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## **Traceability, Trust and Coordination in a Food Chain**

**Christophe Charlier**

Université de Nice Sophia Antipolis and GREDEG/CNRS, France,  
[charlier@idefi.cnrs.fr](mailto:charlier@idefi.cnrs.fr)

**Egizio Valceschini**

<sup>2</sup>Institut National de la Recherche Agronomique, Paris, France,  
[Valcesch@inapg.inra.fr](mailto:Valcesch@inapg.inra.fr)



**Paper prepared for presentation at the 99<sup>th</sup> EAAE Seminar ‘Trust and Risk in Business Networks’, Bonn, Germany, February 8-10, 2006**

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## Traceability, Trust and Coordination in a Food Chain

*Christophe Charlier<sup>1</sup> and Egizio Valceschini<sup>2</sup>*

<sup>1</sup> *Université de Nice Sophia Antipolis and GREDEG/CNRS, France,*

<sup>2</sup> *Institut National de la Recherche Agronomique, Paris, France,  
charlier@idefi.cnrs.fr, Valcesch@inapg.inra.fr*

### Abstract

In response to sanitary crisis, risk management has become a central issue for food producers and distributors in Europe. Organisational responses to sanitary risks usually implying traceability have been conceived by firms. One of the main tasks here is to deal with coordination of the different operators of a food chain. The European Union has developed a regulatory framework with the Regulation 178/2002. This regulation sets a mandatory traceability considered as a risk management tool. Traceability that was considered as a private initiative has therefore become an obligation with this regulation. This paper tries to evaluate if the problem of the operators' coordination on specific traceability practices that any private organisational of a food chain had to face is solved with the strict application of the Regulation 178/2002. For that, the analysis characterises the mandatory traceability and the operators' responsibilities set by the regulation. The coordination task and the problem of trust that it contains is then described. The analysis shows the limits of the mandatory traceability in this context and suggests a solution.

**JEL Codes:** I18, K32, Q18.

**Key words:** *traceability, risk management, food safety*

### 1. Introduction

In response to sanitary crisis, risk management and signalling safety properties have become central issues for food producers and suppliers in Europe. Organisational responses usually implying traceability have been conceived by firms (Bullock and Desquilbet 2002, Mazé 2002, Ménard and Valceschini 2005, Starbird and Amanor-Boadu 2004). One of the main tasks of these organisational responses is to deal with coordination of the different operators of a food chain. The choice of the traceability level depends on that coordination (Souza-Monteiro and Caswell 2005). At the same time, the European Union has developed a regulatory framework with the Regulation 178/2002. This regulation is well known for the European Food Safety Authority it establishes. Together with this Authority, the Regulation 178/2002 sets rules and procedures in the matter of food safety that aim to create a harmonised food safety system for the European Communities. In this context, a mandatory traceability appears and is considered as a risk management tool required for “accurate and targeted withdrawals” of products from the food chain. Traceability that was considered as a private initiative has therefore become an obligation with the Regulation 178/2002.

The paper tries to evaluate if the problem of the operators' coordination on specific traceability practices that any private organisational of a food chain had to face is solved with the strict application of the Regulation 178/2002. For that, the analysis characterises (section 2) both the mandatory traceability and the information produced (as in Charlier 2005). Together with traceability, the operators' responsibilities set by the Regulation 178/2002 are presented. The coordination task and the problem of trust that it contains is then described (section 3). The analysis shows the limits of the mandatory traceability in this context and suggests a solution.

## **2. Traceability and other new food safety principle**

The Regulation 178/2002 sets new obligations for firms with regard to food safety. Traceability is one of these obligations and will be presented first (2.1). However to be fully understood, traceability has to be linked to the other obligations on food safety put forward by the Regulation 178/2002 (2.2).

### *2.1. The Traceability requirements of the Regulation 178/2002*

Precisions on traceability requirements in the Regulation 178/2002 are found in article 18. At all stages of production, processing and distribution, the necessity of traceability concerns food, feed, food-producing animals and any other substance intended to be, or expected to be, incorporated in food or feed. In other words, all inputs of the food production process and the considered food shall be traced. Consequently, every food and feed business operator is concerned with traceability, producers and retailers likewise.

For the Regulation 178/2002, the aim of traceability is to “ensure that food or feed business (...) can identify at least the business from which the food, feed, animal or substance that may be incorporated into a food or feed has been supplied” (Point 29 of the preamble of the Regulation 178/2002). The traceability described in article 18 of the Regulation 178/2002 emphasizes therefore that food and feed business operators shall be able to identify any person, or business client, from whom they have been supplied with a food. This system of traceability has been called “one step backward and one step forward” for that reason. The information shall be registered at each stage of production on specific documents. The time this information should be retained is not specified however. The traceability required by the Regulation 178/2002 is therefore drawn up step by step. It is never demanded that information on the content of a food, its origin etc. goes through the production process and the distribution chain towards the market. The information produced at a stage of production can be confined at this stage. The different information elements can therefore remain scattered through the stages of the production process since no more requirements are made in the Regulation 178/2002. As a consequence, the production process cannot be traced. The traceability request concerns products only and it is the transactions between the different operators of a production process that form its base.

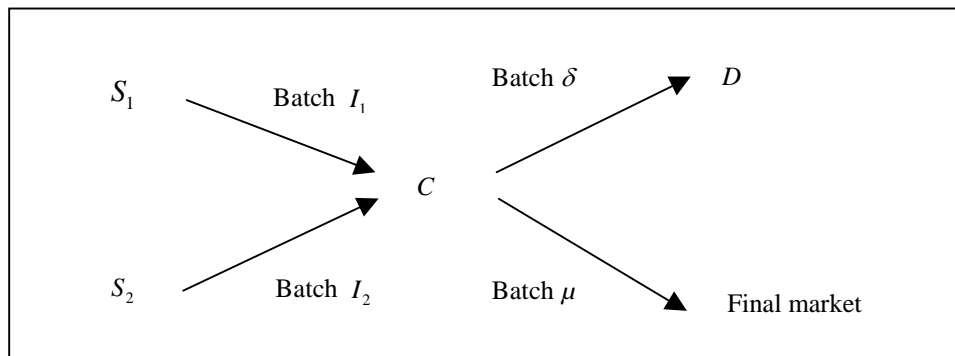
The required traceability is therefore less demanding than a system that would organize simultaneously the production of information and the transmission of information throughout the entire production process. This latter system of traceability would be more efficient

regarding the sanitary security aim highlighted by the Regulation 178/2002 but it would be more costly as well since it would require the labelling of every product. The traceability system asked by the Regulation 178/2002, without any label or document attached with the product as complement, can only create the framework for a “treasure hunt” for the public authorities: It is up to them to discover the path of the product. Furthermore, as is pointed out in the following, this traceability system cannot discriminate goods.

As an illustration, a producer  $C$  makes his output with the help of an input supplied by two producers ( $S_1$  and  $S_2$ ). These producers are therefore linked in a vertical relation as shown in figure 1. Both suppliers sell a batch of input to  $C$ :  $I_1$  for supplier 1 and  $I_2$  for supplier 2 respectively. Perfect substitution between the two inputs is supposed. Therefore, producer  $C$  can produce his output from  $I_1$  or  $I_2$  alone, or mixing inputs from the two batches. The set of the possible input mixings contains therefore three elements:

$$M = \{(I_1), (I_2), (I_1, I_2)\}$$

Finally, producer  $C$  sells his product on the final market and to another producer  $D$ .



**Figure 1.** Traceability

If producer  $C$  only meets the traceability requirements of the Regulation 178/2002 (to be able to identify at least the businesses from which the food inputs have come and the businesses to which the food has been supplied) the information that he should register consists in two sets.

The first information set concerning the input he uses contains two elements:  $I = \{I_1, I_2\}$ . The second set of information concerns the output he sells. This set contains the two elements  $\mu$  and  $d$ , where  $\mu$  and  $d$  mean batches of output sold on the market and to business client  $D$  respectively.

Together with traceability, new dispositions concerning operator's responsibilities are set in the Regulation 178/2002.

## 2.2. Operators' responsibilities

Articles 19 and 20 of the Regulation 178/2002 set responsibilities for food and feed business operators. Like article 18 for traceability, these articles are put into practice since January 2005. They apply to all stages of production, processing and distribution of food and feed and fix operators' obligations concerning food withdrawal, information, and cooperation with public authorities.

In these two articles, the idea of self-control is the basis of the operators' obligations. This idea of self-control appears in the first part of article 17 on responsibilities. Indeed this article states that "food and feed business operators (...) shall ensure that foods or feeds satisfy the requirements of food law which are relevant to their activities and shall verify that such requirements are met". The self-control takes therefore the form of a "conformity inspection requirement". In accordance with this requirement, articles 19 and 20 point out the crucial role of operators' beliefs and private information. It is on the ground of these elements that operators' actions are intended to be initiated: "If a food business operator considers or has reason to believe that a food which it has imported, produced, processed, manufactured or distributed is not in compliance with the food safety requirements, it shall immediately initiate procedures to withdraw the food in question from the market (...) and inform the competent authorities thereof".

The responsibilities presented in articles 19 and 20 cover three distinct fields. The first one, as shown in the preceding quotation, is the withdrawal of products from the market. This operation is placed under the control of the operator who suspects harmful effects on health. Instead of waiting for authorities' intervention, the operators are intended to act on their own initiative. This pro-active behaviour is completed with an obligation to inform authorities. This forms the second field of responsibilities. It is important to note that this obligation appears only once private initiative on risk management has been taken. If the product has reached the consumers, the operators have to inform the consumers "of the reason for its withdrawal". Finally, operators are expected to collaborate with authorities on action taken to avoid or reduce risk, and shall not "prevent or discourage any person from cooperating" with authorities.

All these requirements do not put light directly on traceability. The capacity to withdraw products from the market implicitly needs products traceability however. Therefore the pro-active behaviour put forward by articles 19 and 20 could not be implemented *a priori* without traceability. It is important therefore to evaluate if traceability produces enough information to permit a precise withdrawal of product from the market.

### 3. Operators' coordination for traceability

#### 3.1 Traceability for a targeted withdrawal of products

The traceability requirements of the Regulation 178/2002 presented in section one shows that an operator in the food chain has to be able to identify at least the businesses from which the food inputs have come and the businesses to which the food has been supplied. Complying with these requirements implies costs. If the assumption is made that an operator is looking at the minimisation of these costs, the batches he constitutes, for obvious economic reasons, are based on the identity of the person to whom they are sold rather than on the mixing of inputs they have originated from. Producer  $C$  for example distinguishes batches  $m$  and  $d$ . It is important to note that batch  $\mu$ , for example, can put together outputs that come from the two input mixings  $(I_2)$  and  $(I_1, I_2)$ . As a consequence, the set of information he forms  $\{\mu, \delta\}$  is not necessarily a partition of the set of the possible input mixings. As a result, the created traceability does not allow precise product withdrawal from the market or from the production process. For instance, if a sanitary problem arises because of input from batch  $I_1$ , both batches  $m$  and  $d$  (e.g. the entire production of  $C$ ) should be withdrawn from the market and the production process.

To track every unit of output, producer  $C$  should differentiate three batches corresponding to the three different “inputs mixings” he has operated in his production:

$P_1 = \{\{I_1\}\}$  output produced with input from  $I_1$  alone.

$P_2 = \{\{I_2\}\}$  output produced with input from  $I_2$  alone.

$P_{1,2} = \{\{I_1, I_2\}\}$  output produced with input from  $I_1$  and  $I_2$ .

The set of output batches should therefore be  $DT = \{\{\{I_1\}\}, \{\{I_2\}\}, \{\{I_1, I_2\}\}\}$ . It is important to notice that  $DT$  is the finest partition of set  $M$ . This means that each input mixing is isolated in a subset corresponding to a specific batch. These batches should therefore be registered, in compliance to Regulation 178/2002, on the basis of the person to whom they are sold. If a production from a batch is sold to different persons, an equivalent number of batches should be defined.

The system of traceability created this way thus attaches two dimensions to the batches: their orientation in the production process (with the identification of the persons who buy them) and their nature (with their input composition). This system is called in what follows, “discriminating traceability”, since it can be used to locate precisely each unit of goods in the production process. If  $P_1$  is sold to producer  $D$  and  $P_2$  and  $P_{1,2}$  to the market and if a sanitary

problem arises because of batch  $I_1$  for instance, only batches  $P_1$  and  $P_{1,2}$  should be withdrawn from the market, whereas  $P_2$  remains in the food chain.

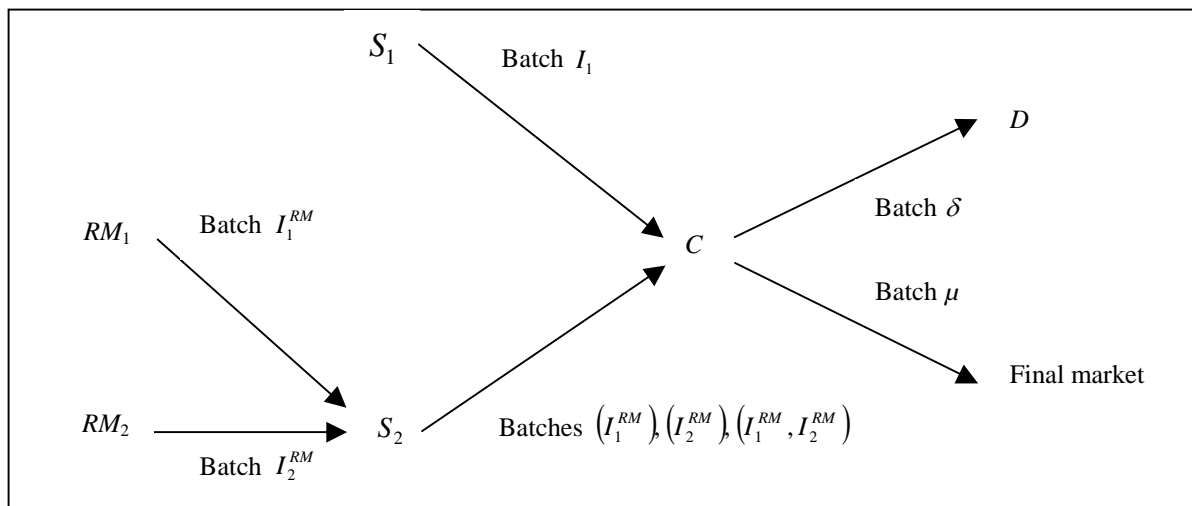
The Regulation 178/2002 however does not impose precise conditions with regard to batches formation. The discriminating traceability will not therefore appear as the mandatory traceability. If implemented, it shall be considered as the result, on the one hand of pro-active behaviours of some operators, and on the other hand of the solution of a coordination problem that these pro-active behaviours will inevitably be confronted with (3.2).

### 3.2 The problem of coordination on specific traceability practices

In a food chain some firms will be more attentive to the requirements on responsibilities that imply auto control and that requires the capacity to withdraw products from the market. Some others will be aware of the cost of a sanitary crisis and will choose traceability practices more stringent than the mandatory one so as to be able to intervene rapidly and to confine the safety problem. In this perspective the notion of collective reputation is of importance in a food chain. Indeed, the consumers' confidence can be broken by wrong practices of few operators and will affect the other operator's reputation.

In this context the fact that traceability is required for food and feed by the Regulation 178/2002 can appear as a good new. The result however is not so straightforward. Indeed, it can be shown that a single operator can "scramble" the information produced by the other operators of the food chain while compelling with the requirements of the mandatory traceability.

To show this result, the simple illustration of a food chain is used:



**Figure 2.**

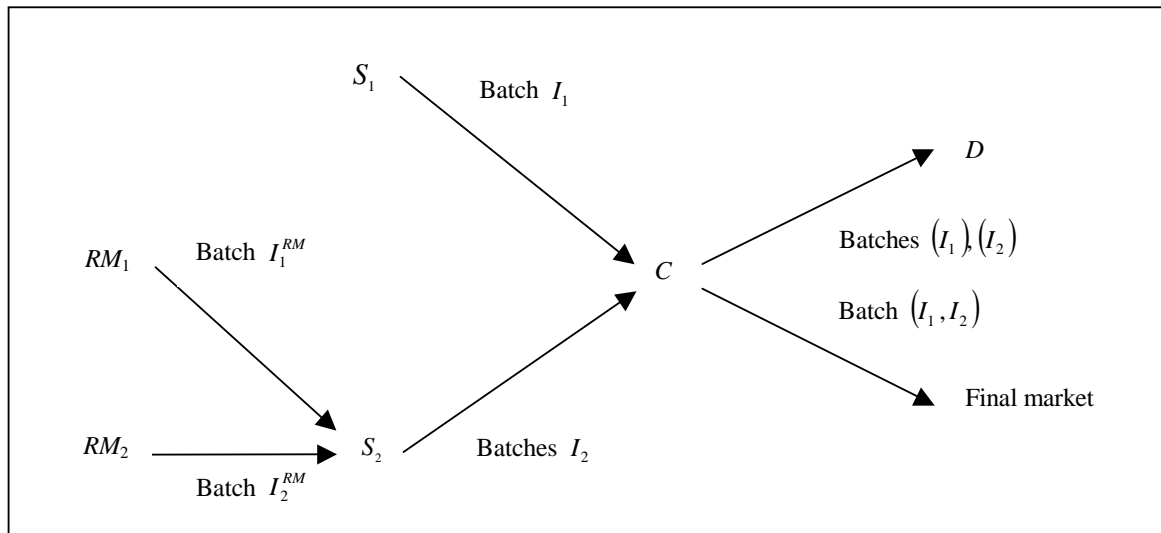
Two suppliers of raw material have been added ( $RM_1$  and  $RM_2$ ) in figure (2). They both sell a batch of their respective raw material to  $S_2$ . This latter is supposed to use these inputs to create an output sold to his business client  $C$ . In this food chain every operator upstream to  $C$  is



supposed to implement a discriminating traceability.  $S_2$  for instance distinguishes three batches –  $(I_1^{RM})$ ,  $(I_2^{RM})$  and  $(I_1^{RM}, I_2^{RM})$  – corresponding to the three raw material mixings operated. Producer  $C$  is supposed to meet the requirement of the mandatory traceability, without however implementing a discriminating traceability. As a result, he scrambles the information produced by others while complying with traceability requirements of Regulation 178/2002. If a sanitary problem arises because of batch  $I_1^{RM}$  of raw material 1, the entire production of producer  $C$  has to be withdrawn from the market. If a discriminating traceability had been chosen by  $C$ , every batches where  $I_1^{RM}$  does not appear would have remained in the food chain (i.e. the batches  $(I_1)$ ,  $(I_2^{RM})$  and  $(I_1, I_2^{RM})$ ).

This situation raises a coordination problem among the operators of a same food chain. Indeed the cost supported by  $RM_1$ ,  $RM_2$ ,  $S_1$  and  $S_2$  to implement a discriminating traceability is made useless by the traceability practice of producer  $C$ . To avoid this problem the operators have to coordinate their traceability practices.

The case depicted in figure (2) forms an extreme scenario since only one operator does not implement a discriminating traceability whereas every firm upstream implement it. Other cases can of course be conceivable. An interesting case for the rest of the article is the one where only producer  $C$  implements a discriminating traceability whereas all other upstream firms do not. This case is illustrated with the figure (3).



**Figure 3.**

In this case, if a sanitary problem appear because of  $RM_1$ , the producer  $C$  should withdraw both batches  $(I_2)$  and  $(I_1, I_2)$ . The entire production of food is not therefore withdrawn from the market. This result reveals an important characteristic. If a producer does not implement a discriminating traceability whereas all other producers implement it, he will scramble more information if he operates downstream of the food chain than upstream.

Before going farther, it is important to note that the possibility to scramble information comes from two characteristics of the Regulation 178/2002. The first characteristic is that the information produced by mandatory traceability is insufficient to proceed to targeted withdrawal of products. If mandatory traceability were sufficiently strong, with precise conditions for example on the constitution of the batches, this problem of coordination would not appear. The second characteristic is that the coordination of operators of a food chain is not considered by the traceability requirements and more generally speaking by the Regulation 178/2002. Two features are particularly salient here. On the one hand, requirements are addressed to operators considered separately and, on the other hand, the “one-step-forward-one-step-backward” principle for traceability has the effect to isolate the traceability practice of an operator from the traceability practices of others. If the first aspect can hardly be avoided in a regulation text, the second one reveals that the “chain dimension” of the food production system is not taken into account in the Regulation 178/2002 when defining traceability requirements.

In front of this result, firms wishing to enhance their traceability for quality and safety reasons should have to deal with organizational control of the food chain since the result of their effort depends on the traceability practices of the other operators. This situation raises an immediate question. Since the private organisation of a food chain is needed for firms that wish to enhance their risk management practice should we conclude that the Regulation 178/2002 miss its aim as far as risk management perspective is considered?

### *3.3. Trust and leadership for traceability*

As soon as an important number of inputs enters the production process, implementing a discriminating traceability becomes illusory. Too many batches should be distinguished from a practical point of view and the cost of such a policy would probably be unacceptable. Therefore, firms who wish to enhance their traceability beyond the mandatory one will choose intermediate forms of traceability permitting to handle the interconnectivity of the different stages of the food chain (see Hennessy et al. 2003). This task however needs two prerequisites. The first one is coordination on a traceability practice between firms of the food chain. This coordination is necessary to determinate how fine the information structure should be. The second prerequisite is a collective agreement on the definition of the sanitary risks the food chain faces (see Golan et al. 2004). This common belief should put the different individual traceability efforts on the same way so as to reach a global coherence. Once these two prerequisites are met, the traceability implemented along the food chain will be more informative than the mandatory one. However, it will be less informative than the discriminating traceability. A perfect-targeted withdrawal of products from the food chain will not be possible therefore.

Precise recommendations are missing for the intermediate forms of traceability. Indeed, the two prerequisites directing the traceability practices of the operators form a guide rather than a traceability standard. As a consequence, an operator cannot know precisely what the traceability practices of the other operators are. In this situation, an operator is unable to predict precisely the consequences of the realization of a specific risk. The extent of the

withdrawal of his products from the food chain does not depend on his sole traceability but related to the traceability implemented by the other operators of the food chain. Consequently, the way the management costs of a sanitary crisis will be shared among the operators of a chain food is unknown *ex ante*.

The lack of trust an operator can have confronted to the costs of traceability creates therefore an incentive problem. A kind of hold up problem on traceability investment appears since the information produced by an operator with its traceability can be scrambled (partially or totally) by inadequate traceability practices of the other operators. The operator cannot therefore takes advantage of its traceability efforts to minimize the *ex post* costs of risk management. This situation does not incite the operator to choose *ex ante* a stringent form of traceability.

In front of this kind of difficulty, the necessity of a private organization of the food chain is usually put forward (Mazé 2002, Ménard and Valceschini 2005). The described situation allows being more specific about the difficulty this organization faces. The lack of a discriminating traceability annuls the possibility to make the products withdrawal from the market contingent to the realized risk. The private organization of the food chain will therefore take the form of an incomplete contract. Such an organizational form cannot however be considered as a direct solution to the problem of under investment on traceability. The difficulty the operators meet *ex ante* to foresee what will be *ex post* the exact repartition of the cost of the management of a sanitary crisis does not incite them to implement a traceability more stringent than the mandatory one. To face this problem a form of leadership has to be decided in the food chain (Hennessy et al. 2001). A leadership hierarchy generating trust in the food chain can improve the situation strengthening the incentives to invest on traceability. The role of the leader should be twofold. First, the leader should choose *ex ante* the traceability standard that has to be implemented through the food chain. Second, he should be decisive *ex post* for the repartition of the burden of the cost of the sanitary crisis management.

Who should be the leader? What should be the criteria allowing to answer this question? Before presenting elements of response it is interesting to note that far from helping, the Regulation 178/2002 is likely to complicate matters. Indeed, the dispositions concerning operators' responsibilities consider indifferently every operator. Their position and function in the food chain is never considered as elements that could differentiate their responsibilities.

The preceding analysis however puts light on a particular point. It shows that an operator located downstream in the food chain has more latitude to scramble the information produced by other operators' traceability than an operator located upstream. The idea to bring other operators' traceability into line with the traceability implemented by the operator placed at the end of the food chain would permit to avoid this problem. This line of reasoning argues in favour of distributors as leader of a food chain. Two other facts put weight on this idea. The first one is that sanitary risks scarcely come from the distributors' activity. Sanitary risks more often come from the inputs employed and the food production process. The second fact appears when considering reputation. The operator that has an interest to build through time the reputation to behave non-opportunisticly in case of unforeseen events should be chosen as leader of an incomplete contract (Kreps 1990). This argument clearly points out distributors

as leader of food chains. A distributor indeed acts as an interface between the food chain and the consumers. Regarding consumers, a distributor will be interested in building the reputation to deliver safe food. The reputation for a distributor not to scramble information produced by others and to behave fairly in front of an unforeseen sanitary crisis should permit him to keep relations with a food chain and to address to other chains for other kinds of food. All these elements differentiate the distributors among the operators of a food chain and can be seen as arguments to give the leadership of a food chain to distributors.

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