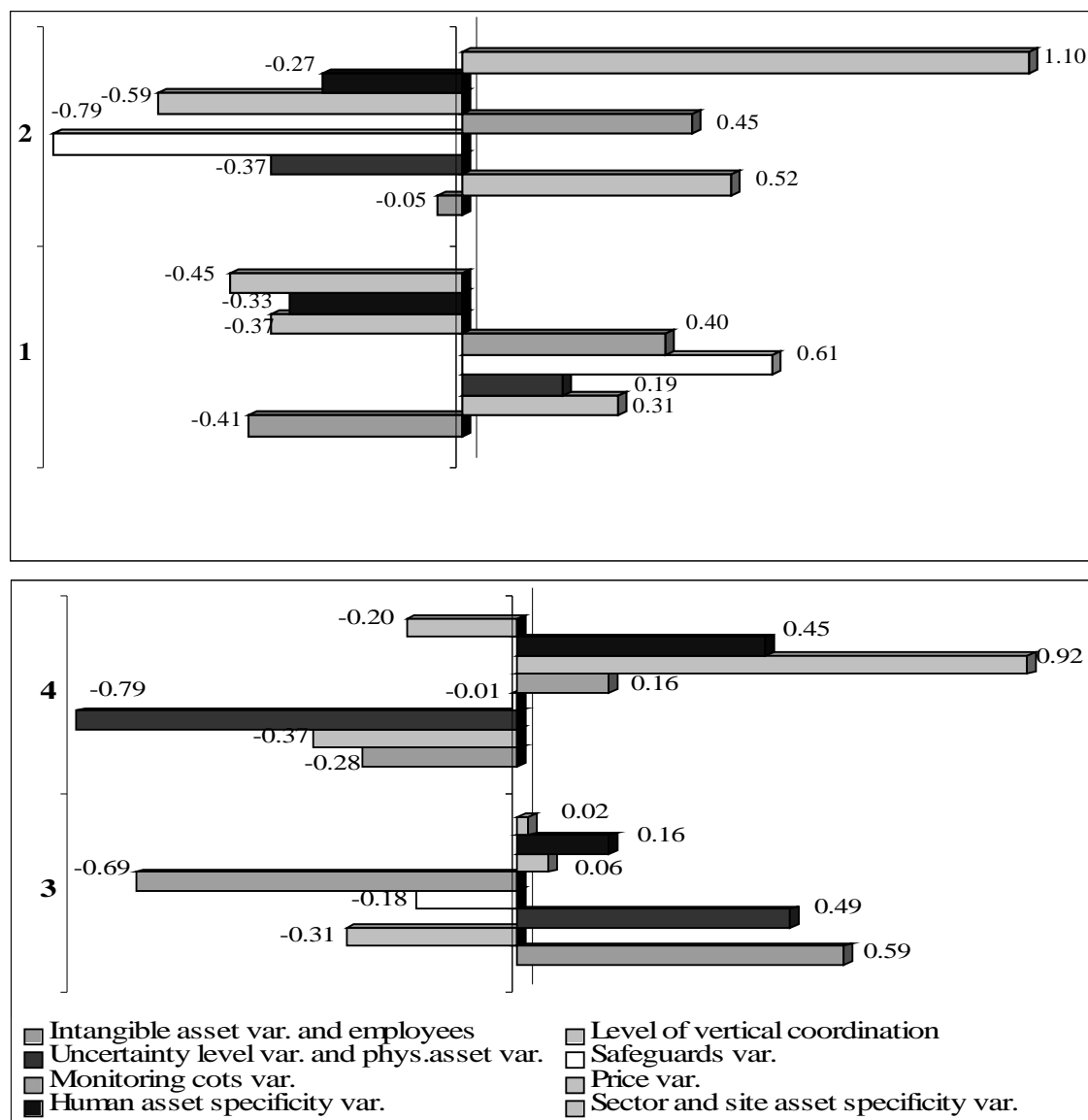


Figure 3. Average of factorial coefficients in each cluster

Source: our survey

The firms grouped in the fourth cluster are 30, of big dimension, and have more than 100 employees. All the interviewees use contracts for vertical exchanges, and state that the reason for the implementation of the voluntary system is mainly to enhance the quality attributes of products. Thus, the standard is applied to only a few suppliers (20%-40%), particularly to those that can guarantee respect for the quality rules established in the supply chain agreements. All the firms grouped in this cluster already have other quality certification systems, and can take advantage of the synergies for the implementation of the voluntary traceability. For this reason these firms do not show any variation in intangible assets (-0.28), and the uncertainty degree remains the same (-0.79) whereas the level of human asset specificity reveals a positive variation (0.45). In this case the increase in asset specificity and the invariance of the level of transaction uncertainty lead to the adoption of economic incentives in order to safeguard transactions (0.92) from the opportunistic behaviour of economic agents.

5 Concluding remarks

The empirical analysis of the Italian traced supply chains has revealed that the firms' purposes for the introduction of voluntary traceability are multiple, but two motives are particularly significant: an improvement in food quality standards due to the introduction of production rules and controls for the agents of the supply chain, and a better liabilities attribution among the participants of the supply chain through the introduction of a system that connects information flow with product batches.

Moreover, cluster analysis has revealed the presence of different organisational solutions connected to the introduction of voluntary traceability. According to the transaction costs approach, this voluntary standard leads to an increase in asset specificity (intangible, physical, human and site asset specificity) of transactions.

This positive variation can lead firms to choose different types of transactions governance depending on:

- the degree of uncertainty of transactions after the introduction of voluntary traceability
- the level of the firms' vertical co-ordination.

Referring to the uncertainty degree, firms that assist in increased informative transparency (like firms grouped in the third cluster) do not lead to any reorganisation of vertical relations although an increase in bilateral dependency between economic agents is observed. In accordance with Williamson's theory, the reduction of the transaction uncertainty degree reduces the risk of contractual infringements. In such a situation subjects do not increase the level of vertical co-ordination in order to ensure the correct execution of agreement conditions.

The growth in information transparency is connected to the implementation of the voluntary system on most of the suppliers of agricultural raw material.

On the other hand, if the level of uncertainty remains the same and the level of asset specificity increases (like in the first and fourth clusters) variations in the organisation of transactions are observed. According to Williamson's contracting scheme, economic incentives (cluster 4) or more stringent contractual safeguards (cluster 1) are established for traced suppliers. In this case the firms extend the voluntary traceability to only a part of their suppliers.

Finally, referring to the relation between the variation in the transaction governance and the level of the firms' vertical co-ordination, we can outline three different situations:

- firms that used oral agreements before the introduction of voluntary traceability show an increase in vertical co-ordination due to the introduction of formal agreements with specific safeguard conditions;
- firms that use contracts for exchanges can undergo variation in transaction conditions established in the agreements (price incentives);
- vertically integrated firms do not register any variation in the governance of transactions as they are already internally safeguarded.

Firms, by adopting voluntary traceability, can enjoy many different benefits related to food safety, food quality and efficiency of vertical exchanges. Furthermore, traceability also represents a strategic choice for firms as it guarantees specific quality standards and can respond to consumer demand concerning food safety, even though a critical point can be seen to be the communication, to the consumer, of the characteristics of voluntary traceability.

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