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# Voluntary Approaches to Food Safety: New Insights

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# Voluntary Approaches to Food Safety: New Insights

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**Abstract:** Food safety economists have raised numerous questions according to the emergence and the multiplication of safety quality management system within the food supply chain. However, few research deal with the voluntary implementation by firms of these systems (Segerson, 1999; Venturini, 2003; Noelke-Caswell, 2000). Our paper aims to develop a unified analytical framework of these research. We obtain three results.

First, in a market model when the mandatory threat is strong, the voluntary adoption of safety measures is an equilibrium without need of the cost differential assumption (Segerson, 1999) nor of a reputation effect (Venturini, 2003). Second, when the mandatory threat is weak the reputation effect and the rule of liability could induce the voluntary adoption on different extent depending on the situation of safety contamination. Third, in a supply chain model we introduce a retailer and show that a well designed contract offered by the retailer induce upstream firms to voluntarily implement safety measures. Private incentives are thus very powerful and can be used as the sole mechanism to implement the efficient system.

**Keywords** *: Food Safety, Voluntary Approaches, Supply Chain.*

## 1. Introduction

In the nineties, the multiplication of food safety outbreaks has raised concerns about food safety both from governments and from consumers. In this context, food safety regulation has evolved from performance process-related requirements to performance standard, granting more flexibility to firms. That is, firms can choose the least cost method to reach the performance standard (Caswell-Hooker, 1996; Unnevehr-Jensen, 1996). Consequently, in the food supply chain, quality management metasystems(Caswell and al., 1998) have emerged both to enhance food safety and to comply with new food safety regulation. Therefore, papers in the food safety literature have mainly focused on the impact of this new safety regulation. For example, Loader-Hobbs (1999) have shown that this legislation can provide incentives and opportunities for firms requiring very fast strategic actions. Similarly, Henson-Heasman (1998) have analyzed the firm's compliance process to food safety regulation and show that firms follow a common sequence of activities when they have decided to comply with a new safety regulation. Buzby and Frenzen (1999) have focused on the US product liability system for food contamination episode and its impact on the firm incentives to produce safer food. Others research analyzed what goes on inside the firm. For example, Unnevher-Jensen (1999) have scrutinized the role of the HACCP safety control system as a public standard of food safety, and Henson-Hooker (2001) have dealt with both private and public implications of a private management of safety controls. Both have documented the different strategies that a firm may face when it has to comply with new safety requirements. Caswell and al. (1998) show that the adoption of a quality management system affects both firm's profit and competitiveness in the food supply chain.

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However, if some papers analyze the firm's incentives to adopt quality management systems (Henson- Holt, 2000; Holleran et al., 1999; Northen, 2001), there is little formal discussion putting the emphasis on the voluntary nature of the implementation by firms of these systems. A first strand studies a "market model" where the firm faces only to the regulator who can impose a mandatory (public) safety system. Following the large body of literature in environmental economics that deals with voluntary approaches (see Khanna, 2001 for a survey), Segerson (1999) develops a model to analyze the voluntary choice of firms assuming that a mandatory program is more costly than a voluntary one. She shows that the only credible mean to induce a firm to adopt voluntary preventive measures is a strong mandatory threat to be imposed a more costly system. Venturini (2003) relaxes her assumption and argues that a strong mandatory threat is a necessary but not a sufficient condition to induce voluntary implementation of safety measures by firms. That is, an additional government intervention is needed: it must help firm in signalling safer food products to consumers. A second strand analyzes a "supply chain" model where a retailer (downstream firm) can impose its own (private) safety system. Noelke- Caswell (2000) explore the incentives to implement a voluntary system in a simplified supply chain where three different quality management systems could be implemented under two different systems of rules of liability. The authors show that the level of safety the firm implements through a voluntary quality management system is always higher than through a mandatory or a quasi- voluntary one (imposed by the downstream firm). However, this level depends on the safety level implemented by the upstream (supplier) and the downstream firm (retailer). They also show that under a rule of negligence, firms implement a higher level of quality management than under a rule of strict liability. Indeed, a rule of negligence system leads most of the time to over- compliance by firms.

Our paper aims to develop a unified analytical framework of these two strands. First, considering a "market model" we analyze the making decision process of a firm marketing food products that will be consumed in their fresh form (e.g. meat, fish, fruit and vegetables). This allow us to divide the safety risk in two categories related to the consequences of a contamination on human health. First, we distinguish situations of major safety risk with immediate and strong consequences on consumers' health. We particularly point out the pathogenic or microbiological risk where products contamination could be lethal for consumers (for example we could find such a safety risk in the fresh meat or fish industries). Second, we distinguish situations of minor safety risk with very low probabilities of strong and instant consequences for human health after consumption of an altered product. We have in mind a safety risk as the pesticide risk we find in the fresh produce industry which can be qualified as being a "minor" risk in comparison to the pathogenic one. On these statements we thus assume that the magnitude of consumer's response following a contamination episode will differ according to the type of risks. The response from consumer will be "hard" in the former case, and thus can destroy the “reputation” of the firm, and “soft” in the latter. In such a setting we show two main results: (i) when the regulator involvement in promoting food safety is strong, whatever the nature of consumer response, neither the cost differential assumption (Segerson, 1999) nor the reputation effect (Venturini, 2003) are needed to implement a voluntary safety system; (ii) when the regulator involvement is weak, two mechanisms may have some impact: the reputation effect and the rule of liability. However, when the consumer response is “soft”, there is no reputation effect and only the rule of liability may induce the voluntary adoption of safety measures by firms. This result raises issues of the design of the rule of liability and of the effectiveness of civil litigations in situations of safety failures when the response from consumers is “soft”. Second, maybe the addition of some “private” incentives may solve the problem. Introducing a retailer (namely, supermarkets) in the supply chain model, we show that a well designed contract offered by “a large scale retailer” can induce upstream firms to voluntarily implement safety measures. That is “private incentives” provided by the retailer are very powerful and can be used as the only mechanism to implement the efficient choice.

The paper proceeds as follows. Section 2 deals with the market model. Section 3 extends the framework to deal with the firm's decision to voluntarily adopt safety measures in a supply chain. Sections 4 concludes.

# 2. A market model

In this section, we develop a model that focuses on a firm face to the regulator and “the market'”, that is consumer. The model does not deal with the regulator's willingness to pay to induce firm to voluntarily implement measures to improve food safety (“carrot” approach). The firm will thus not receive subsidies for voluntarily implementing safety measures. Therefore, incentives to implement voluntary measures comes from: (*i*) the regulator ability to impose to the firm a mandatory system improving food safety (“stick” approach); (*ii*) the different types of sanctions (economic and legal) that the consumers (“the market”) can impose to the firm following a contamination episode.

## 2.1. Set up

We consider a two- stage game (see Figure 1). In the first stage, the firm has two courses of actions: (i) implementing a voluntary safety system to produce and market safer products; (ii) not to voluntarily take any safety measures. If the firm implements a voluntary safety system the game is over. If the firm decides not to implement voluntary safety measures, the game continues. Thus, in the second stage the regulator intervenes with a probability $r \quad 0;1$ . We assume that $r$ is an exogenous probability, which reflects the probability that the regulator imposes a mandatory safety system to the firm. When $r \quad 0$ there is no mandatory threat, albeit when $r \quad 1$ the imposition of a mandatory system is certain. Whatever the firm's decision, a contamination episode may occur. If the firm does not adopt any voluntary safety measures and the regulator does not impose any mandatory safety measures, there is a probability $p \quad 0;1$ that a contamination episode occurs. When (voluntary or mandatory) safety measures are undertaken, there is a probability $q \quad 0;1$ of contamination. Since undertaking (voluntary or mandatory) safety measures can reduce contamination risks but does not allow to completely avoid it we assume that $0 \quad q \quad p$ . We suppose that $p$ and $q$ are exogenous probabilities. When a contamination episode occurs, consumers may sue the firm for damages. Let $L$ denote the positive amount to be paid related to the judicial proceedings following a contamination episode. $L$ will depend on the rule of liability which is operative regarding the payment of damages for injured consumers.

Concerning the payoff function of the firm, consider first the cost of implementing safety measures. Let $C_V$ and $C_M$ be the costs that a firm bears when it reaches a given level of food safety through respectively a voluntary and a mandatory safety system. Following the voluntary approaches literature in the environmental economics, Segerson (1999) assumes that the compliance costs associated to the implementation of a mandatory safety system (training employees, record keeping equipment, etc.) are higher than those associated to the implementation of a voluntary one. In contrast, Venturini (2003) suggests that such a cost differential is not supported by empirical evidence on the implementation of safety system such as HACCP[1].

Therefore, in what follows we suppose as Venturini (2003) that $C \quad C_M \quad C_V \quad 0$ . Consider now the firm's benefit of implementing safety measures. Following Venturini (2003), and in contrast to Segerson (1999), we split the gross benefit of implementing voluntary measures in three components. That is $B_V \quad B_0 \quad B_D \quad B_R$ , where $B_0$ reflects the net revenue from products sales, $B_D$ the direct market benefit due to an increased demand for its product as a result of increased safety, and $B_R$ the benefit due to the firm's stock of reputation. Similarly, when the regulator imposes a mandatory safety system to the firm, it will receive $B_M \quad B_D \quad B_0$. When no safety measures (voluntary or mandatory) are implemented, it only receives $B_0$ its benefit from the sale of products. This implies that the minimum benefit the firm can get is $B_0$ . Moreover, since the direct market benefit $B_D$ is the same whether the firm implements a voluntary or a mandatory safety

[1] See Colatore and Caswell, 1999; Zaibet and Bredhal, 1997. For example, Colatore and Caswell (1999) show that for eight breaded fish companies the costs adoption of a mandatory HACCP raises the annual total costs of only 0.25%.

system, the "incentive" component for a firm to adopt voluntary safety measures is $B_R$, that is the benefit due to its stock of reputation. We assume that after a contamination episode $B_R$ could be altered, even if $B_R$ still remains nonnegative. Indeed, the firm may loose its "good reputation'' ($B_R$ can decrease to 0) depending on the magnitude of consumers' response following a contamination episode. We consider two situations. First, a contamination episode leads to a "hard" response from consumers because of strong or lethal consequences following a contamination episode (pathogenic risk in the fresh meat sector). In that case, a contamination episode is followed by a dramatic fall of the firm's reputation. Second, a contamination episode leads to a "soft" response from consumers. This is the case with pesticides issues in the fresh produce industry since most of the time consumers are not fully aware about health problems linked to consumption of contaminated fruit and vegetables which primarily have not instant but cumulative effects.

## 2.1. Case 1: Contamination involving a hard response from the consumer

We refer here to situations where contamination episode may have immediate and strong consequences (lethal) for consumers. In such cases, firms, which have marketed, altered products face to very high commercial stakes. When the firm has undertaken a voluntary safety system and there is no contamination episode, the firm gets all the net full return $B_V \; C_V$ from voluntarily increasing products safety. In contrast, when a contamination episode occurs with a probability $q$, then the the firm gets only $B_0 \; C_V \; L$. Indeed, in such a case the "hard" consumer's response has two consequences. First, the benefit decreases from $B_V$ to $B_0$ since the reputation and increased demand components associated to the increased food safety measure disappear (i.e. $B_D \; B_R \; 0$). Second, it must pay an additional fee $L$ due to legal proceedings. Therefore, the expected payoff that a firm gets when it voluntarily implements safety measures is $q \, B_0 \; C_V \; L \quad 1 \; q \; B_V \; C_V$. When the firm has not voluntarily undertaken any safety measures and the regulator imposes a mandatory safety system, the reputation component in the benefit disappears since the measures are mandatory. Therefore, the net return from increasing the safety is $B_M \; C_M$. When no safety measure have been implemented (voluntary or mandatory), the gross benefit reduces to the minimum gross benefit $B_0$. In both situations, the occurence of a contamination episode implies only a reduction of the expected losses relative to the payments of damages $L$. Therefore, the expected payoff that a firm gets when no voluntary measures are undertaken is $r \, q \, B_0 \; C_M \; L \quad 1 \; q \; B_M \; C_M \quad 1 \; r \; B_0 \; pL$. Then implementing a voluntary safety system is an equilibrium if:

$$q \, B_0 \quad C_V \quad L \quad 1 \quad q \quad B_V \quad C_V \quad r \, q \, B_0 \quad C_M \quad L \quad 1 \quad q \quad B_M \quad C_M \quad 1 \quad r \quad B_0 \quad pL$$

or equivalently

$$qB_0 \quad C_V \quad qL \quad 1 \quad q \; B_V \quad r \, qB_0 \quad C_M \quad qL \quad 1 \quad q \; B_M \quad 1 \quad r \quad B_0 \quad pL \quad \textbf{(1)}$$

Following Segerson's suggestion (1999) we consider now two extreme cases depending on the magnitude of the regulator's involvement in promoting food safety.

### 2.1.1. Strong mandatory threat $r \quad 1$

The regulator imposes mandatory measures if the firm does not voluntarily adopt safety measures. Then (1) becomes

$$1 \quad q \quad B_V \quad B_M \qquad C_M \quad C_V$$

or

$$1 \quad q \; B_R \qquad c \quad \textbf{(2)}$$

Condition (2) implies that the reputation component of the benefit ($B_R$ must outweigh the cost differential $c$. Since we assumed that $c \quad 0$, condition (2) is then

$$1 \quad q B_R \quad 0 \qquad \textbf{(3)}$$

which always holds because $B_R$ is positive. This result implies first that, in contrast to Segerson (1999), a positive cost differential assumption is not necessary to sustain voluntary measures when there is a strong mandatory threat. Indeed, if having a good reputation generate some benefits, then the firm adopts voluntary safety measures. Moreover, it is easier for firms to implement voluntary safety measures when there is no cost differential than when such a differential exists. Second, contrarily to Venturini (2003) claim, there is no need of a government intervention supporting safety signalling to implement reputation effect. Even if the firm has no reputation, that is $B_R \quad 0$, condition (3) is trivially satisfied.

#### 2.1.2."Laissez faire" policy $r \quad 0$

If the government does not impose to the firm a mandatory safety system, then (1) becomes

$$qB_0 \quad C_V \quad qL \quad 1 \quad q B_V \quad B_0 \quad pL$$

or, equivalently

$$1 \quad q \quad B_D \quad B_R \quad p \quad q \; L \quad C_V \qquad \textbf{(4)}$$

This condition implies with a "laissez- faire" policy, the adoption of a voluntary safety system depends on two mechanisms: a "carrot" and a "stick". The "carrot" corresponds to the components of the benefit ($B_D \; B_R$ that can increase when voluntary safety measures are implemented. This potential increase can be quite weak since $B_D$ can be very low because of difficulties in signalling food safety to consumers [2]. But, if a good reputation has a high return, then $B_R$ can be high enough to induce a voluntary adoption of safety measures improving the safety of products it sells. Second, the "stick" corresponds to the reduction of expected losses related to judicial proceedings ($p \quad q \, L$) following a contamination episode occurrence. Therefore, designing an efficient legal rule is an issue. For example, the rule of negligence, which is operative in the United Kingdom, can be an efficient solution to implement voluntary safety measures. Indeed, under the rule of negligence, when a contamination episode occurs the firm is held liable if the level of the safety system it has implemented is equal or lower than what the court could expect. Therefore, this rule often leads firms to “overinvest” in safety measures to comply with the "standard" of the court (Noelke and Caswell, 2000).

### 2.2. Case 2: Contamination involving a soft response from the consumer

In this section we deal with situations where, following a contamination episode, unawareness about the safety risk leads to a weak response from the consumer. This statement is relevant in cases where the appraisal of safety risks and contamination occurrence are quite difficult and costly to monitor. Because the consequences of a contamination episode are not instant in such cases these risks can be assumed as cumulative and have long- term effects on human health. Moreover, because it is difficult and costly to detect and to monitor, the likelihood of a broad contamination is quite low. To take into account of the specificity of this safety risk we suppose here that $q$ and $p$ do not more reflect the likelihood of a contamination episode, but the probabilities for a firm to fail to a test aiming to monitor the safety. In the case of failure, the

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[2] For example in France, signalling food safety is indirectly prohibited by law (Codron et al.. *forthcoming*).

firm's benefit is supposed to be softly affected since consumers are unaware about the safety risk. That is, in contrast to the case 1, when the firm implements a voluntary system the firm gets all the net full return ($B_V \; C_V$ from increasing food safety even if a contamination episode occurs. Given this slight modification in the firm's payoff, now a voluntary strategy is an equilibrium if

$$B_V \quad C_V \quad qL \quad r\, B_M \quad C_M \quad qL \quad 1 \quad r \quad B_0 \quad pL \qquad \textbf{(5)}$$

As previously, we consider two extreme cases.

### 2.2.1.Strong mandatory threat $r \quad 1$

Here, the mandatory threat to impose a safety measure is certain. In this case, the firm will adopt voluntary measures if and only if

$$B_V \quad C_V \quad qL \quad B_M \quad C_M \quad qL$$

or equivalently

$$B_R \quad 0 \qquad \textbf{(6)}$$

The condition (6) always holds because $B_R$ is nonnegative. Even if $B_R$ is equal to zero, i.e. there is no gain to have a good reputation then condition (6) is trivially satisfied. Thus, no additional constraint is needed to induce the implementation of a voluntary safety system.

### 2.2.2."Laissez faire" policy $r \quad 0$

That is the regulator does not impose a mandatory safety measure within the firm. Then, (5) becomes

$$B_V \quad C_V \quad qL \quad B_0 \quad pL$$

or,

$$B_D \quad B_R \qquad p \quad q\, L \quad C_V \qquad \textbf{(7)}$$

As in (4), the firm voluntary adoption of a safety system depends on the same both mechanisms (stick and carrot) which have to outweigh $C_V$. However, if the carrot mechanism (firm's stock of reputation) is still effective, there is a need to discuss about the nature of stick mechanism (the legal issue). As in the "hard" response case, there is a need to a well- designed rule of liability. Civil litigations could be efficient if the consequences of a contamination episode are instant and thus consumers can sue firms which have not be enough preventive. In such cases, the rule of negligence can be considered as the best instrument since a firm can avoid judicial proceedings if it has implemented a level of safety higher than the court can expect. However, civil litigations cannot be efficient when consequences of a contamination episode are not instant and when it can take decades before people gets sick. Indeed, consumers cannot sue a firm which failed to provide safe goods because it is both difficult and costly, and most of the time impossible, to prove the real nature of a contamination. In such a situation, the rule of liability must not be linked to the "outcome" (is there a contamination or not?) but to the "process" (does the firm comply to the monitoring plan designed by the regulator?). For example, in France importers or producers of fresh produce are held liable under criminal law if they fail to the pesticide testing designed by the government agency (Codron et al., *forthcoming* ).

## 3. A supply chain model

In this section, we extend our previous market model by introducing a new player: a retailer. That is, we assume now that the firm does not take decisions only with regard to the regulator, but also to a retailer. Following Noelke and Caswell (2000), we thus consider a simplified supply chain where the previous firm (upstream firm) does not market directly its goods but sells them to a "large scale retailer" (downstream firm). We aim to determine on what extend private incentives from the retailer can influence the decision of the upstream firm to adopt voluntary measures when the consumer response is soft.

### 3.1. Set up

Now, our model is a four- stage game (see Figure 2). The structure of the game is the following. In the first stage, the retailer offers a take- it- or- leave- it contract. If the firm accepts such a contract, the game continues . In the second stage, the firm chooses to implement a voluntary safety system or not. If the firm adopts a voluntary safety system, the game is over. If the firm does not implement a voluntary safety system, then the regulator intervenes in the third stage with a probability $r$ $0,1$ . If the regulator intervenes and imposes a mandatory safety system to the firm, then the game is over. If the regulator does not impose a mandatory safety system, the retailer intervenes in the fourth stage and imposes its own safety system at a probability $s$ $0,1$ . The retailer is supposed to test only the compliance with the safety public standard, since we assume that the retailer does not aim to provide a stronger safety standard than the public one. That is, there is some kind of "task sharing" between the regulator and the retailer: the regulator designs the (public) safety standard and the retailer enforces (monitors the compliance with) the standard. Thus, a product fails to the retailer safety testing with a probability $q$ $0,1$ whatever the firm has implemented or not a safety system.

Following Noelke and Caswell (2000), we distinguish four types of safety systems: *(i) voluntary safety system* , where the firm voluntarily undertakes safety measures. The firm decides to implement a safety system improving the safety of products without any explicit prompting, neither by the retailer nor by the regulator; *(ii) a quasi- voluntary safety system* , where without any explicit prompting by the regulator to implement safety measures the firm could be forced to do so by the retailer. Then, the firm must implement the retailer's requirement and increase its safety level. This system is not really voluntary because firm if they want to keep their contract with the retailer are obliged to implement these systems; *(iii) mandatory safety system* , where all the firm involved in one food industry are forced to implement a safety system imposed by the regulator. Note, that the mandatory system is compulsory, the public system is supposed to be prevalent. That is the retailer is supposed not to ask an additional safety measures to comply with its own requirements; *(iv) no measures* , where no safety measures are undertaken neither by the firm, nor imposed by the regulator or the retailer.

The payoff functions are also slightly modified. Concerning the cost notations, let $C_C$ be the cost associated to the retailer's system implementation. For example, $C_C$ can be the certification costs that the firm must bear when the retailer required a third party private certification. There is no gain for voluntarily implementing safety system we assume that $C_C$ $C_V$ . Similarly, let $B_C$ represent the benefits a firm receives when it implements a quasi- voluntary safety system. Since we assume there is no beneficial advantage to implement a quasi- voluntary safety system rather than a voluntary one, that is $B_V$ $B_C$, more formally, $B_V = B_C = B_R + B_D + B_0$ . Finally, the introduction of a retailer in our food safety game implies that it can design a menu of contracts $P_1$, $P_2$,$P_3$,$P_4$ , where $P_i$ denote the private penalties that the retailer applies to the firm when it fails to provide safe products. More precisely, $P_1$ is associated to a failure with a voluntary safety system, $P_2$ is associated to a failure with a quasi- voluntarily system, $P_3$ with a mandatory one, and $P_4$ is applied when the firm do not undertake safety measures. Below, we assume that $P_3$ $P_4$, that is the sanction related to a firm's failure is higher when the firm has not implemented safety measures than when it has implemented the retailer' system.

### 3.2. Private incentives and voluntary adoption

As in the section 2, we consider two extreme cases depending on the regulator's involvement in the design of safety measures within the supply chain.

### 3.2.1 Strong mandatory threat ($r$ 1 ),

If the mandatory threat is certain ($r$ 1 ), then we get

$$B_V \quad C_V \quad qP_1 \quad qL \quad B_M \quad C_M \quad qL \quad qP_2$$

or equivalently,

$$B_R \quad q \; P_2 \quad P_1 \quad 0 \quad \mathbf{(8)}$$

Since $q$ is always nonnegative and $B_R$ 0 , then condition (8) becomes

$$P_1 \quad P_2 \quad \mathbf{(9)}$$

$B_R$ 0 because there are no reputation effects when the consumer response is soft. We have shown in our market model that a strong mandatory threat is a sufficient condition to implement voluntary measure. In a our supply chain model, an additional constraint is needed: the penalty for failure from the retailer associated to the voluntary system must be lower than the penalty associated to its compulsory alternative, the mandatory one (quasi- voluntary system).

### 3.2.2."Laissez faire" policy with private incentives $r$ 0

We consider the general case where the retailer imposes its own safety system with a probability 0 $s$ 1. In such a case, a voluntary strategy is an equilibrium if

$$B_V \quad C_V \quad qP_1 \quad qL \quad s \, B_C \quad C_C \quad qP_3 \quad qL \quad 1 \quad s \quad B_0 \quad qP_4 \quad qL$$

that is,

$$1 \quad s \quad B_D \quad B_R \quad q \; P_1 \quad P_4 \quad sq \; P_3 \quad P_4 \quad C_V \quad sC_C \quad \mathbf{(10)}$$

Since the consumer response is soft, then $B_D$ $B_R$ are next to 0 and $C_C$ $C_V$ then we get

$$q \quad {}_P \quad C_V \quad sC_V \text{ or } \quad q \quad {}_P \quad 1 \quad s \; C_V \quad \mathbf{(11)}$$

where ${}_P$ $P_1$ $P_4$ $s \, P_3$ $P_4$ . This implies that ${}_P$ 0 and , which holds if

$$P_1 \quad sP_3 \quad 1 \quad s \; P_4 \quad \mathbf{(12)}$$

That is, the penalty associated to a failure with voluntary safety system $P_1$ must be lower than the weighted mean of both penalties either when the firm do not undertake any measures ($P_4$), or when quasi- voluntary measures are implemented $P_3$ and $P_4$ . According to condition (12), if the retailer imposes its own safety system with certainty, then

$$P_1 \quad P_3$$

in contrast if he does not impose its own safety system, then

$$P_1 \quad P_4$$

These results imply that a well- designed menu of penalties can induce voluntary safety measures adoption. Indeed, if the retailer chooses $P_1$ such that $P_1$ $\min P_2, P_3, P_4$ , then the firm will undertake

a voluntary safety measure. And this holds whatever the mandatory threat, or the probability that the retailer imposes its own safety system. That is, the private incentives provided by the contract with the retailer are very powerful and can be used as a sole mechanism to induce the voluntary adoption of safety measures by the upstream firm.

## 4. Conclusion

In food safety economics the emergence and the multiplication of safety quality management system have raised numerous questions from food safety economists. However, in the food safety literature there is little formal discussion on the voluntary nature of the implementation of safety measures by firms. In our knowledge, there is only two strand of literature dealing with firms' incentives to voluntarily implement safety management system. On the one hand, Segerson (1999) following by Venturini (2003) develops a market model where a firm faces both to the regulator and the consumer to characterize firms' incentives to adopt voluntary safety management system. On the other hand, Noelke-Caswell (2000) suggest a supply chain model to determine firms' incentives to voluntarily implement safety measures.

This paper is an attempt to provide a unified analytical framework of these two strands. We provide two significant results. First, from the "market" model we suggest that a strong mandatory threat from the regulator is a sufficient condition for a voluntary implementation of safety measures be an equilibrium. In contrast to recent papers, we show that neither a differential cost between voluntary and mandatory system (Segerson, 1999) nor the existence of reputation effects (Venturini, 2003) are needed to support such implementation. However, when the mandatory threat is weak, the voluntary adoption of safety measures depends on two complementary mechanisms, a "carrot" (reputation effects) and a "stick"(rule of liability and expected looses according to judicial proceedings). Because safety is a credence attribute of food products there are difficulties in signalling safety to consumers and thus the reputation effect can be very low. Thus, the sole mechanism that induces a voluntary adoption of safety measures is the rule of liability. How to design an efficient rule of liability and how to enforce this rule in case of soft response from consumer are two interesting questions to deal with.

Second, in a "supply chain" model our result suggests that private incentives from the retailer (downstream firm) by designing contracts with the firm (upstream firm) can be used as the exclusive mechanism to induce voluntary adoption of safety measures. These results raise two interesting directions for further research. On the one hand, we could extend our model by exploring how do our results evolve: i) when we introduce moral hazard in the relationship between the firm and the retailer. That is, we should consider that the detection probabilities are endogenous and determined by effort the upstream firm makes in monitoring or in managing the safety products it sells. ii) when even the mandatory system does not satisfy the retailer and this latter imposes its own safety scheme inducing costs for suppliers. On the other hand, our result suggesting that private incentives are the sole mechanism to induce voluntary adoption of safety measures, namely the efficient one, raises welfare issues of the enforcement and the design of safety standard by private parties: What are retailers' incentives in designing, implementing and enforcing management system to provide safer food? Avoiding blame for consumers or capturing the law? What are the consequences and costs on the exclusion and/or the reorganization of suppliers in the food supply chain?

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**Figure1.A Market Model**

Firm

Regulator

r

1- r

q

1- q

q

1- q

p

1- p

**Case 1:** $B_0$-$C_M$-L

**Case2:** $B_M$-$C_M$-L

**Case 1:** $B_M$-$C_M$

**Case2:** $B_M$-$C_M$

**Case 1:** $B_0$-L

**Case2:** $B_0$-L

**Case 1:** $B_0$

**Case2:** $B_0$

**Case 1:** $B_0$-$C_V$-L

**Case2:** $B_V$-$C_V$-L

**Case 1:** $B_V$-$C_V$

**Case2:** $B_V$-$C_V$

**Figure 2.A Supply Chain Model.**

Retailer

*Take it*

*Leave it*

*Out of retailer's market*

Firm

Regulator

q

1- q

$B_V$-$C_V$-L-$P_1$

$B_V$-$C_V$

**Voluntary system**

1-r

r

Retailer

q

1- q

$B_M$-$C_M$-L-$P_2$

$B_M$-$C_M$

**Mandatory system**

s

1- s

q

1- q

q

1- q

$B_C$-$C_C$-L-$P_3$

$B_C$-$C_C$

$B_0$-L-$P_4$

$B_0$

**Quasi- Voluntary system**

**No measures**