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Voluntary Traceability and Transaction Costs: An Empirical Analysis in the Italian Meat Processing Supply Chain

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Abstract

This paper analyses voluntary traceability effects on the coordination of the food supply chain from the transaction cost perspective. The analysis concerns Italian firms and makes particular reference to the meat sector. A survey was conducted by questionnaire to assess the changes in key transaction factors and costs after the introduction of traceability. The results underline an increase in the degree of human, material and site asset specificity, and reveal a reduction in the degree of uncertainty in transactions. Growth in some transaction costs related to monitoring is also observed. Factorial and cluster analysis were used to underline the different organisational solutions of the firms.

Keywords: *traceability, trust, transaction cost, vertical relationships, meat chain*

1. Introduction

In the EU traceability systems are aimed at reducing the probability of unsafe food and at imputing specific liability to the agents of food supply chains (European Commission, 2000). Therefore, traceability systems are part of food safety policies introduced to reduce market failure connected to information asymmetry (Hobbs, 2004a) and to public good characteristic of food safety (Ritson and Mai, 1998). It is possible to distinguish two different traceability systems in the EU: mandatory and voluntary. These systems have different economic effects for the firms involved in a supply chain.

Mandatory traceability is regulated by Reg. 1760/2000 for the meat sector, and by Reg. 178/2002 for all other agri-food products. With regard to the traceability system provided by Reg. 178/2002, economic agents have to register the flow of goods along the food supply chain with an appropriate documentation procedure. They have to document from whom they buy the raw materials and to whom they sell the processed products. This system can be called “*supply chain traceability*”, but it does not allow the individual product to be traced back to the specific agricultural raw materials from which it came.

1. Corresponding author: A. Banterle. The paper is the result of the collaboration of the authors. The drawing up of the text is attributed as follows: section 1 and 5 to A. Banterle; section 2 and 4 to S. Stranieri; section 3 to L. Baldi.

Voluntary traceability is not regulated by any EU legal framework, and different standards are determined at the country level. In Italy the national standard organisation (UNI) has set standard rules for voluntary traceability (UNI 10939). This system allows traceability at both the level of the agents involved in the supply chain (*supply chain traceability*) and at the level of single firm organisation (*product traceability*), separating the different batches of raw materials in the production processes of the firm (Peri *et al.*, 2004). In this way, firms are able to reconstruct the complete history of a specific product, and it is possible for a single product to be traced back to the relative agricultural raw materials.

The economic effects on firms of voluntary traceability mainly concern three aspects: food safety for better risk management (Velthuis *et al.*, 2003), food quality for better quality standard management, and vertical coordination in the food supply chain. With regard to this last aspect, the positive outcome of voluntary traceability on vertical relations is connected to an improvement in information, trust and liability among the agents of the food supply chain.

The purpose of this paper has been to analyse the voluntary traceability effects on food supply chain coordination, using a transaction cost perspective. The analysis relates to the Italian situation and is concentrated on the meat sector because of its involvement in recent food safety crises. The paper is organised as follows: the theoretical framework of transaction cost is presented in section 2; the survey conducted to assess changes in transaction factors and costs and the methodological issues are examined in section 3; the results are analysed in section 4 and the concluding remarks are set down in section 5.

2. Theoretical framework

In the Williamson (1985, 1996) theory, agents carrying out any exchange incur costs because of information asymmetry, bounded rationality and opportunism. Such costs are classified in three main categories depending on where they arise in the transaction. Information or search costs identify costs that arise *ex ante*; negotiating costs take place during transactions; monitoring and enforcement costs occur *ex post* to a transaction after the exchange has been negotiated (Hobbs, 1996).

In his heuristic model Williamson states that the minimisation of the sum of transaction and production costs, i.e. the organisational efficiency, depends on the governance structure chosen to conduct specific transactions with specific characteristics. Indeed, the governance structure of transactions depends on three key transaction factors, namely, degree of asset specificity, uncertainty level and frequency level.

The first factor, degree of asset specificity, identifies the bilateral dependency of agents by reason of the specific investments needed to carry out a transaction. There are different kinds of asset specificity depending on the nature of the investment, be it human asset, site asset, physical asset or dedicated asset specificity.

The second factor, uncertainty level, relates to the probability that subjects will respect obligations endorsed in agreements; uncertainty depends mainly on information asymmetry between subjects and their opportunistic behaviour. From the seminal work of Akerlof (1970), it is well known that the difficulty in observing food safety and food quality attributes in

foodstuffs (credence attributes) and the information asymmetry between buyers and sellers makes it necessary to have guarantees in an institutional form to ensure food quality and counteract uncertainty in transactions (Holleran *et al.*, 1999). Therefore, this aspect of the transaction has become very important, given the new uncertainties in the food market and the increasing role of asset specificity investments, and of closer vertical coordination forms such as contracts, supply chain alliances and so on (Hobbs, 2004b; Menard and Valceschini, 2005).

The last factor, the frequency of transactions, is the lapse of time between one transaction and another. It was not considered in the present paper.

The degree of these three factors and the relative costs of obtaining information, negotiating and monitoring determines a consequent governance transaction arrangement. The costs of governance and the need to safeguard transactions from opportunistic behaviour increase as the complexity of transaction asset specificity builds up (Williamson, 1979).

In this theoretical framework, we believe that the implementation of a voluntary traceability system leads to an increase in asset specificity, and to a variation in the relative degree of uncertainty and of transaction costs, especially monitoring costs. Information costs are not considered in this analysis. Variation in bilateral dependency gives subjects an incentive to promote continuity and to safeguard transactions throughout the introduction of new forms of transaction governance based on *supply chain agreements*, that introduce specific verification procedures and improve the information, liability and trust of the economic agents of the supply chain.

According to the Williamson contracting scheme, during the formulation of these agreements economic actors play a role in deciding whether to increase the price of raw materials ($p > 0$) or contractual support ($s > 0$) of transactions to reduce the risk of contractual infringements.

Subjects vertically integrated do not follow this scheme in the formulation of supply chain agreements because they do not need to be safeguarded from opportunistic behaviour thanks to an organisation under unified ownership.

3. Methodological issues and statistical results

A survey to assess changes in key transaction factors and costs connected to the introduction of voluntary traceability was conducted by a questionnaire organised in 3 sections: i) overview of firms, ii) transaction costs, iii) traceability effects on transactions. In order to obtain numerical answers most of the questions were in multiple choice form by rating or agreement scales (Kalton, 1983).

The sample represents Italian firms certified UNI 10939 and consisted of 190 firms extracted from a population of 215 firms; the respondents were 146 and represent 68% of the total. These firms are located throughout Italy although 77% of them are found in the north. The sectors of the sample firms were dairy 21%, meat processing 21%, fruit and vegetable processing 21%, wines 12% and others sectors 25%.

The results presented in this paper were concentrated on the meat sector because of its involvement in recent food safety crises. In this sector the sample consisted of 40 firms and the respondents were 32. Factor analysis and cluster analysis were utilised for this sub sample. A first analysis was run before the cluster analysis to reduce the number of variables and find significant factors.

Factor analysis is a statistical technique that allows to explain the major part of the variability among a number of observable random variables in terms of a smaller number of unobservable random variables called factors (Gorsuch, 1983). The observable random variables are modeled as linear combinations of the factors plus "error" terms. Seventeen of the total of answers like initial variables were considered, and Principal Component Analysis was applied to analyse total variance. SPSS was utilized to extract the principal components; first, Bartlett's Test of Sphericity to investigate the null hypothesis that the correlation matrix is an identity matrix was calculated and null hypothesis was rejected at 0.001 level of significance.

Seven factors with eigenvalues greater than 1 were extracted, and together account for 79% of the total variance. Orthogonal rotation (Varimax), which imposes the restriction that the factors cannot be correlated, was carried out after the initial extraction of the factors, so the total amount of variance accounted for is redistributed over the seven extracted factors to yield more interpretable results. Finally, the 7 factor score variables were calculated from factor score coefficients and utilised to run cluster analysis (see section 4 for the interpretation of factors).

Hierarchical clustering performed by a bottom up agglomerative approach arranged the set of firms into homogeneous groups (Jobson, 1992). This method starts with each case describing a cluster, and then combines them into more inclusive clusters until only one cluster remains.

Pearson correlation was used to measure similarity between cases, and the Average Linkage Within Groups method was chosen to merge nearest clusters into broader groups. This method combines clusters so that the average distance between all cases in the resulting cluster is as small as possible. Thus, the distance between two clusters is the average of the distances between all possible pairs of cases in the resulting cluster.

The agglomeration schedule and dendrogram were used to follow up the grouping process of all the firms at the different stages. In conclusion, 3 clusters representing the best result in terms of the following criteria were determined: i) minimum number of firms for each cluster; ii) 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); iii) different characteristics of the resulting clusters.

4. Results and discussion

The descriptive analysis shows that the sample of meat sector consists mainly of private firms (84%): 49% of the respondents operate in ham production, 38% in slaughtering and 13% in chicken meat processing. The annual turnover of 28% of the firms is less than 10 million Euro, 38% is between 10 and 25, 13% between 25 and 50 and 22% higher than 50 million. Most of them use contracts (formal agreements) and register a low level of vertical integration. Of the sample, 66% do not have the ownership of any farms (table 1).

The survey underlines an increase in the degree of human, site and physical asset specificity. Firms state that i) a long term business relationship is an important factor to decide which suppliers can be part of a traced supply chain (84% of answers); ii) the substitution of certified suppliers is more difficult than the substitution of uncertified suppliers (63%); iii) most of the suppliers involved in the voluntary traceability system are located near the firm (50%); iv) the implementation of the voluntary traceability system needs some material investments (28%).

Therefore, the results show that there has been a decrease in the uncertainty degree in transactions, a consequence of the greater frequency (91%) and quantity (81%) of exchanged information.

The interviewed firms also revealed that there has been an increase in transaction costs relating to monitoring: an increase in supplier activity controls (91%) and raw material controls (78%).

Table 1. Firms perceptions about effects of voluntary traceability on transactions characteristics, costs and vertical coordination ⁽¹⁾

	Meat processing firms (%)					Total (%)				
	Low	Medium	High	Very high	Total	Low	Medium	High	Very high	Total
Firms characteristics										
turnover (**)	28.1	37.5	12.5	21.9	100.0	45.2	23.3	13.0	18.5	100.0
contracts formalisation (*)	21.9			78.1	100.0	15.8			84.2	100.0
level of vertical coordination	65.6		15.6	18.8	100.0	42.5		17.8	39.7	100.0
final product price variation (*)	50.0			50.0	100.0	71.2			28.8	100.0
Asset specificity variation										
<i>1) Human asset specificity variation</i>										
Long business relations with suppliers	9.4	6.3	40.6	43.8	100.0	4.8	8.2	24.0	63.0	100.0
Difficulty in substitution of suppliers	21.9	15.6	21.9	40.6	100.0	32.2	19.9	20.5	27.4	100.0
Training of suppliers	3.1	9.4	40.6	46.9	100.0	7.5	11.0	34.2	47.3	100.0
<i>2) Physical asset specificity variation</i>										
Processing facilities variation (*)	71.9			28.1	100.0	62.3			37.7	100.0
<i>3) Site asset specificity variation</i>										
Certified suppliers closeness	12.5	37.5	43.8	6.3	100.0	8.9	21.2	35.6	34.2	100.0
Uncertainty variation										
Frequency of information flow variation	3.0	6.3	46.9	43.8	100.0	10.2	6.8	27.2	55.8	100.0
Quantity of information flow variation	6.2	12.5	21.9	59.4	100.0	7.5	8.2	15.8	68.5	100.0
Precision of information flow variation	6.1	6.3	43.8	43.8	100.0	11.0	6.8	20.5	61.6	100.0
Transaction costs variation										
<i>Monitoring costs variation</i>										
Suppliers activity controls variation	6.3	3.1	34.4	56.3	100.0	13.0	2.7	31.5	52.7	100.0
Raw materials controls variation	12.5	9.4	34.4	43.8	100.0	22.6	8.2	32.2	37.0	100.0
Governance arrangements										
Raw materials price variation (*)	75.0			25.0	100.0	71.9			28.1	100.0
Liability degree variation	9.4	15.6	28.1	46.9	100.0	5.5	9.6	25.3	59.6	100.0
Production rules enforcements	18.8	21.9	34.4	25.0	100.0	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=<10 mio euro; medium=10-25 mio euro; high=25-50 mio euro; very high=>50 mio euro

Factorial analysis was applied to summarise the important variables that can explain the organisational changes within the meat supply chain after the introduction of a voluntary traceability system. Rotated factor matrix was calculated to permit interpretation of seven factors (table 2).

The first factor explains the information expressed by contractual support variations, i.e. the liability degree variation (factor coefficient is equal to 0.806) and production rules variation

(0.809). The second represents variables describing firm characteristics, i.e. the degree of vertical coordination (0.919), the legal shape (0.887) and the level of contract formalisation (0.320). The third factor explains economic incentives and final product price variations after the introduction of supply chain agreements (0.865 and 0.755). The other factors are connected with variables explaining physical asset specificity variation (0.867), human asset specificity variation (0.863), site asset specificity variation (0.837), and uncertainty degree variation (0.892).

Cluster analysis applied to the above described components reveals the presence of three groups of firms that differ, one from the other, in terms of voluntary traceability effects on vertical coordination. To facilitate the interpretation of the clusters we calculated the average of factorial coefficients firms in each cluster for each component (figure 1).

Table 2. Rotated component matrix

Variables	Contractual support var. (s)	Firms characteristics	Economic incentives (p), final price var.	Physical asset var., monitoring costs var.	Human asset var.	Site asset var.	Level of information var.
Firms characteristics							
legal shape	-0.076	0.887	-0.122	-0.036	-0.160	0.080	-0.059
turnover	0.002	0.242	0.440	0.123	0.500	-0.436	0.125
contracts formalisation	-0.130	0.320	0.530	0.473	0.298	0.041	0.248
level of vertical coordination	-0.046	0.919	0.180	-0.037	0.002	-0.146	0.024
final product price variation (*)	-0.066	-0.263	0.755	-0.326	0.084	0.073	-0.100
Asset specificity variation							
<i>1) Human asset specificity variation</i>							
Long business relations with suppliers	0.013	-0.186	0.077	0.126	0.863	-0.038	-0.096
Difficulty in substitution of suppliers	0.253	-0.237	0.222	-0.568	-0.201	-0.094	0.433
<i>2) Physical asset specificity variation</i>							
Processing facilities variation (*)	0.080	-0.222	0.062	0.867	0.048	-0.183	0.119
<i>3) Site asset specificity variation</i>							
Certified suppliers closeness	-0.118	0.000	-0.080	-0.185	0.044	0.837	-0.153
Uncertainty variation							
Frequency of information flow variation	0.363	-0.037	0.121	0.082	-0.068	0.624	0.285
Quantity of information flow variation	0.071	0.004	-0.042	0.021	-0.001	-0.022	0.892
Precision of information flow variation	0.817	-0.097	-0.187	0.082	0.125	0.176	0.206
Transaction costs variation							
<i>Monitoring costs variation</i>							
Suppliers activity controls variation	0.557	-0.024	0.190	0.385	0.366	0.300	-0.138
Raw materials controls variation	0.297	-0.065	0.024	-0.486	0.538	0.237	0.299
Governance arrangements							
Raw materials price variation (*)	0.154	0.149	0.865	0.169	0.030	-0.068	-0.011
Liability degree variation	0.806	-0.064	0.195	-0.121	-0.194	-0.086	-0.357
Production rules enforcements	0.809	-0.011	0.036	-0.127	0.060	-0.083	0.233

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=<10 mio euro; medium=10-25 mio euro; high=25-50 mio euro; very high=>50 mio euro

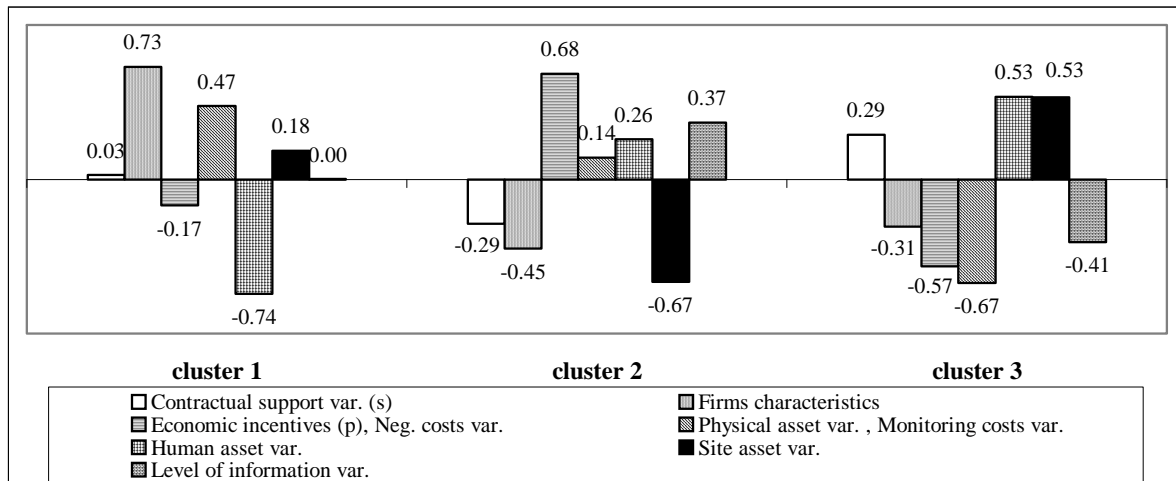


Figure 1. Average of factorial coefficients in each cluster

Source: our survey

In agreement with the Williamson contracting scheme all the interviewed firms reported an increase in asset specificity degree, but it should be noted that each cluster is composed by firms that chose different organisational solutions to promote continuity and safeguard transactions.

The first group, which is explained by the factor of firm characteristics (0.73), consists of eleven firms, most of which are small co-operatives and private vertically integrated firms. These firms have an increase in transaction-specific investments, particularly physical asset (0.47) and site asset specificity (0.18), and there is no increase in human asset specificity as the transacting parties belong to the same company (-0.74). In this case the asset specificity variation does not lead to any reorganisation of the supply agreements because there is no opportunistic behaviour among agents. In this case there is no need for economic incentives or contractual support variation.

The second group, composed by 11 firms with more than 80 employees, adopt economic incentives to safeguard transactions (the third factor is 0.68). These firms have an increase in bilateral dependency because of the human and physical asset specificity variation and a reduction in transaction uncertainty degree because of the increased information flow along the supply chain. In this case the increase in the price of raw materials to respect transaction obligations is sufficient as the firms have had to adopt specific production agreements with their suppliers, most of whom have different quality certification systems.

The last cluster has 10 small firms that are not vertically integrated, and that are characterised by oral agreements for exchanges. These firms register an increase in human (0.53) and site (0.53) asset specificity. The respondents in this cluster did not register any reduction in information asymmetry, and the higher bilateral dependency connected with the traceability system is safeguarded by new contractual supports, like liability variations and production rules enforcement. The factor explaining this information has an average factorial coefficient of 0.29.

5. Concluding remarks

Voluntary traceability plays an important role not only within the framework of food safety measures, as in the European mandatory system, but also in guaranteeing food quality standards and improving vertical coordination in food supply chains. The reorganisation of vertical relations is connected to the introduction of a new transactions governance based on supply chain agreements. This reorganisation involves a leadership position for one firm in the supply chain and calls for the implementation of production rules for the economic agents. In our analysis the leaders of the supply chain are the meat processing firms.

From the transaction cost perspective these vertical changes have led to variations in key transaction factors and monitoring costs. The empirical analysis of the meat processing supply chain in Italy showed three major effects resulting from voluntary traceability: an increase in the bilateral dependency of the economic agents, highlighted by growth in human, site and physical asset specificity, a decrease in the uncertainty level of transactions, and an increase in monitoring costs due to the enforcement of controls.

Cluster analysis revealed that the vertical organisational changes are clearly more obvious in the smaller firms as, before the introduction of voluntary traceability, most transactions were based on informal relations. Even so, also the bigger firms have shown supply chain reorganisation, but this is less evident because of the presence of other quality system certifications.

Moreover, the analysed clusters reveal different safeguarding conditions for agreements; small firms provide for contractual supports to avoid the risk of contractual infringements, whereas the bigger firms set price incentives to reduce opportunistic behaviour among the economic actors of the supply chains.

Thus, our empirical analysis of voluntary traceability has outlined an improvement in information flow, and a reinforcement of trust and liability among the economic agents of the supply chain. Nevertheless, few Italian food firms apply the system; this could be due to the difficulties encountered in implementing the voluntary traceability system and to consumer 'backwardness' in conferring recognition.

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